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Short Description:
This document identifies a set of interoperability tools and their objectives and requirements in the framework of the WP2 “Comparative Analysis” activities of the GIGAS Project.
Keywords:
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1 Introduction

1.1 Purpose and Scope

The GEOSS INSPIRE and GMES Action in Support (GIGAS) project seeks to carry out a Support Action (SA) aiming at a rapid adoption of standards, protocols and open architectures in support of INSPIRE, GMES, and GEOSS initiatives.

GIGAS will identify and define what is needed to enable a full integration of the architectures of the three initiatives via a consensus.

This document defines the activities of the GIGAS Project aiming to propose tools and contributions to fulfil the interoperability requirements among GEOSS, INSPIRE and GMES.

GIGAS, in the course of these activities, will identify and propose tools and contributions to advance interoperability including the analysis and definition of persistent test-bed and provisions of operation tools.

This document aims to:

- Identify a list of tools supporting interoperability,
- Define these tools in terms of their objectives,
- Present existing examples of similar tools,
- Define requirements for these tools.

During the following Work Package 3 activities the analysis of these tools will continue aiming to identify a self-sustainable governance model for the most relevant ones.

This document is the GIGAS deliverable D2.4 “List of tools and Contributions” as per [AD1].

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

Consensus building is a key element in GIGAS with the goal to setup a consensus building framework and a community. A GIGAS specific consensus building methodology is defined in [AD4].

The interoperability tools to be identified into the present document aim to support the GIGAS consensus building process defined in [AD4].

The GIGAS consensus building process consists of a series of steps. A more precise mapping between the interoperability tools and the GIGAS consensus building process steps will be performed in the next project phases.

1.2 Documents

1.2.1 Applicable Documents

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

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

AD 3. GIGAS Refine Scope and targets Issue 100 31/08/2008

AD 4. GIGAS Consensus Building Methodology 102, 24/10/2008

1.2.2 Reference documents

RD 1. GIGAS Technology Watch Architecture TN

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

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

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

RD 5. GIGAS Technology Watch Catalogue-Metadata-Resource Discovery TN

RD 6. GIGAS Technology Watch Sensor Planning Service TN

RD 7. GIGAS Technology Watch User Management TN

RD 8. GIGAS Technology Watch Ordering TN

RD 9. GIGAS Technology Watch WMS TN

RD 10. GIGAS Technology Watch Observation & Measurements TN

1.3 Acronyms & Glossary

1.3.1 List of Acronyms

Acronym	Description
CEN	Comité Européen de Normalisation or European Committee for Standardisation
DAIL	Data Access Integration Layer
DGIWG	Digital Geospatial Information Working Group
EO	Earth Observation
FE	Feature Expert
FIG	Fèdèration Internationale des Gèometres or International Federation of Surveyors
FP	Framework Program
GEOSS	Global Earth Observation System of Systems
GIGAS	GEOSS INSPIRE and GMES Action in Support
GMES	Global Monitoring for Environment and Security
ICT	Information and Communication Technology
IE	Initiative Expert
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IFP	Initiative Focal Point
INSPIRE	Infrastructure for Spatial Information in the European Community
ISO	International Organization for Standardization
IT WG	Interoperability Tools Working Group
KO	Kick-Off
M WG	Methodology Working Group
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geospatial Consortium
RASDS	Reference Architecture for Space Data Systems
RM	Reference Model

Acronym	Description
RM-OA	Reference Model ORCHESTRA Architecture
RM-ODP	Reference Model Open Distributed Processing
RST WG	Refine Scope & Target Working Group
SANY	Sensor ANYwhere
TBC	To Be Confirmed
TBD	To Be Defined
TBV	To Be Verified
TDWG	Taxonomic Database Working Group
TN	Technical Note
UML	Unified Modeling Language
W3C	World Wide web consortium
WG	Working Group
WMS	Web Map Service
WP	Work Package

1.3.2 Glossary

(Internet) Forum

An Internet forum, or message board, is an online discussion site. People participating in an Internet forum can build bonds with each other and interest groups will easily form around a topic's discussion, subjects dealt within or around sections in the forum.

Testbed

A testbed is a platform for experimentation for large development projects. Testbeds allow for rigorous, transparent and replicable testing of scientific theories, computational tools, and other new technologies.

Wiki

A wiki is a page or collection of Web pages designed to enable anyone who accesses it to contribute or modify content, using a simplified markup language.[1][2] Wikis are often used to create collaborative websites and to power community websites.

1.4 Document Overview

This document consists of the following sections:

- Chapter 1 is an introduction

The subsequent a chapters each describe a possible tool/instrument in terms of objectives and of existing examples. The current version of the document contains the following chapters/tools:

- Chapter 2 defines Community and Consensus building activities
- Chapter 3 defines Interoperability and test programs
- Chapter 4 defines the concept of persistent testbed
- Chapter 5 defines the concept of a meta-testbed
- Chapter 6 defines Open Source Implementations
- Chapter 7 defines possible Communication and Network Tools
- Chapter 8 contains Recommendation,.

Annexes contain

- the requirements identified for persistent testbed and metatestbed
- a proposal for the European SIF .

2 Community & Consensus Building Activities

2.1 Objectives

Nowadays, interoperability is achieved by standardization: communities agree and develop common specifications to address heterogeneities; the objective is to pursue interoperability at different levels, such as:

- Semantic, the objective of which is ensuring the precise meaning of exchanged information is understandable by any application involved;
- Technical, which is concerned with the technical issues of linking up computer systems, the definition of open interfaces, data formats and protocols;
- Organizational, which deals with modeling organizational processes, aligning information architectures with organizational goals, and helping these processes to co-operate.

INSPIRE, GMES and GEOSS are engaged in integrating knowledge stemming from different disciplines about the constituents parts of the complex Sun-Earth system with the objective of understanding its properties as a whole system.

Therefore, the interoperability issues are important and there is a clear need to establish European and international forums for the Earth and Space Systems Science multidisciplinary community, in the framework of the international Spatial Information Community. Valuable examples in point are multidisciplinary Focus Workshop and Focus Groups.

The main objective of these European and international Focus Workshop and Groups is to explore a new science & technology paradigm in order to enable a big-science approach. This includes:

- To discuss the benefits of using IT solution for the Earth and Space Science domains.
- To promote interoperability among the disciplines involved in the study of the Earth System.
- To discuss the profiling and adoption of the present geospatial information standards.
- To conceive cyber-infrastructures/e-infrastructures for service the Earth System Science community and the Decision Makers.
- To establish a new Scientific Community which recognizes informatics and ICT as the fourth pillar of science –in addition to: experimental observations, theory, and computation.

2.2 Existing Examples

2.2.1 AGU-ESSI

The American Geophisics Union (AGU) is a worldwide scientific community that advances, through unselfish cooperation in research, the understanding of Earth and space for the benefit of humanity[1].

AGU is a scientific society with a membership of 50,000 researchers, teachers, and students. AGU conducts meetings and conferences, publishes journals, books and a weekly newspaper, and sponsors a variety of educational and public information programs. The AGU mission is:

- Promote the scientific study of Earth and its environment in space and to disseminate the results to the public,
- Promote cooperation among scientific organizations involved in geophysics and related disciplines,
- Initiate and participate in geophysical research programs,
- Advance the various geophysical disciplines through scientific discussion, publication, and dissemination of information.

The Earth and Space Sciences Informatics Focus Group

AGU's ESSI Focus Group serves to facilitate communications and coordinate activities related to issues of data management and analysis, large-scale computational experimentation and modeling, and the hardware and software infrastructure needs to span the range of scientific topics of interest to the Union[2].

2.2.2 EGU-ESSI

The European Geosciences Union, founded in 2002 as a merger of the European Geophysical Society (EGS) and the European Union of Geosciences (EUG), is a dynamic, innovative, and interdisciplinary learned association devoted to the promotion of[3]:

- the sciences of the Earth and its environment and of planetary and space sciences;
- cooperation between scientists.

The means of achieving these objectives are:

- organize annual General Assemblies;

[1] http://www.agu.org/about/

[2] http://www.agu.org/focus_group/essi/index.html

[3] http://www.egu.eu/home.html

- organize, sponsor or co-sponsor appropriate workshops, scientific meetings, topical conferences, short courses, summer schools, etc. outside General Assemblies, including those organized by other bodies;
- publish a Newsletter;
- publish appropriate scientific journals and books on all media, in particular, online and free-access;
- undertake outreach activities, which should include: identifying and drawing attention to social problems which could be addressed by the scientific work of its members and communication with the non-scientific public;
- establish links which would allow influence to be brought to bear on decision-makers, primarily but not exclusively, in Europe;
- establish liaisons with other scientific organizations, both within and outside Europe, to mutual benefit;
- encourage participation of young scientists in the affairs of the Union through concessionary fees and a limited number of travel awards to assist attendance at General Assemblies.

The Earth and Space Sciences Informatics Division

EGU's ESSI Division was recently established; it serves as a virtual intellectual commons for the international geosciences community discussing and sharing ideas and knowledge on advanced technologies that are of interest to the geospatial science community[4].

Earth and Space system analysis is a real challenge for scientists as much as it is for information technology. In fact, the scope and complexity of the Earth and Space system investigations demand for the formation of distributed, multidisciplinary collaborative teams. The ESSI division aims at facilitating the integration of different discipline information systems, facing the heterogeneity that characterizes their data and metadata models, protocols, interfaces, semantics, and knowledge.

Advanced infrastructures (e.g. e-infrastructure and cyber-infrastructures) will support the formation and operation of the Earth and Space Systems Science Community, based on multidisciplinary knowledge integration. The ESSI division promotes the conceiving the experimentation reports of these infrastructures from a temporal and spatial science point of view – to complement and integrate the technological perspective.

In order to achieve these objectives, the ESSI division promotes and discuss the present process to scale from specific and monolithic systems (data-centric) towards independent and modular (service-oriented) enabling infrastructures. These approach aims to provide scientists, researchers and decision makers with a persistent set of independent services and information that scientists can integrate into a range of more complex analyses.

The ESSI division supports Earth and Space scientists to leverage the recent revolution in information and communication technologies (e.g. Model Driven Architectures (MDA), Service-Oriented Architectures (SOA), semi-structured data model and encodings, etc.) and consequent infrastructures (e.g. Internet, GRID, etc.).

At the EGU General Assembly meeting held in Vienna, 19-24 April 2009, the ESSI sessions will cover the following topics:

[4] http://sites.google.com/a/imaa.cnr.it/egu-essi/Home

- International Informatics Collaborations and Projects
- EU - Africa Cyberinfrastructures
- ESSI Education and Public Outreach
- Biodiversity Informatics
- Informatics in Oceanography
- Earth System Modeling: Strategies and Software
- General System Design, Image Processing and Data Infrastructures
- Data Preservation and Long Term Access
- Data and Metadata Models & Mark-up Languages
- The SOA approach for Earth and Space Sciences
- Semantic Interoperability, Knowledge and Ontologies
- Collaboration Technologies, Social Networking and Web 2.0
- Geosciences Applications on Grid and HPC
- Grid for Geosciences applications
- Virtual Globes and Visualization Tools
- Seismic Visualization

These sessions are organized by more than 30 leading researchers, managers and scientists from Europe as well as from US, Australia and Africa.

2.2.3 GEOSS SIF

The GEO Architecture and Data Committee (ADC) established a Standards and Interoperability Forum (SIF) to facilitate the interchange of information and the development of recommendations for standards and interoperability in GEOSS[5]. The SIF will also oversee the Standards and Interoperability Registry. The purpose of the SIF is to provide advice, expertise and impartial guidance on issues relating to standards and interoperability for GEOSS. The goal of the SIF is to enable ever greater degrees of interoperability among GEOSS components through facilitation, technical analysis, advocacy and education. The SIF is composed of experts nominated by GEO Members and Participating Organizations, and will also draw on subject matter experts globally to support its objectives and goals.

Therefore, the SIF will help GEOSS contributors understand how to work with the GEOSS interoperability guidelines and how to enter their “interoperability arrangements” (standards or other ad hoc arrangements for interoperability) into the GEOSS registries. This will greatly facilitate the utility of GEOSS and encourage significant increase in participation.

[5] http://seabass.ieee.org/groups/geoss/index.php?option=com_content&task=view&id=17&Itemid=61

To carry out its work most effectively, the SIF promotes to form Regional Teams. They will help to organize and optimize the support coming from the different parts of the World and reach out regional and multi-disciplinary Scientific Communities. This will allow to have true global representation in supporting GEOSS interoperability. GIGAS has been supporting the starting phase of the SIF European Team according to the recommendations with details in annex.

2.2.4 OGC GALEON Network

The GALEON OGC-network[6] provides an intellectual commons for continued work on GALEON (Geo-interface to Atmosphere, Land, Earth, Ocean, NetCDF). For the first year, GALEON existed as an OGC WCS Interoperability Experiment (IE) for implementing and testing clients and servers for WCS gateways to netCDF datasets.

GALEON was organized by: Unidata/UCAR, the Italian CNR-IMAA, the George Mason University, and NASA. Presently, the network started an interoperability experiment phase 2.

The objectives of GALEON Phase 2 include:

- Defining and Adopting a "WCS Profile" for CF-netCDF as a WCS encoding format
- Expanding the set of WCS clients, servers, and datasets available for interoperability testing
- Collaborating closely with the OGC GEOSS Services Network (GSN) and the GMLJP2 initiative.
- Developing OGC catalog services (CSW) to complement the WCS interface on GALEON servers.

Collaboration with the OGC Ocean IE is under consideration.

GALEON established a permanent testbed capacity for OGC WCS and CS-W interoperability testing with Fluid Earth Sciences datasets.

GALEON is also open to non-OGC members. For this purpose a Wiki site is available: https://sites.google.com/site/galeonteam/

GALEON objectives is comprised of short term and long term actions. Short term actions include:

- Expanding the set of WCS clients, servers, and datasets available for interoperability testing.
- Developing OGC catalog services (CS-W) to complement the WCS interface on GALEON servers.
- Defining and implementing a "WCS Profile/Extension" for CF-netCDF –possibly for fluid earth scienes domain.

Long term actions include:

[6] http://www.ogcnetwork.net/galeon

- Analyzing fluid earth siences requirements for simple and effective interface specifications to access datasets in a multidisciplinary framework.
- Defining a more general data model for CF-netCDF in order to support different dataset catagories.

2.2.5 INSPIRE SDIC/LMO

The INSPIRE Directive states what needs doing, but the how will be left to Member States[7]. Within this broad framework, the Implementing Rules (IRs) provide the technical guidelines to facilitate the coherent application of the Directive. Such Implementing Rules cannot be developed in isolation but need to take into account the broader international developments in the field of spatial data infrastructures and e-government. But also the many initiatives, operational experiences, and international agreements and protocols already in place across the many thematic and geographical communities having a stake in the development of INSPIRE need to be considered.

With these considerations in mind, an open call was launched on March 11th 2005 for the registration of interest by Spatial Data Interest Communities (SDIC) and Legally Mandated Organizations (LMO). LMO represent those organizations at local, regional, national, or international level that have a formal legal mandate giving them the responsibility for specific thematic data resources. This call 2005 for the registration of interest by SDICs and LMOs remains open on the INSPIRE web site. As part of the open call, SDICs and LMOs were asked to put forward experts and reference material to support the preparation of the Implementing Rules.

The call addressed any organisation or network which has an interest in the spatial information themes and services referred to in the agreed text for the INSPIRE directive . They

- proposed to organise or be part of a community with interests in spatial data for particular uses (SDIC);
- registered as a legally mandated organisation (LMO)
- proposed experts to participate in Drafting Teams working on the preparation of the detailed implementing rules of INSPIRE
- proposed reference material for INSPIRE implementing rules development
- proposed pilot projects to feed or test INSPIRE implementing rules
- provided comments to draft Implementing Rules

This call allowed organisations or networks to become involved in the preparation of the implementation of INSPIRE.

The deadline for the registration of experts was the 29th of April, 2005. By that date, the following had registered on the INSPIRE web site:

[7] http://inspire.jrc.ec.europa.eu/reports/P43-47_GI_06_2005.pdf

- Spatial Data Interest Communities (SDICs): 133;
- Legally Mandate Organisations (LMOs): 82;
- Proposed Experts: 180;
- Referenced Materials: 90;
- • Identified Projects: 91.

The experts proposed are not paid by the European Commission, but are supported instead by the organizations and communities that have nominated them.

Presently, there are 161 registered LMOs and 267 registered SDICs. They also registered 121 projects to implement and test the INSPIRE IRs. They submitted 206 documents as reference material and proposed 227 individuals as potential experts.

2.2.6 ESI Summit

An Earth & Space Science Informatics Summit was convened in Rome 13-14th March 2008 as an Electronic Geophysical Year (eGY) activity[89]. Participants represented the interests of more than 45 leading agencies and initiatives with an interest in geoinformatics. The Summit successfully establishing the basis for better mutual understanding and communication among the leaders of Earth & space science informatics programs worldwide, and confirmed a common resolve to work together cooperatively on data[10] issues that demand a global approach.

This was an Electronic Geophysical Year activity organized by IUGG, IUGS (CGI and OneGeology), and the Earth and Space Science Informatics groups in AGU and EGU. The Summit was hosted by the International Geographical Union at the magnificent Villa Celimontana (Home of Geography) in the gardens adjacent to the Coliseum in the heart of Rome.

Participants noted the extraordinary growth of informatics in the Earth & space sciences, as well as elsewhere, to the extent that informatics is becoming the fourth pillar of the scientific method. At this formative stage, it is inevitable that special interest groups take individual approaches to establishing systems, interoperability protocols, data models, and so forth. Now is a critical time for establishing communication and coordination at the international level to seek uniformity in practices and standards, and reduce replication of effort.

What stood out as the main challenge to be addressed is the lack of infrastructure and governance to (i) cater for the professional needs of scientists and engineers engaged in informatics and (ii) provide an international framework for policy and action. The International Council for Science (ICSU) was recognised as the peak body best positioned to exert the necessary leadership. The Summit applauded the steps already taken by ICSU in

[8] http://www.egy.org/files/ESI_Summit.pdf

[9] http://groups.google.com/group/essisummit

[10] The term ‘data’ is often used generically in the report document to cover the data-information-knowledge continuum, spanning both the science and the engineering.

this regard, and endorsed enthusiastically the recent recommendations of the ICSU's Strategic Committee for Information and Data.

Informatics and data stewardship activities are generally a low priority for research scientists. Further, the present reward systems provide little incentive for change. Participants at the Summit regretted this situation as it fails to reflect the growing importance of informatics and the shift in work load from the user to the provider of data. It also compromises the availability and re-use of data. Some simple, achievable steps to rectify this situation are recognized and listed in the Workshop report document[11].

In addition to the above broad issues, the Summit dealt with a range of technical, community, marketing, and governance issues. The Summit concluded with a stronger sense of common purpose among the participants and a clearer view of the steps needed to establish a productive international framework for governance and leadership. A series of recommendations were developed under the groupings Governance, Professional Structure and Coordination, Technical and Systems, Marketing, Status and Approaches to take.

2.2.7 EC GIS & GI Portal and Workshops and EGIP

The EC GI & GIS portal provides information on European GI & GIS activities including information on GI & GIS activities within the the European Commission[12]. EC GI & GIS organizes Workshops. Over the last few years, the EC GI & GIS Workshops have focused on the development of a European Spatial Data Infrastructure (ESDI) and contribution of SDIs on environmental analyses and modelling.

The European GI Policy (EGIP)[13] is a discussion forum for the exchange of information, opinions and news relating to GI Policy in Europe.

2.2.8 Geoinformatics.info

Geoinformatics.info aims at establishing an information portal for geoinformatics community. Th emain goal ist o serve a communication resource for members oft he geoinformatics resources. Th eportal includes news, announcements of events, links, and other information to share with the geoinformatics comunity[14].

2.2.9 G-OWS Working Group

OGF (Open Grid Forum) and OGC (Open Geospatial Consortium) established a MoU in order to collaborate for the standardization geospatial services implementation on grid-based e-infrastructures/cyber-infrsatructures.

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[11] ESI Summit, Rome. 13-14 March 2008: REPORT

[12] http://www.ec-gis.org/

[13] http://www.ec-gis.org/egip/

[14] http://www.geoinformatics.info/

The G-Lite OGC Web Services (G-OWS) Working Group[15] serves a forum to discuss how to develop the APIs for implementing OWS on the G-Lite middleware of European Grid infrastructure: EGEE (Enabling Grids for E-sciencE).

The main objectives of G-OWS are:

- To address the OGF standardization needs as far as the Earth and Space Science Communiy, GMES and GLite are concerned;
- To establish an open forum to govern the implementation specification for OGC services on the GLite platform. This allows:
- Effective grid-enabled implementations leveraging GLite assets;
- Real interoperability among different implementations;
- To contibute to the OGC-OGF initiative

In a first phase, the following FP6 and FP7 projects are involved:

- CYCLOPS (FP6);
- GENESI DR (FP7);
- DORII (FP7).

Specific sessions are going tob e organized at the OGF meetings.

2.2.10 AGILE

The Association of Geographic Information Laboratories for Europe (AGILE) 16was established in 1998 to promote academic teaching and research on GIS at the European level and to ensure the continuation of the networking activities that have emerged as a result of the EGIS Conferences and the European Science Foundation GISDATA Scientific Programmes.

AGILE seeks to ensure that the views of the geographic information teaching and research community are fully represented in the discussions that take place on future European research agendas. AGILE also provides a permanent scientific forum where geographic information researchers can meet and exchange ideas and experiences at the European level.

Activities of AGILE are managed by an eight person council elected by its members. Its main tasks are to develop an organisational structure to realise the goals of AGILE, to further develop with the help of the

[15] https://sites.google.com/site/gowswg/

[16] http://www.agile-online.org/

members a European research agenda, to instigate and stimulate initiatives, and to organise a yearly GI-conference.

The title of the organisation conveys the following:

- it is an Association
- consisting of geographic information laboratories
- in Europe.

The idea of an Association presents few problems nor does the term "Europe". However, the use of the term "geographic information laboratories" needs some clarification. The term "laboratories" emphasises that this is an association of groups rather than individuals. It also reflects the fact that geographic information teaching and/or research tends to be a group activity in most institutions.

The mission of AGILE is: "*to promote academic teaching and research on GIS at the European level and to ensure the continuation of the networking activities that have emerged as a result of the EGIS Conferences and the European Science Foundation GISDATA Scientific Programme*."
Although rather wordy, the mission statement highlights the two main objectives of AGILE:

- to promote academic teaching and research at the European level. This will be reflected by the organisation of initiatives on specific topics intended to influence the future European geographic information research agenda.
- to facilitate networking activities between geographic information laboratories at the European level. This will be reflected in several different kinds of activity including focused meetings based on state-or-the-art presentations on key research issues and European geographic information research conferences.

3 Interoperability Tests

3.1 Objectives

The objective of an “interoperability test” is to implement an interoperability demonstrator during an activity which has clear interoperability objectives and is performed within a limited time period and with a well-defined number of participants. The result of the interoperability test is a working demonstrator and possibly a set of recommendations to improve specifications and/or software components. Such interoperability tests are also known as “plugfests” or “testbeds”, The infrastructure used to host the demonstrator may be temporary (I.e. disappear after the final demonstration) or in some cases be part of a permanent testbed.

Two types of Interoperability tests can be considered:

- Interoperability “Testbeds” are typically performed in a distributed way and over a period of a few months. They end with a demonstration of a scenario which was agreed at the start, organised at a particular location. Examples are the OGC OWS testbeds.
- “Plugfests” are typically a bit shorter (from a few days to a week) and are done in a central location where the participants meet to perform the interoperability tests. Such plugfests are organised by organisations such as Microsoft, Google or OGC.

3.2 Existing Examples

3.2.1 GEOSS AIP

The GEOSS Architecture Implementation Pilot (AIP) develops and pilots new process and infrastructure components for GEOSS. AIP supports the use of GEOSS resources by multiple Communities of Practice. AIP develops cross-cutting technology solutions to support the CoPs with consistent service oriented architecture approaches. AIP facilitates continuation of the Interoperability Process Pilot Project (IP3) as a means of coordinating cross-disciplinary interoperability studies and pilots.

AIP incorporates GEOSS contributed infrastructure components into pilot implementations of the GEOSS Architecture to augment the operational GEOSS baseline. AIP provides phased delivery of components to the GEO operations task. Each AIP phase consists of: architecture refinement based on user interactions; component interoperability testing; and SBA-focused demonstrations.

As the result of AIP Phase 1 and other GEO Tasks, a GEOSS Common Infrastructure (GCI) has been deployed as an Initial Operating Capability (IOC). The GCI consists of several registry components, three GEO Web Portals and Clearinghouses. The GCI is accessible from the GEO main web site[17].

AIP Phase 2 will augment the GCI IOC. AIP-2 will elaborate the GEOSS Service Oriented Architecture (SOA) and provide persistent exemplar resources to augment the GCI IOC. AIP-2 is defining multiple use cases to describe the reusable technology of an SOA. The use cases are then use to support multiple societal benefit area scenarios. AIP-2 is promoting the registration and testing of services to serve as exemplars. Operational exemplars are planned to persist for several years, with high level of availability, hosted on a reliable network and have plans for performance scaling. AIP-2 is developing a Test Facility for Service Registration. This facility builds on existing test facilities to support organizations who want to test their deployed services before registering them with GEOSS>

3.2.2 OGC Plugfests

An OGC plugfest is an event at which developers gather in a cooperative effort to test and improve interoperability between their product implementations of OGC standards. The procedure is to find problems, document them on a form, deliver the form to the appropriate participant, and work together to fix the problems.

The goals of an OGC Plugfest are to 1) ensure that different products interoperate together as intended, and 2) to attain an 'installed base maturity' in the market by providing a reliable procedure for assuring that OGC specification-based solutions work together. OGC is interested in providing a continuing capability for developers to validate the ability of their products to interoperate with other offerings implementing the same OGC Standards.

[17] http://earthobservations.org/gci_gci.shtml

To achieve this goal, the OGC Plugfest Program will adopt specific guidelines and principles, utilize various test suites from the OGC Compliance Testing Program, and develop a process to test specific aspects of the OGC specifications. If for any reason, the OGC Plugfest Program discovers any problems or difficulties with an OGC specification, it will forward that information back to the OGC Technical Committee.

Each OGC Plugfest event is self-funded through participation fees collected from participants. Each Plugfest is be separately planned and funded in this manner. OGC may engage third-party services and pay that third-party directly for those Plugfest event services on behalf of its participating members.

Individual OGC Plugfest tests address critical “high priority” aspects of existing standards, to promote consistency and compatibility among mainstream products, as well as foster continuous operation in heterogeneous environments. However, the program does not produce industry standards, nor address all required aspects of adherence to industry standards. Additionally, the program does not certify that all adherence to standards and interoperability issues have been addressed. Therefore, the OGC Plugfest program does not certify any combinations of OGC Plugfest branded product will operate error free, or guarantee 100% interoperability. The program is not intended to provide a compliance suite for all portions of all available standards.

3.2.3 OGC Testbeds and Pilots

OGC’s Interoperability Program is a global, hands-on and collaborative prototyping program designed to rapidly develop, test and deliver proven candidate specifications into OGC’s Specification Program, where they are formalized for public release. In OGC’s Interoperability Initiatives, an international team of technology providers’ work together to solve specific geo-processing interoperability problems posed by the initiative’s sponsoring organizations. OGC Interoperability Initiatives include testbeds, pilot projects, and interoperability experiments – all designed to encourage rapid development, testing, validation and adoption of open, consensus based standards.

An OGC IP Testbed is a research and development activity emphasizing the evaluation of what should be in a specification, how the specification should act, and how specification-based software should respond. While development is done during testbeds in terms of defining, documenting, and distributing specifications and in terms of developing prototypical software that exercises the specification, this development is generally along the lines of proof-of-concept rather than in deliverable software.

The OGC organises OGC Web Services (OWS) testbeds on roughly a yearly basis . OWS testbeds engage a number of participants to implement a scenario proposed by the „sponsors“ in a short timeframe, typically between 6 and 9 months. The results of an interoperability testbed are Engineering Reports which document the findings and issues encountered during the testbed. These ER documents are provide to the OGC specification program to improve existing specifications or initiate the development of new ones.

An OGC Pilot is a collaborative effort that applies the OGC Technical Baseline and other (non-OGC) technologies to Sponsor scenarios. In practice, a Pilot is where OGC specifications 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.

3.2.4 GALEON IE

GALEON is an OGC Interoperability Experiment (IE). While being an element of the OGC Interoperability Program, IEs are managed and operated mostly by OGC member organizations. The process is facilitated – not led – by an OGC staff person. This approach is in contrast to OGC Testbeds and Pilots which are managed by OGC staff.

The OGC "Geo-interface for Atmosphere, Land, Earth, and Ocean netCDF" (GALEON) Interoperability Experiment supports open access to atmospheric and oceanographic modeling and simulation outputs.

The GALEON IE implements a geo-interface to netCDF datasets via the OGC Web Coverage Server (WCS 1.0) standard. The interface provides interoperability among netCDF, OPeNDAP, ADDE, and THREDDS client/server and catalog protocols. The IE generates change requests to the WCS and other OpenGIS specifications.

3.2.5 AGILE/OGC/EuroSDR PTB

A project to establish a persistent geospatial interoperability test-bed (PTB) was commissioned in 2007 by the OGC, Association of Geographic Information Laboratories in Europe (AGILE) and Commission 5 (Networks) of the European Spatial Data Research (EuroSDR) organisation.

The PTB was established as recognition of the need to explore new and innovative approaches for facilitating interoperability between OGC web services. Further, the recent publishing of the INSPIRE directive acted as motivation for a European-oriented test-bed initiative (CITE INSPIRE Directive and Data Models).

The PTB would stimulate collaboration in geospatial and SDI research.

4 Persistent Testbed

4.1 Objectives

In order to fulfil the needs of the current users/customers of geoinformation in Spatial Data Infrastructures (SDI) in terms of high-level operational information services, it is necessary to integrate geospatial data and geospatial information services of various sources (Earth observation, in-situ, simulations, etc.). The complexity of this next generation of integrated services may also require a network of partners who will contribute to the production of information services.

To this end, the identification of a set of common SDI related standards for services and data and the support of a neutral and open service-enabling environment becomes mandatory to respond to the need for geospatial services and “information products” closer to user expectations and processes (easily understandable and ready-to-use).

The envisaged testbed aims to fulfil the above objectives and it is assumed to provide

- An open, permanent infrastructure in which organisations or external projects (e.g. EC projects, OGC FEDEO etc.) can integrate their (compliant) services.
- A permanent test environment to design, develop and test new services and service interfaces and to foster related research by to offering a *sandbox* for not yet established services
- Optionally conformance test tools (as for example CITE),
- A set of tools supporting the target interfaces (ideally offered as freely available open source tools),

The testbed would provide a mechanism for organizations to share data and services capability increasing the productivity of research by reducing duplication. It would also provide a benchmark for other consortiums to compare their geospatial service-oriented architectures against.

The persistent character of the testbed allows a more sustainable usage of itself, especially for teaching purposes.

The testbed is designed to provide a valid support in any standardization and harmonization process including

- offering a platform to test interoperability
- verifying the standards in use,
- identifying gaps vis a vis requirements,
- defining the requirements for new or updated standards for an increased interoperability and multiple mission inter-accessibility,
- helping to derive new requirements/scenarios

Additional objectives/features of the testbed are the capabilities to

- Allow rapid prototyping of servers for
    - Further protocol design,
    - Service development,
- Offer a one stop shop for geospatial
    - Development,
    - Testing,
    - Integration.

4.2 Existing Examples

4.2.1 AGILE/OGC/EuroSDR PTB

In the context of the AGILE/OGC/EuroSDR Persistent Testbed for Research and Teaching (see Chapter 3 for more information about the PTB) four use cases for demonstrating geospatial interoperability were developed, with the aim being to eventually expand the use cases to include more service providers. Consequently Phase 1 of the project involved pilot use cases on:

- Schematisation (Centre for Geospatial Science (CGS) at the University of Nottingham and the International Institute for Geo-Information Science and Earth Observation (ITC))
- Secure portrayal (Universität der Bundeswehr München and EDINA at the University of Edinburgh)
- Fog monitoring (Newcastle University and Universität Rostock)
- Semantic web services (Institute for Geoinformatics, Universität Münster)

In order to overcome funding constraints, the use cases reused products of recent projects. In the next phase, which is currently starting, more use cases will be added and integrated into the testbed.

4.2.2 Service Support Environment

The concept of support environments refer to neutrally managed, open and distributed platforms that streamline the definition and prototyping of (EO and Geospatial) Information Services integrating a wide range of data. Each platform is a kind of portal which should implement an open service-oriented and distributed environment, enabling the orchestration and integration of data and services from multiple sources.

Support environments play a key role in supporting competitiveness and uptake of standards.

The permanent service-enabling environment facilitates service provision and orchestration, allowing each organisation to exploit the know-how and service provision ability of the others, also for the creation of new services from a horizontal set of basic services supplied by multiple service providers.

A platform satisfying the above features is a key element and a valid support to

- widen range of actors involved in standardisation and prototyping (sme, institutional, university,…),
- widen implementation base,
- shorten development length,
- foster cooperation across developers and users,

The platform works to:

- Orchestrate synchronous and asynchronous Web Services for online and offline processes

- Provide an overarching infrastructure, neutrally managed by a supervising body
- Integrate the access to (EO) data within service prototyping and delivery
- Empower service providers through a business process management platform
- Minimize service providers' upfront investments
- Allow the use of Open standards to facilitate adoption and evolution
- Facilitate the integration of satellite data and geospatial information within the processing and exploitation chains

Support environments are a key solution for multiple classes of individuals including

- Developers

  Experiment fast prototyping and service design processes automating the task execution, work with the best technologies and standards, find mutual support for most development problems, improve skills by sharing ideas with other professionals.

- Service Managers

  Speed up service delivery to the end-user, leverage the investments in IT and find new business opportunities.

- Service Designers

  Create new services by integrating a wide range of heterogeneous (EO and Geospatial) information services, including product catalogues, innovate the (EO) field by sharing ideas and skills with its best professionals.

Moreover Support environments allow to:

- Easily access multiple sources of data
- Chain basic services into a complex one directly deliverable to the users
- Browse a distributed digital library of information services
- Join and share knowledge with the best professionals of the field
- Find new partners to innovate products
- Disseminate R&D projects, skills and value
- Advertise and integrate new and existing services
- Support the evolution and maintenance of services

- Integrate services from multiple domains, e.g. geospatial, meteorological, in-situ, EO

Support environments include also support services aiming to boost development and business and tools to spread the knowledge and skills present in the network/community.

The ESA Ground Segment Department in ESRIN (Frascati) is making available a Service Support Environment called SSE (http://services.eoportal.org) to internal and external projects and initiatives wanting to perform interoperability tests. The environment is available since 2003 and its operation is currently funded through the ESA EOP-G Framecontract task 3.

The following is a list of projects and initiatives which have used the environment for part of their work or have proven integration with the environment to work:

- ESA HMA-I, HMA-T, CoMu, COPS-B, COPS, ESIT, NSI, SAS
- FP6 ORCHESTRA, FP6 WIN
- FP6 SANY, FP6 BOSS4GMES, FP6 InterRisk
- OGC OWS-4, OWS-5 and OWS-6 testbeds.
- GEOSS AIP: the three GEOSS Clearinghouse candidates were made accessible through the SSE Portal end of 2007.

The SSE Environment allows external „service providers“ to publish Web services through a Portal and orchestrate them with a workflow engine. The fully distributed environment uses open standards from W3C, OASIS, OGC, ISO which facilitate the integration of external components and services. Although the environment mainly provides access to Earth Observation (EO) – related services, it is not limited to Earth Observation. For instance, sensor-related services from the OGC SWE initiative were successfully integrated by projects such as COMU, COPS-B and FP6 SANY.

The environment also provides access to:

- Various open-source software components,
- A conformance test environment based on the TEAM engine and the CTL language also adopted by the OGC, allows implementers to check compliance of their HMA-compliant interfaces.

Support to external users of the environment is provided by an on-site team, and various resources such as a Wiki and Forum (http://wiki.services.eoportal.org).

5 Meta Testbed

5.1 Objectives

It is commonly agreed, that testbeds serve as a major tool for testing interoperability of web services and the exchange of data.

Beside prominent testbeds like the German GDI-NRW testbeds (rather historical now) and OGC's Web Service – Phase X (currently OWS-6) testbeds, a lot of other rather unknown testbeds do exist, most of them exist only for a limited life-span or focus on a specifiv geographical or thematic area.

In contrast there are initiatives (as the AGILE/OGC/EuroSDR Persistent Testbed for Research and Teaching) which propose a rather unlimited life-span. The life-span is only one key aspect among a lot of others. The objectives of the existing testbeds are rather heterogenous. They lead from solving problems from a very specific problem domain to providing long-term service availability for e. g. teaching purposes.

A central registry is needed to outline and summarise all these aspects of current testbeds, perhaps also to provide taxonomy of test beds and to make them available for interested public.

Such a communication and integration platform could be named Meta Testbed.

This Meta Testbed would foster and ease the participation of international teams of technology providers and researchers in testbeds. Hence, they are able to concentrate on solving specific geo-related interoperability problems in already existing testbeds instead of using their brainpower to create a testbed infrastructure on their own using only own services to test again.

To conclude, within the frame of the GIGAS project a Meta Testbed Platform should be established, i.e. a web portal informing about the various existing (European) testbeds and their:

- objectives (e. g. call for participation),
- participation criteria (e. g. usage/license constraints, level of publicity, commercial aspects),
- proposed life-span,
- partners with their contact persons,
- an overall testbed contact point and URL
- funding informations, etc.

Additionally, it should serve as a knowledge base for upcoming testbeds, informing about issues related to establishing own testbeds offer acces to user groups and so forth.

There are a number of major objectives of the meta testbed:

- The main goal is to give an overview about potential testbeds to participate in for researchers and technology providers.

- Furthermore, make testbed metadata queryable/searchable like in the concept of registries or catalogue services.
- Collecting/publishing issues to be considered for upcoming or own testbeds to be established.
- Link to other groups that share the same interest in testing interoperability for a specific topic, area, or technology

5.2 Existing Examples

To our knowledge, there are no existing examples. The concept is partly similar to a geoportal, with the difference, that testbed metadata is query able and searchable instead of web service or data metadata.

6 Open Source Implementations

6.1 Objectives

The base idea from OpenSource or Free Software results from the core principle of science. Traditionally, science is based on free exchange of knowledge and mind. Animated by this principle, the Free Software Foundation (FSF) was established in 1984. The FSF propagates the free exchange of knowledge in the form of programmed pieces of software.

The FSF defines the following four freedoms for Free Software (http://www.fsf.org/philosophy/free-sw.html):

- *The freedom to run the program, for any purpose (freedom 0).*
- *The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.*
- *The freedom to redistribute copies so you can help your neighbor (freedom 2).*
- *The freedom to improve the program, and release your improvements (and modified versions in general) to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.*

The Open Source Initiative (OSI) attempted to widespread the term *Open Source* for free software to create a protected notion and a marketing program. The definition coincides with the four freedoms from FSF.

To protect the rights and freedoms of software, a large number of Open Source licenses do exist. They not only grant the freedoms, but do protect them in various degrees. The most prominent example, the GNU General Public License (GPL), states, that software, which contains pieces or libraries licensed by GNU GPL, have to be licensed in the GNU GPL itself. Other license models (e. g. the GNU Lesser General Public License) grants the freedoms, but do not protect them.

Free and open interfaces and data formats (e. g. OGC specifications) are independently form Free Software. They serve the free exchange of information, for example between the various components and services in a Spatial Data Infrastructure. A standardization of interfaces and data formats is not necessarily part of the basic concept of Free Software, but supports it significantly.

To summarize, free or open source software is a development and distribution method for software that is normally distributed peer reviewed and created following a transparent process. Hence, it promises better quality, more reliability and flexibility and has lower costs. By using it – in the best case in combination with open interface and data format standards – the dependency to proprietary software vendors is reduced.

6.2 Existing Examples

6.2.1 HMA Tools

Open-source tools are already provided and being prepared to facilitate the implementation of the interfaces from the Contributing Missions with the GMES Space Component CDS. ESA is financing (extension) of the following open-source implementations:

- "SSE Toolbox": facilitates the creation of a Web services façade to a legacy infrastructure. Is downloadable from http://services.eoportal.org ("Software").
- "ERGO catalogue": implements a catalogue supporting the EO (OGC 06-131) and CIM (OGC 07-038) extension packages for CSW ebRIM Application profile. The CIM extension package defines how to store ISO 19139 metadata in an OGC CSW ebRIM Application Profile catalogue. More information at http://wiki.services.eoportal.org/tiki-index.php?page=ERGO+EbRIM+Implementation+with+GEONETWORK+and+OMAR
- "HMA Skeleton": implements a simple client and can also simulate a service back-end supporting one of the GMES CDS interfaces such as OGC 06-131, OGC 06-141, OGC 07-018, OGC 07-038, OGC 07-118. It can be downloaded from http://wiki.services.eoportal.org/tiki-index.php?page=HMA+Skeleton

6.2.2 The Open Source Geospatial Foundation (OSGEO)

The Open Source Geospatial Foundation, or OSGeo, is a not-for-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data. The foundation provides financial, organizational and legal support to the broader open source geospatial community. It also serves as an independent legal entity to which community members can contribute code, funding and other resources, secure in the knowledge that their contributions will be maintained for public benefit. OSGeo also serves as an outreach and advocacy organization for the open source geospatial community, and provides a common forum and shared infrastructure for improving cross-project collaboration.

The foundation's projects are all freely available and useable under an OSI-certified open source license.

The following more detailed goals support the overall mission:

- To provide resources for foundation projects - eg. infrastructure, funding, legal.
- To promote freely available geodata - free software is useless without data.
- To promote the use of open source software in the geospatial industry (not just foundation software) - eg. PR, training, outreach.

- To encourage the implementation of open standards and standards-based interoperability in foundation projects.
- To ensure a high degree of quality in foundation projects in order to build and preserve the foundation "brand".
- To make foundation and related software more accessible to end users - eg. binary "stack" builds, cross package documentation.
- To provide support for the use of OSGeo software in education via curriculum development, outreach, and support.
- To encourage communication and cooperation between OSGeo communities on different language (eg. Java/C/Python) and operating system (eg. Win32, Unix, MacOS) platforms.
- To support use and contribution to foundation projects from the worldwide community through internationalization of software and community outreach.
- To operate an annual OSGeo Conference, possibly in cooperation with related efforts (eg. EOGEO).
- To award the Sol Katz award for service to the OSGeo community.

Prominent examples of projects summarized under the OSGEO umbrella are:

- degree
- UMN Mapserver
- OpenLayers
- GRASS GIS
- GDAL/OGR

6.2.3 Common GI Tools and Frameworks

A lot of open source software tools and frameworks do exist in the geospatial domain. Following is an unfinished list of common and widespread software for the web:

- 52°North – Initiative for Geospatial Open Software: International research and development company whose mission is to promote the conception, development and application of free open source geo-software for research, education, training and practical use. 52°North backs an open initiative, which is driven by leading research organizations and individuals in the international GIS field. Cooperation partners participate in research and development with focii on Sensor Web Enablement (SWE), Web Security and Geo-Rights Management, as well as Geo-Processing. (http://52north.org)
- Deegree – Free Software for Spatial Data Infrastructures: deegree supplies the building blocks of a Spatial Data Infrastructure, while implementing the standards of the Open Geospatial Consortium (OGC) and ISO/TC 211

- Geoserver: GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS).
- JUMP: The foundation of The JUMP-Project is a suite of free, open-source applications that provide an extensible API and graphic user interface (GUI) for viewing and manipulating spatial data-sets.
- Open Layers: OpenLayers is a pure JavaScript library for displaying map data in most modern web browsers, with no server-side dependencies.
- University of Minnesota Mapserver: MapServer is an open source development environment for building spatially-enabled web mapping applications and services. It is fast, flexible, reliable and can be integratated into just about any GIS environment. Originally developed at the University of Minnesota, MapServer is now maintained by developers around the world.
- User-friendly desktop internet GIS (uDig): The goal of uDig is to provide a complete Java solution for desktop GIS data access, editing, and viewing with a strong focus on enabling clients for OGC web services.

Besides, a large number of geospatial software libraries do exist. Prominent examples are:

- Geotools: GeoTools is an open source (LGPL) Java code library which provides standards compliant methods for the manipulation of geospatial data. The GeoTools library implements Open Geospatial Consortium (OGC) specifications as they are developed, in close collaboration with the GeoAPI project.
- JTS Java Topology Suite: The JTS Topology Suite is an API for modelling and manipulating 2-dimensional linear geometry. It provides numerous geometric predicates and functions. JTS conforms to the Simple Features Specification for SQL published by the Open GIS Consortium.
- GDAL/OGR: The Geospatial Data Abstraction Library (GDAL/OGR) is a cross platform C++ translator library for raster and vector geospatial data formats. Currently, it is used in many GIS software, e. g. GRASS, ArcGIS, ILWIS and Google Earth.

Classical examples of desktop and non-distributed GIS are:

- GRASS: GRASS (Geographic Resources Analysis Support System) is a Software for performing spatial analysis. It consists of more than 350 modules for processing vector (2D/3D), raster and voxel data. Many interfaces to other programs in related domains like geostatistics, databases, mapserver and even other GIS software exist. It can serve as a Desktop GIS and as the backbone of a complete GIS infrastructure.
- ILWIS: ILWIS is a remote sensing and GIS software which integrates image, vector and thematic data in one unique and powerful package on the desktop.

A more or less complete list of existing geospatial open source software is provided by the freegis.org website (http://freegis.org).

7 Communication and Networking Tools

7.1 Objectives

Communication and Networking tools are support services (aiming to boost development and business) and tools to spread the knowledge and skills present in the network/community.

These support services help to:

- reach excellence in one's work;
- get in touch every day with other professionals in the same domain;
- find new opportunities to develop technologies, standards and services.

The support services are led by the professionals of the field mutual and are a support for the developers, resources & expertise sharing, partner searching, and more.

Examples of support services are:

- Moderated Forums,
- Wikis,
- RSS feeds,
- Directory information (e.g. social networks),
- Email reflectors,
- Blogs.

Communication and Networking tools are a key solution for multiple classes of individuals including

- Developers

  Discuss about technologies and standards, find mutual support for development and integration problems, improve skills by sharing ideas with other professionals.

- Service Designers

  Innovate the field by sharing ideas and skills with its best professionals.

Moreover Communication and Networking allow to:

- Easily link and access information and tools from multiple sources
- Join and share knowledge with the best professionals of the field

- Find new partners to innovate products
- Disseminate R&D project results, skills and value
- Advertise existing services and tools

7.2 Existing Examples

7.2.1 Service Support Environment „Join and Share“ Area

The ESA Ground Segment Department in ESRIN (Frascati) is making available this networking tool (http://wiki.services.eoportal.org) to internal and external projects and initiatives wanting to perform interoperability tests (See also section 4.2.2). Support to external users of the environment is provided by an on-site team, and various communications and networking tools such as a Web Portal, Wiki with RSS feeds, Blog and Forum.

7.2.2 Mail reflectors

To communicate easily on the web via emails, various mailing lists do exist. Usually, these mailing lists are available to everyone to read and comment. They can be used from just announcing activities (unidirectional) to discussing intensively over certain topics (bidirectional). The most common mailing reflectors for the European GI community are the regional GSDI list “sdi-europe” (http://lists.gsdi.org/mailman/listinfo/sdi-europe) and the European GI Policy Discussion Forum (EGIP) list maintained by the SDI Unit of the Joint Research Centre (http://www.ec-gis.org/egip/).

7.2.3 European INSPIRE Geoportal

The INSPIRE Community Geoportal is Europe's Internet access point to a collection of geographic data and services within the framework of the infrastructure for Spatial Information in Europe (INSPIRE) Directive. INSPIRE aims at making available relevant, harmonised and quality geographic information to support formulation, implementation, monitoring and evaluation of policies and activities which have a direct or indirect impact on the environment. The geoportal does not store or maintain the data. It acts as a gateway to geographic data and services, distributed around Europe, allowing users to search, view or, subject to access restrictions, download geographic data or use available services to derive information.

The portal is under ongoing development. It should be up and running in May 2010 (see the INSPIRE Roadmap on http://inspire.jrc.ec.europa.eu/). Currently, a Metadata Catalogue, a Map Client and the INSPIRE Metadata Editor are available.

8 Recommendations

It is proposed from the analysis of the interoperability tools in GIGAS WP2 to WP3 that the following recommendations are considered for further implementation:

8.1 REC-IT-001 Persistent Testbed

It is recommended to GIGAS to define a sustainable model for a persistent test-bed so that uptake of standards by industry and institutions is eased.

The envisaged testbed is assumed to provide

- An open, permanent infrastructure in which organisations or external projects can integrate their (compliant) services.
- A permanent test environment to design, develop and test new services and service interfaces and to foster related research by to offering a sandbox for not yet established services
- Optionally conformance test tools (as for example CITE),
- A set of tools supporting the target interfaces (ideally offered as freely available open source tools),

Requirements for a persistent testbed are in Annex.

8.2 REC-IT-002 Meta testbed

It is recommended to GIGAS to define a sustainable model for a meta testbed aiming to foster and ease the participation of international teams of technology providers and researchers in testbeds.

The Meta Testbed concept refers to a web portal informing about the various existing (European) testbeds and their issues including:

- objectives (e. g. call for participation),
- participation criteria (e. g. usage/license constraints, level of publicity, commercial aspects),
- proposed life-span,
- partners with their contact persons,
- an overall testbed contact point and URL
- funding informations, etc.

Requirements for a meta testbed are in Annex.

8.3 REC-IT-003 SIF European Team

It is recommended that GIGAS supports the creation of the GEOSS SIF European Team and plays a leading role inside.

The purpose of having a European Regional Team is to increase efficiency in carrying out the work of the SIF, addressing issues such as:

- bring local knowledge;
- reach out multi-disciplinary and regional science Communities;
- provide knowledge and experts about regional standard and interoperability arrangements;
- support the SIF to complete the tasks submitted by Communities.
- teleconferences effectiveness (e.g. minimizing time zone differences);A proposal for the SIF European Team is in Annex.

8.4 REC-IT-004 Synergy and Exploitation of Existing Resources

It is recommended that GIGAS identifies synergies with the following initiatives/programs:

- The GEOSS Common Infrastructure Initial Operating GCI IOC could be used as a basis for interoperability testing between GIGAS initiatives.
- The GEOSS AIP-2 Use Cases, Persistent Exemplars Services, and Test Facility for Service Registration could be a basis for interoperability testing between GIGAS initiatives.
- OGC Testbeds could be used by the sponsoring organizations of GIGAS Initiatives to develop specifications for new areas of interoperability.
- OGC Pilots could be used by the sponsoring organizations of GIGAS Initiatives to develop Best Practices for using open standards for interoperability.
- OGC Interoperability Experiments could be used to focus on specific interoperability refinement for GIGAS.
- The ESA Service Support Environment services and opportunities could be used to support the GIGAS interoperability initiatives.

8.5 REC-IT-005 Methodology

It is recommended that GIGAS promotes the use of the methodology defined for GIGAS WP2 technology watch in [AD2] to ensure harmonisation within and across initiatives and programs.

9 Annexes

9.1 Persistent Testbed Requirements

9.1.1 General

GIG-PT-GEN-100 The testbed shall support interoperability and compliance testing of web services.

GIG-PT-GEN-110 The testbed shall provide a research environment for web services architecture work (and teaching).

GIG-PT-GEN-120 The testbed shall provide an infrastructure enabling the business to business interactions among service providers and with users.

GIG-PT-GEN-130 The testbed shall be persistent.

GIG-PT-GEN-140 The testbed shall be focused on EO.

GIG-PT-GEN-150 The testbed shall host multiple services and datasets.

GIG-PT-GEN-160 The testbed shall provide a stable set of services to facilitate web service composition and chaining in scientific manner (repeatable results).

GIG-PT-GEN-170 The testbed shall be based on open standards.

GIG-PT-GEN-180 The testbed shall be able to be used as a sandbox area for non-stable services.

GIG-PT-GEN-190 The testbed shall support distributed architectures.

GIG-PT-GEN-200 The testbed shall maintain a reference implementation of the supported services.

GIG-PT-GEN-210 The testbed shall have its own web hosting for a wider visibility and a neutral identification.

GIG-PT-GEN-220 The testbed shall have web presence (e.g. on the OGC Network).

GIG-PT-GEN-230 The testbed shall be connected to catalogues, to facilitate the discovery of services offered.

GIG-PT-GEN-240 The testbed shall support the evolution and maintenance of services.

GIG-PT-GEN-250 The testbed shall be scalable.

GIG-PT-GEN-260 The testbed services (processing and data) shall be available without licensing restrictions.

GIG-PT-GEN-270 The testbed shall be provided with manuals documenting each service and dataset.

GIG-PT-GEN-280 The testbed reliability, availability and maintainability figures shall be compatible with the expected use and accessibility from the contributors.

9.1.2 Functional

GIG-PT-FUN-100 The testbed shall support service chaining (e.g. via BPEL).

GIG-PT-FUN-110 The testbed shall support portrayal services.

GIG-PT-FUN-120 The testbed shall support catalogue services (ebRIM/CSW).

GIG-PT-FUN-130 The testbed shall be able to plug into catalogue instances.

GIG-PT-FUN-140 The testbed shall support testing of WFS-T and WMS-C.

GIG-PT-FUN-150 The testbed shall support data exchange via WFS, WFS-T, GML.

GIG-PT-FUN-160 The testbed shall support testing of WPS.

GIG-PT-FUN-170 The testbed shall support testing of Web terrain services.

GIG-PT-FUN-180 The testbed shall support testing of Ordinary SOAP services gazetteer.

GIG-PT-FUN-190 The testbed shall be a platform to test specifications.

GIG-PT-FUN-200 The testbed shall be a tool for conformance testing on OGC and other standards.

GIG-PT-FUN-210 The testbed shall be designed as a starting point for compliance testing INSPIRE IR.

GIG-PT-FUN-220 The testbed shall support semantic issues.

GIG-PT-FUN-230 The testbed shall host helper services for schematization (maximal alignment of geometry to a grid and topologically consistent grid-alignment).

9.1.3 Interface

GIG-PT-INT-100 The testbed shall be an open system into which, at later stages, additional services and functions can be added.

GIG-PT-INT-110 The testbed architecture shall allow for easy integration of new services, possibly without any need for additional software development, or shutdown of the system.

GIG-PT-INT-120 It shall be possible to increase the testbed service portfolio with new service or service types without changing the testbed architecture.

GIG-PT-INT-130 The testbed shall support schema transformation services (e.g. from Orchestra project).

GIG-PT-INT-140 The testbed shall support SOAP wrappers for OGC services (conformant with Orchestra service types, but could be adapted to correspond to OGC interfaces)

GIG-PT-INT-150 The testbed shall be able to host/manage additional international (non-European) data.

GIG-PT-INT-160 The testbed shall allow basic and end-to-end services to remain on the service provider infrastructure

GIG-PT-INT-170 The testbed shall integrate services from multiple domains, e.g. geospatial, meteorological, in-situ, to exploit multi-domain synergies

GIG-PT-INT-180 The testbed shall be able to interface and exchange data with

- GeoNetwork,

- OpenLayers,
- Corine.

9.1.4 Security

GIG-PT-SEC-100 The testbed shall be a tool for analyzing security aspects of geoservices.

GIG-PT-SEC-110 The testbed shall support the application of general IT security standards

GIG-PT-SEC-120 The testbed shall allow testing diverse combinations of services to test security elements.

GIG-PT-SEC-130 The testbed shall use a Virtual Private Network (VPN) for basic security among testbed participants.

9.2 Meta Testbed Requirements

9.2.1 General

GIG-MT-GEN-100 The Meta-Testbed shall be a permanent infrastructure.

GIG-MT-GEN-110 The Meta-Testbed shall be maintained via a self-sustainable mechanism.

GIG-MT-GEN-110 The Meta-Testbed shall be Database driven to optimise queries and searching.

9.3 Proposal for the SIF European Team

9.3.1 Objectives

To help advance the interoperability goals of the Global Earth Observing System of Systems (GEOSS), the Group on Earth Observations (GEO) Architecture and Data Committee (ADC) has established a Standards and Interoperability Forum (SIF) to support GEO organizations offering components and services to GEOSS.

The SIF will help GEOSS contributors understand how to work with the GEOSS interoperability guidelines and how to enter their “interoperability arrangements” (standards or other ad hoc arrangements for interoperability) into the GEOSS registries. This will greatly facilitate the utility of GEOSS and encourage significant increase in participation.

To carry out its work most effectively, the SIF promotes to form Regional Teams. They will help to organize and optimize the support coming from the different parts of the World and reach out regional and multi-disciplinary Scientific Communities. This will allow to have true global representation in supporting GEOSS interoperability. A SIF European Team is foreseen.

The main role of the SIF is facilitating interoperability and working with members and participating organizations as they offer data and information services to the users of GEOSS. In this framework, the purpose of having a European Regional Team is to increase efficiency in carrying out the work of the SIF, addressing issues such as:

- bring local knowledge;
- reach out multi-disciplinary and regional science Communities;
- provide knowledge and experts about regional standard and interoperability arrangements;
- support the SIF to complete the tasks submitted by Communities.
- teleconferences effectiveness (e.g. minimizing time zone differences);

The European Regional team will identify subject matter experts representing each (or most) of the Societal Benefit Areas of GEOSS in Europe.

The European Regional team will facilitate the registration of European standards and interoperability best practices (e.g. special arrangements).

The European Regional team will be prepared to review standards and special arrangements submitted for entry into the standards registry.

The European Regional team will help reach out to scientific Communities in Europe, as far as GEOSS is concerned.

9.3.2 Structure and roles

Role	Task
The Team of experts	The European Regional Team will consist of experts with an understanding of the protocols, standard arrangements and other technological practices for Europe, representing each (or most) of the societal benefit areas of GEOSS. Experts will be considered for the following GEOSS sectors: • Data and Architecture; • Disaster; • Health; • Energy; • Climate; • Water; • Weather; • Ecosystems; • Agriculture; • Biodiversity.
Sector Experts	The sector experts are the members of the SIF Regional Team. The regional expert names will be inserted in the SIF experts database. The team members will discuss the Regional Team positions and will carry out the tasks assigned by SIF.
Lead	The lead of the European Regional Team will serve as the regional representative on the SIF.
Executive Committee	An Executive Committee will support the lead of the regional Team. The committee may be structured in secretaries.

Table 1 European SIF Roles

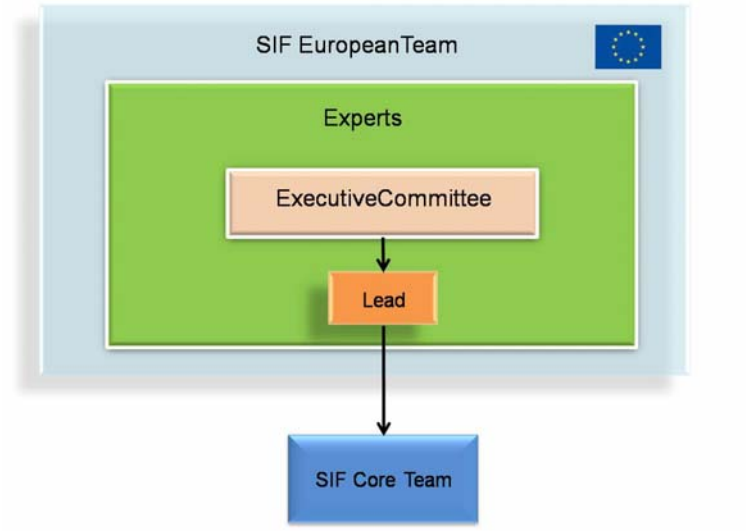

Figure 1 European SIF Regional Team structure

9.3.3 Workflow

According to the SIF process (see the SIF Task Workflow), interoperability arrangements that are submitted to the SIF for consideration will be directed to regional teams for review.

The regional teams will analyze and provide an opinion on the acceptability of this arrangement, based on criteria established by the SIF.

These recommendations will then go to the SIF for consideration and disposition with the original submitter.

The regional experts may contact and support the interoperability arrangements submitter, according to the SIF procedure.

9.3.4 Effort

The participation in the regional activities will be by telephone and email exchange.

The lead of the regional Team will attend one to two meetings per year where travel may be required.

9.3.5 Deliverables

- Review tasks as assigned by the SIF core team.
- A periodic report on SIF activities;
- A periodic report on the Regional Team activities.

9.3.6 Structure Implementation

Phases

The SIF European Team is going to be implemented in two phases:

1) a starting and preparatory phase;

2) a regime phase.

Preparatory phase

We are in the starting and preparatory phase. In fact, GIGAS has been supporting this phase by facilitating and supporting the regional Team constitution. Actually, GIGAS devoted part of its resources to start up the Team and provide the pro-tempore lead (point of contact: Stefano Nativi). This is in the scope of the project funded by the EC in the framework of the FP7. This phase may coincide with the duration of the GIGAS project.

The Regional Team point of contact has participated to the SIF conference and workshops providing support for registering European components, such as HMA. He will attend the first face-to-face SIF meeting in Washington D.C., presenting the GIGAS actions on SIF. The Team was recently presented at the OGC European Forum held in Darmstadt, October 2009: a possible liaison is under discussion.

Regime phase

In a regime phase, the Team will be constituted by expert nominated by European Organizations and Projects through open calls.

9.3.7 Preparatory Roadmap

Date	Step	Note
4 Sep 2008	European Regional Team Draft proposal	To GIGAS Executive Committee
10 Sep 2008	European Regional Team Final Draft	To GIGAS Steering Committee
21-24 Sep 2008	Presentation to the ADC meeting (Boulder)	To ADC
28-29 Jan 2009	Presentation to the GIGAS workshop (Brussels)	To the European stakeholders
19-24 April 2009	Presentation to the EGU General Assembly Meeting	To Geosciences Community
1 Oct 2009	Presentation to the OGC European Forum (Darmstadt)	To OGC European Community

12-13 Nov 2009	First face-to-face SIF Regional Meeting, (Washington D.C.)	To GEOSS SIF

Table 2 European SIF Schedule

9.3.8 GIGAS Resources

In order to prepare a plan and support the preparatory phase, GIGAS project needs an estimation of the GIGAS resources (how many experts, how many hours per year/month) to be allocated for the SIF European Team activities.

On the basis of the resource estimate, GIGAS will assign a task to support the SIF European Team.