The GEOSS Interoperability Process Pilot Project

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Abstract— We describe approaches that the Global Earth Observation System of Systems (GEOSS) is employing to achieve interoperability among its component systems and give an overview of the GEOSS Interoperability Process Pilot Project (IP3). The IP3 is contributing to the development of the GEOSS architecture by exercising core GEOSS components and processes.

Keywords—GEOSS; interoperability; standards

I. INTRODUCTION

The Group on Earth Observations, GEO, was established by a series of three ministerial-level summits. It currently includes 68 member countries, the European Commission, and 46 participating organizations. The vision of GEO is to create a Global Earth Observation System of Systems (GEOSS) to help realize a future wherein decisions and actions for the benefit of humankind are informed via coordinated, comprehensive and sustained Earth observations and information.

GEOSS is being built initially from existing systems and initiatives, with an emphasis on the creation of synergies among GEOSS component that provide increased benefits to society. The goal is to leverage existing programs and established standards wherever possible, and to broaden convergence of systems based on agreed interoperability arrangements.

We describe the specific approaches that GEOSS has proposed for achieving interoperability among its component systems and give an overview of the GEOSS Interoperability Process Pilot Project (IP3). The IP3 was conceived as a way to exercise the process that has been defined for reaching interoperability arrangements. We describe the phases and status of the IP3, identify the system components, and discuss the standards, interface protocols and interoperability agreements currently used by these systems. This information is being captured in web-accessible catalogs and registers that will become part of the core GEOSS architecture.

II. BASIS FOR INTEROPERABILITY

Systems contributed to GEOSS will continue to operate separately within their own mandates while embracing data sharing principles and interoperability arrangements reached through consensus among GEO members. All GEOSS Components are bound by the requirements on contributed systems as stated in The GEOSS 10 Year Implementation Plan [1] and its companion Reference Document [2]. Quoting the latter,

"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."

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.

Systems contributed to GEOSS are built to serve particular needs, but those systems should also be designed or adapted so their inputs and outputs support interoperability with other systems. Consequently, we focus on interoperability situations that are surfaced by actual requirements to interface with other GEOSS- affiliated systems through GEOSS "interoperability arrangements."

A. Differential Interoperability

In GEOSS interoperability is not a goal unto itself. Different domains within GEOSS should pursue attainable improvements in interoperability on whatever time scale is appropriate to their separate needs and available resources. Only a few functions (e.g. the Clearinghouse supporting searchable catalogs of services and data holdings) are required to encompass all parts of GEOSS. Potential interconnections among components are almost endless. No "master data system" encompassing all parts is envisioned.

III. THE IP3

A. Origins of the IP3

The GEO Architecture and Data Committee, recognizing the need to begin implementing the GEOSS infrastructure and testing the process for reaching interoperability, initiated “Interoperability Process Pilot Project” in July 2006 and gave GEO Task AR-06-01 the responsibility of developing a series of projects involving different Societal Benefit Areas, leading up to a suite of demonstrations suitable for presentation at the GEO Ministerial Summit.

Four systems/disciplines were initially identified as sources for the pilot project, covering weather, climate, seismology, and biodiversity. This selection was based on the desire to have participation from diverse disciplines and the commitments of representatives from the disciplines to actively support the process.

IV. GEOSS REGISTERS

Fundamental to the operation of GEOSS is access to information about its components. GEOSS Components will be described in a “Components Register” while the services these components offer will be described in a “Services Register.” The standards that are in use by GEOSS will be described in a “Standards Register.” All GEOSS registries will be interoperable and accessible via the GEOSS Clearinghouse. The relationships between key GEOSS registries is illustrated in Fig. 1.

Figure 1. Diagram of relationships between key GEOSS Registers.

V. THE STANDARDS AND INTEROPERABILITY FORUM

A Standards and Interoperability Forum (SIF) is being created to carry out impartial review of GEOSS interoperability issues and to recommend solutions. The SIF will have representation from organizations with a significant interest in GEO-relevant standards such as CEOS, OGC, and ISO.

The Standards and Interoperability Forum will provide a mechanism to monitor relevant activities within GEO and the broader community to examine issues relating to currently adopted standards and determine whether there are potential issues in the adoption and conformance to the GEOSS-recommended interoperability specifications.

The Standards and Interoperability Forum will facilitate linkages and partnerships between established Standards Development Organizations, users and new groups or organizations interested in collaborating in GEOSS standards efforts. The SIF will encourage broader use of existing standards in the GEOSS Standards Register as one factor in recommending interoperability arrangements. The SIF will consider existing international standards organizations and institutes as a focal point for the GEOSS interoperability objectives. In rare cases where no existing standard fulfills GEOSS needs, the SIF could identify appropriate Standards Development Organizations to carry out the standards development process.

A. The Component Registration Process

The process for registering a component in GEOSS is illustrated in Fig. 2. A GEO Member or Participating Organization nominates a GEOSS Component by completing a component registration form, available in paper or electronic format. This information is entered into the Component Register. If the component exposes an interface then the contributor has the option of registering the service that enables access to that component. Service registration is done through a series of online forms. The user is presented with a list of standards registered in the Standards Register and prompted to select those that apply to their service. If the conventions used for access, data format or metadata content do not reference standards in the Standards Register, the process is then referred to the SIF. In designing interfaces to support interoperability among two or more component systems of GEOSS, the objective is to deploy a solution that not only solves the interoperability requirement, but does so by taking full advantage of existing international standards.

Figure 2. The GEOSS Component Registration Process

The SIF process is diagrammed in Fig. 3. The SIF will enlist the support of technical and discipline experts. The first question the SIF addresses is whether an existing standard can be adapted to solve the interoperability issue. If the answer is Yes, the SIF recommends this as the solution. If the answer is No, the next step the SIF takes is to evaluate whether the convention currently being used by the component is already widely adopted within one or more communities. If the answer

is Yes, this *de-facto* standard is entered as “Special Arrangement” into the Special Arrangements register.

If the SIF, in consultation with technical and discipline experts, determines that no existing standard fulfills GEOSS needs, the SIF will identify appropriate Standards Development Organizations (SDOs) to carry out the standards development process.

Figure 3. How the Standards and Interoperability Forum oversees the GEOSS Process for Reaching Interoperability Arrangements.

VI. A PHASED APPROACH

The IP3 will achieve its goals in phases. These phases will be repeated with new scenarios and components, or with new interfaces to existing components, in order to encompass other disciplines and Societal Benefit Areas.

A. Phase I - Populate the GEOSS registers

The goal of Phase I is to register the participating components in the GEOSS registers and to identify the standards, interface protocols and other interoperability arrangements in use. This information will be provided to the GEOSS Clearinghouse as it is brought online. The main actions of this Phase are to identify *de-jure* and *de-facto* standards in use for data & metadata models and service protocols.

Another aspect of Phase I is to analyze the data integration activities of the projects represented by the components being registered. All of the candidate GEOSS components participating in the IP3 are themselves composed of heterogeneous distributed systems. The IP3 will examine why and how interoperability arrangements were made and maintained, how the interoperability arrangements worked under the computer and network environment of the time, and what the impacts were of these arrangements. Some of this information will be candidate content for the GEOSS Best Practices Registry.

B. Phase II - Cross-System Interoperability Scenarios

In Phase II scenarios are developed that require the exchange of data and information between disparate systems which have not yet established a mechanism for such an exchange. The scenarios must address needs identified in one

or more of the Societal Benefit Areas and satisfy relevancy and realism criteria. These scenarios demonstrate how the GEOSS architecture, data, and services have made it possible to realize benefits that would not have been easily achieved otherwise. Some of the scenarios are selected to ensure that the SIF is invoked to assist in the formulation of interoperability arrangements between systems.

C. Phase III - Demonstration

Where the component systems supporting a scenario have the resources available to create implementations of the scenarios, these will be prepared and a demonstration will be presented to the GEO Architecture and Data Committee, and eventually made available to all GEO Members and Contributing Organizations. A live implementation of data and information exchange via the defined arrangements will be demonstrated in conjunction with those GEOSS infrastructure components that have been implemented such as the Components, Service and Standards Registries.

D. Phase IV - Higher Levels of Interoperability

In Phase IV the IP3 will seek to develop higher levels of interoperability. This could involve exercising more completely the capabilities of the protocols and interfaces identified. It may also address semantic interoperability – whereby the meaning of the data and information exchanged through the interfaces is automatically intelligible to the recipient systems.

VII. IP3 SCENARIOS

The criteria applied in formulating the IP3 scenarios were stated earlier. The scenarios, along with the component systems participating in the IP3, are described below:

- Species Response to Climate Change - Ecological Niche Modeling is applied to study the adaptation of butterflies in Canada and Alaska to various climate change scenarios. Requires interoperability between the GBIF (Global Biodiversity Information Facility) and components of the WIS (World Meteorological Organization Information System).
- Flood Risk Scenario – A distributed surface run-off model provides data for flood warning and dam operation systems. Requires interoperability between CEOP (Coordinated Enhanced Observation Period) systems and components of the WIS.
- Landslide Risk – Analysis to determine whether rainfall and seismic data be used to predict locations where hillsides are susceptible to collapse. Requires interoperability between the FDSN (International Federation of Digital Seismographic Networks), the WIS, and an interoperable landslide database network in Australia.
- Fault Lubrication – Analysis to determine whether high rainfall rates or excess groundwater produce increased earthquake activity in areas of known faults. Requires interoperability between FDSN and WIS components.

- Seismic Events from Glacier/Ice Sheet Disintegration – Analysis of seismic signals and a combination of remote sensing and in situ data for selected glaciers to determine whether global seismic networks can be used to monitor ice sheets and glacial activity and thus remotely sense effects of warming on a global scale. Requires interoperability between FDSN and databases at the National Snow and Ice Data Center.

Some scenarios may not evolve past the conceptual stage due to lack of resources. A detailed use case is the final product for such scenarios. These scenarios may require “special arrangements” to be registered through the SIF, which will thereby satisfy at least some of the objectives of the IP3. The main deliverables of the IP3 are a revised “Process for Reaching Interoperability” document, and a report describing the project with key issues that were surfaced and addressed.

Descriptions of the IP3 scenarios and up-to-date implementation status will be provided in the talk.

VIII. SUMMARY

The Interoperability Process Pilot Projects are contributing to the development of the GEOSS architecture by exercising core GEOSS components and processes. The scenarios under development are fully compliant with, and representative of, the GEOSS process for reaching interoperability.

REFERENCES

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