DISTRIBUTED SERVICES FOR INTEGRATED MANAGEMENT OF EARTH & SPACE SCIENCES DATA

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ABSTRACT. In the framework of a joint research aiming at identifying and experimenting new methods and technologies for environmental monitoring, we investigated the integration between discovery and access services for the Siberian Earth System Science Cluster, a large database of datasets and value-added products spanning central Siberia.

The overall aim of this activity was to contribute to the development of the CNR inter-departmental GIIDA project, led by the Department of Earth and Environment, where a multidisciplinary national e-infrastructure for the management of Earth and environmental resources is being designed and implemented.

1. INTRODUCTION

The Earth and Space Science Informatics Laboratory at the Institute of Methodologies for Environmental Analysis of the Italian National Research Council (Italy) and the Department of Earth Observation (EO) of the Friedrich-Schiller-University (FSU) of Jena (Germany) established in 2007 a research collaboration to benefit from each others expertise and exchange knowledge, technical developments as well as research personnel.

The collaboration aims at identifying and experimenting new methods and technologies for environmental monitoring, to support the scientific community, as well as to complement the traditional resource management systems and decision-support tools in general.

Such objective takes full advantage of complementary and synergetic competences and facilities of the two institutions: the EO Department of the FSU is managing the Siberian Earth System Science Cluster (SIB-ESS-C), a large database of datasets and value-added products spanning the central Siberian region; IMAA-CNR is leading the inter-departmental project GIIDA (acronym for Integrated and Interoperable Management of Environmental Data), aiming at designing and developing a multidisciplinary e-infrastructure for the management, processing, and evaluation of Earth and environmental resources.

In the past months (also with the support of the 2008 Short-term Mobility Program of the Italian National Research Council), a study was started on advanced geomatics services to facilitate GMES applications in Spatial Data Infrastructures (SDIs)[1]. The study led to the definition of SIB-ESS-C intended users, use-cases, and data types; to the identification

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of the requirements for their cataloguing, discovery and access; and to the implementation of a prototype catalogue solution for SIB-ESS-C.

Prosecuting that study, during a 3-weeks research visit supported by the 2009 Short-Term Mobility Program of the Italian National Research Council, the following activities have been carried out:

- Evaluation of the current international standards and tools for service composition and workflow.
- Interoperability tests for the integration of discovery and access services.
- Consolidation of the prototype SIB-ESS-C catalogue service solution.

The next sections provide background information about GIIDA and SIB-ESS-C and summarize the results of the above activities and the future development of the collaboration.

2. The GIIDA Project

GIIDA is an inter-departmental project of CNR, led by the Department of Earth and Environment and aiming at designing and developing a multidisciplinary e-infrastructure (cyber-infrastructure) for the management, processing, and evaluation of Earth and Environmental resources (i.e. data, services, model and sensors) at the national level.[1]

The main goals of GIIDA are: networking among CNR institutes, re-engineering the environmental observation, modelling and processing systems of CNR and developing mediation methods and instruments for implementing international interoperability standards.

Following a system-of-systems approach, the GIIDA infrastructure will strengthen the CNR presence in the national and international context for: spatial data infrastructures; support to decision making, land management and sustainable development; multidisciplinary interoperability for environmental protection and sustainable development; and will contribute to international projects and initiatives, such as: INSPIRE, GMES, GEOSS and SEIS.

Besides the national focus, the development of GIIDA infrastructure is of high relevance to the international research community at large. Hence, the involvement of international partners in the project will foster the knowledge transfer and create awareness and recognition.

3. The Siberian Earth System Science Cluster

SIB-ESS-C is a SDSI for remote sensing product generation, dissemination and analysis currently being established at the EO Department of the FSU.[2] SIB-ESS-C prime objective is to enable researchers to extract information on the state and the evolution of the Siberian environment by means of standard Web services.

The SIB-ESS-C team is currently pursuing the implementation of web-based tools and comprehensive support to environmental and Earth system research in Siberia, including:

[1]For more information, see `http://www.dta.cnr.it/content/view/2735/2735/lang,en/`.

[2]For more information, see `http://www.sibessc.uni-jena.de`.

FIGURE 1. SIB-ESS-C region of interest (red bounding box).

- access to data products through standard interfaces (e.g. OGC CSW, WCS, WFS).
- continuous data product generation to build up time series.
- online visualization tools for spatio-temporal data analysis.
- integration wih Earth science models.

SIB-ESS-C is intended to cover the whole area of Siberia, spanning a vast number of ecosystems of in northern Eurasia ranging from the tundra, the boreal and temperate forests, mountainous areas and grasslands. The region is believed to play a critical role in global climate change and has been also defined by the International Geosphere-Biosphere Programme (IGBP) as one of the Boreal transects, representing a strong climate change hot spot in Northern Eurasia. Figure 1 shows the region of interest of SIB-ESS-C.

4. PERFORMED ACTIVITY

During a 3-weeks research visit (9-31 august 2009), we have investigated the integration of the phases of discovery, access, processing and visualization of geospatial information.

In particular, the integration between discovery and access services for SIB-ESS-C has been evaluated, also by means of interoperability tests between the current SIB-ESS-C catalogue solution and other open-source implementations of the relevant standards, as briefly described in the following paragraphs.

Standard evaluation: several international standards and tools for service composition and workflow have been evaluated. The following technologies have been considered: Taverna,[3] Kepler,[4] OWL-S.[5] The former two tools are being used and supported by an active community of users, but do not seem to rely on standard solutions for workflow expression and encoding. This could be a potential limitation for evolvability. The latter technology is a W3C standard and hence a promising alternative, but its current uptake by the industry and the users, as well as the availability of operational tools and solutions, seems somewhat limited.

[3] http://www.mygrid.org.uk/tools/taverna/
[4] https://kepler-project.org/
[5] http://www.w3.org/Submission/OWL-S/

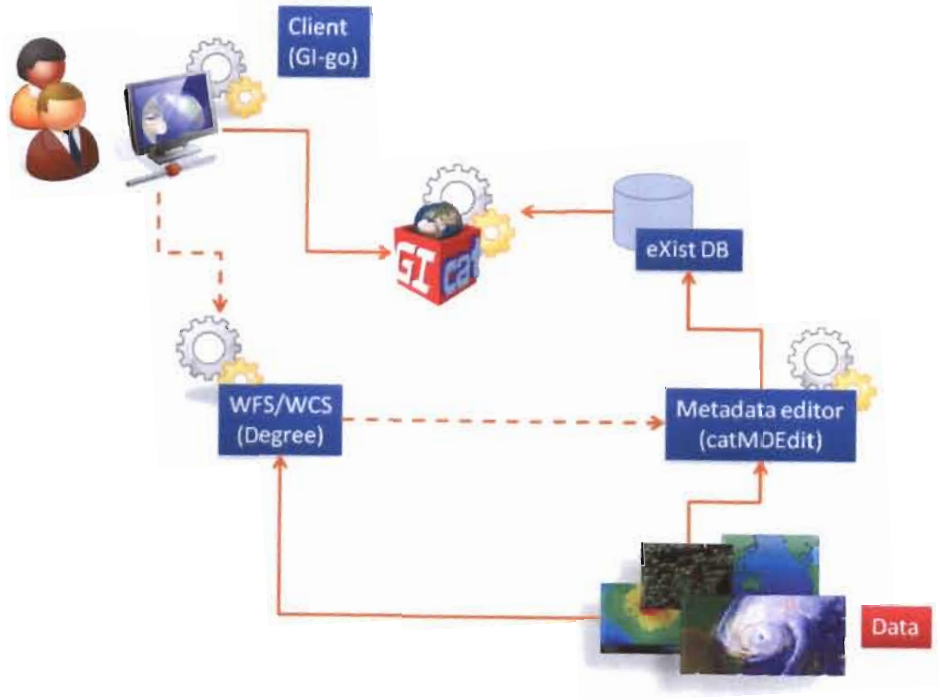

FIGURE 2. Architecture of the testbed.

Testbed Implementation: the integration of discovery and access services, notwithstanding the adoption of suitable standards, poses subtle interoperability issues that are not apparent until experimented in practice. To this end, a basic but meaningful testbed of discovery and access services has been designed and implemented, including consolidated open-source technologies for data annotation/publishing and storage (see figure 2). Several students of the Master's Degree are being involved in assessing and experimenting with the designed testbed. The lessons learnt from this activity are of immediate interest for the GIIDA community, that is also implementing similar capabilities (although at a wider scale).

SIB-ESS-C consolidation: the prototype SIB-ESS-C catalogue, implemented based on the GI-cat technology[2],[6] with an ad-hoc module that directly accesses the underlying database, has been upgraded to the latest GI-cat release.

[6] http://zeus.pin.unifi.it/cgi-bin/twiki/view/GIcat/WebHome

5. Conclusions and future Work

This research visit allowed to strengthen the existing research collaboration between IMAA-CNR and the EO Department of the FSU, as well as to join forces on the development and implementation of the GIIDA e-infrastructure, that was our overall aim.

GIIDA will continue benefitting from this collaboration in the near future, also by means of a forthcoming research visit of FSU personnel (partially supported by the 2009 Short-term Mobility Program), whose expertise in the implementation of Web Processing Services for web-based analysis is highly relevant to GIIDA objectives.

Conversely, GIIDA will leverage these cooperative efforts and further disseminate the results of this study.

The presented research activity also participates in the current international frameworks for standardization and interoperability in EO and geospatial information management. In particular, given the author's involvement (as co-editor) in the specification of the EO Extension Package of the ebRIM Application Profile of the OGC CSW 2.0.2 standard specification, the SIB-ESS-C/GI-cat use-case is providing an effective contribution to the assessment of the standard.

Research aspects to be possibly investigated in the near future are: integration of models via the OGC WPS interface; integration of Grid computing via Grid Services; geospatial data annotation.

References

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