



**NOAA-NASA GOES-R and GMU CSISS joint efforts for persistent
GOES data services, weather scenarios, Web geoprocessing services,
and BPEL-based workflows in the GEO Architecture
Implementation Pilot – Phase 2 (AIP-2)**

Center for Spatial Information Science and Systems (CSISS)
George Mason University (GMU)
6301 Ivy Lane, Suite 620
Greenbelt, MD 20770

Business POC Name: Ken McDonald

Technical POC Name: Liping Di

Business POC email: Kenneth.Mcdonald@noaa.gov

Technical POC email: ldi@gmu.edu

Business POC phone: +1 301 713 2789 – ext 143

Technical POC phone: +1 301 982 0795

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NOAA-NASA GOES-R and GMU CSISS Responses to the GEOSS AIP-2 CFP

1 Overview

The CFP calls for establishing “persistent operational exemplars” for GEOSS Societal Benefit Areas and augmenting the Initial Operating Capability of the GEOSS Core Infrastructure established during the first phase of Architecture Implementation Pilot. Elaborated Societal Benefit Areas (SBAs) are disasters, health, energy, and ecosystems (biodiversity), out of the nine SBAs of GEOSS. Three types of participation roles are called for. They are (1) participant in the collaborative development of SBA scenarios, (2) service providers for SBAs, and (3) contributor for the refinement of architecture and interoperability.

These objectives are in alignment with those of the Center for Spatial Information Science and Systems (CSISS) and NOAA-NASA GOES-R project office. CSISS has been actively involved in developing interoperability standards and prototypical software, especially in compliance with OGC specifications and ISO/TC211 standards. The center has accumulated tremendous experiences in developing standards and technology for the interoperability of geographic information. The center has been extremely active in either leading or participating in the development of FGDC, NCITS/L1, OGC and ISO TC 211 interoperability standards. Experiences have been gained in all previous OGC Web Service initiatives as an OGC-funded participant of OGC WMT I, WMT II, OWS 1.1, OWS 1.2, OWS 2, OWS 3, and OWS 4. CSISS has also participated in the first phase of AIP and contributed several components, including the development and operation of GEOSS Registry, and provision of standard-compliant geospatial Web services and workflow engine. The center is competent in contributing to the GEOSS API Phase 2 in all levels. The NOAA-NASA GOES-R project office is interested in contributing the future GOES-R data to GEOSS for applications in all GEOSS societal benefit areas.

In this initiative, we propose to **(1) participate in the SBA exemplar development, mainly disasters and weather (e.g. task # DI-06-09) by using GOES data as one of inputs, (2) provide persist GOES data services consistent with the GEOSS architecture, Web geoprocessing services (WPS), and a BPEL workflow engine for SBA exemplars, and (3) contribute to the refinement of architecture and interoperability, especially those related to integration of geospatial Web services and refinement of GEOSS registry (e.g. Task #DA-06-04).**

2 Proposed Contributions

We propose to contribute to the Pilot program in all three levels, as a scenario participant, a service provider, and an interoperability refinement contributor.

2.1 Societal Benefit Area Alignment and Support

2.1.1 Societal Benefit Area Alignment

The project team proposes to participate in the development and persistence of two SBA scenarios, weather and disaster, by making data from current Geostationary Operational Environmental Satellites (GOES) available.

2.1.1.1 Persistent GOES data services

GOES data will be made accessible through OGC-compliant Web Coverage Service (WCS) and Catalog Service for Web (CSW) to the GEOSS community for weather and related activities. For the API2, persistence data services for current GOES data will be provided. These services will provide the proof of concept for contributing data from the future GOES-R satellite series to GEOSS in the future.

Currently, GOES data are searchable and orderable through NOAA's Comprehensive Large Array-data Stewardship System (CLASS). However, there is no WCS or CSW interface available. The first task will be the enablement of discovery and serving of GOES and related data through CSW and WCS. The proposed solution is to add the CSW and WCS interface on top of the prototype Simple NOAA Archive Access Protocol (SNAAP) API developed by Eric Kihn and Rob Prentice at NOAA's National Geophysical Data Center (NGDC). Figure 1 shows the existing architecture and the additions (yellow blocks) to be developed on top of the architecture in order to offer persistence data services for GOES data. **The proposed CSW and WCS services will demonstrate how access to all data in CLASS could be provided in the future, as a contribution to GEOSS.**

2.1.1.2 Weather

An application scenario will be developed for the detection and tracking of severe weather events using GOES data. This will be a web service-oriented use case. All processes will be published and managed in an open, service-oriented environment. Figure 2 shows the workflow of the major components and collaborators involved. All processes/algorithms, e.g. severe weather detection algorithm and severe weather tracking algorithm, will be deployed as a WPS process and managed by WPS server. Results will be delivered through standard geospatial Web services, such as WFS and WCS.

Participants for this effort will include NOAA-NASA GOES-R project office and GMU CSISS. This effort will integrate multiple systems and services across NOAA, NASA, and GMU CSISS. CLASS has an operational service that allows users to discover and retrieve data with a short delay. NGDC has developed a prototype API for CLASS and other data archive systems called SNAAP. Its services are published as a Representational State Transfer (REST) service and as OGIS-DAI services. NASA GSFC has developed two algorithms for weather detection and tracking respectively. These have been enabled as WPS processes in a joint effort between NASA GSFC and GMU CSISS. GMU CSISS has the established collaborations with NOAA and NASA and has

strong technical and standard experiences in geospatial Web services, workflows, and products.

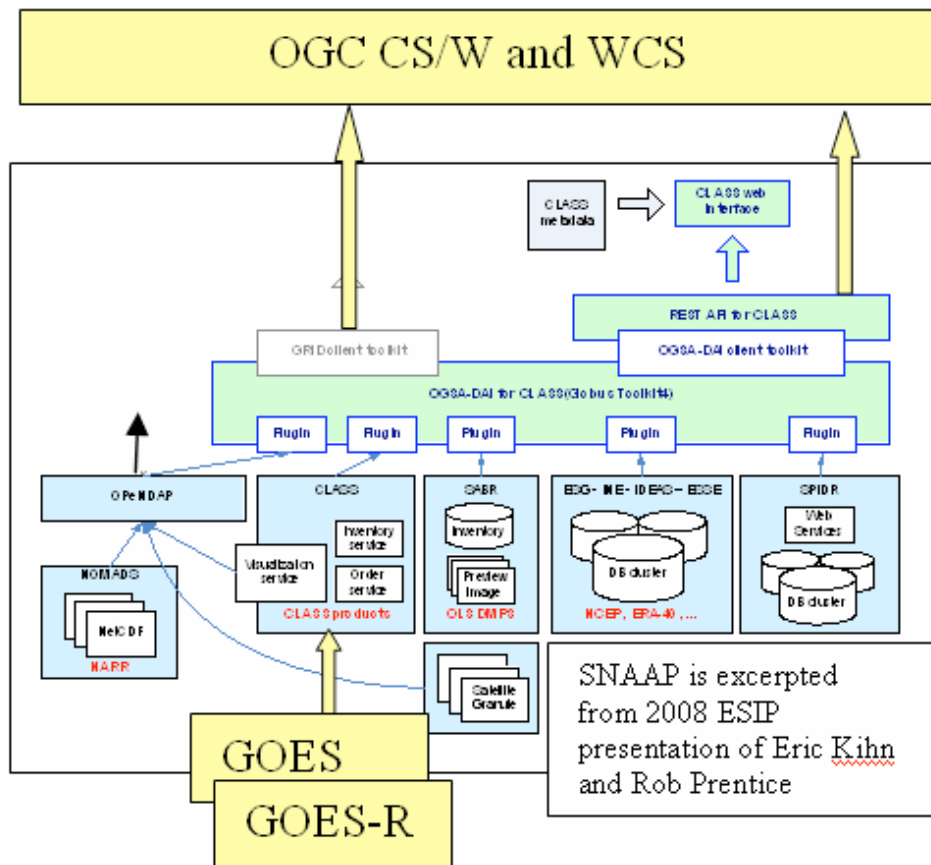


Figure 1. GOES/GOES-R OGC-compliant WCS services

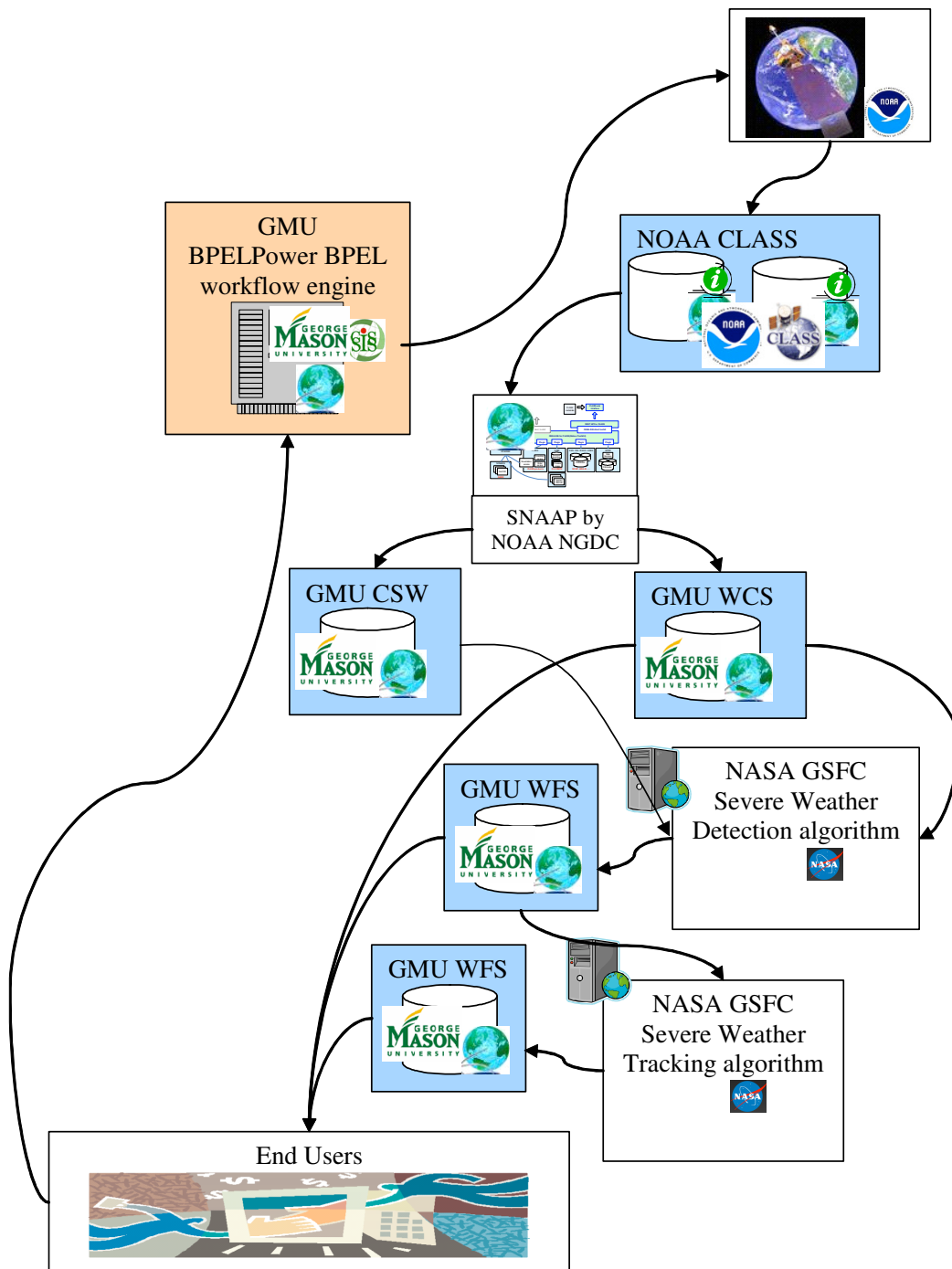


Figure 2. Scenario for Severe Weather Event Detection and Tracking

2.1.1.3 Disasters

Section 2.6.1 of the GEOSS AIP Phase 2 CFP – Annex B – Architecture outlines a flood scenario. CSISS will contribute to the construction of the scenario by providing standard Web services. The **main component services will be a BPEL execution engine** that is capable of handling open security specification and OGC-compliant Web services.

2.1.2 Societal Benefit Area Support

CSISS has developed and been operating a lot of geospatial Web services and software over years of research projects. CSISS has experiences in almost all of OGC-specified geospatial Web services. These include WFS, WCS, WMS, CS/W, WPS, Sensor Planning Service (SPS), Sensor Observation Service (SOS), Sensor Alert Service (SAS), and Web Notification Service (WNS). In addition to standard OGC services, CSISS has developed a suite of geospatial web services by converting the GRASS GIS software system into SOAP-based Web services (over 200 functions). CSISS has a special strength in BPEL and related technologies. A seasoned BPEL execution engine, called BPELPower, has been developed and successfully used in many phases of OGC-initiatives. Those services have been operational for several years. **We will operate persistently the suit of OGC and SOAP-based geospatial web services and BPELPower workflow engine as the contributions to GEOSS AIP 2.** All of them will be useful in developing scenarios of SBAs listed in Section 2.6 of the AIP CFP Annex B.

Workflow is the driving forces for leveraging different services and automating the collaborations among different agencies and departments. Workflow plays an important role in integrating Web services from different vendors to achieve the collective goal. CSISS is especially strong and experienced in geospatial workflows using standard BPEL and related technologies. One special value of the BPELPower BPEL engine developed in CSISS is its support to OGC Web Services. This made it easy and useful in chaining OGC-compliant Web services in a workflow. **CSISS will contribute the development and executions of workflows for societal benefit areas.**

2.2 Component and Service Contributions

2.2.1 Persistent WCS and CSW services for GOES data

The GOES WCS and CSW services described in section 2.1.1.1 will be contributed to AIP2 as persistent services.

2.2.2 GEOSS Registries

This is the component developed under the GEOSS task AR-07-01. It supports Universal Description Discovery and Integration (UDDI), Organization for the Advancement of Structured Information Standards(OASIS) e-business registry information model (ebRIM) and ebXML Registry Services Specifications (ebRS), and Sun Java Application Programming Interface for extensible Markup Language Registries (JAXR). The GEOSS Registry is hosted at CSISS and consists of two software components, i.e. Sun's service registry and GeoBrain OGC CSW. The registry has a hierarchical service taxonomy and

the base is universal resource name (URN). Users interact with the registry through registry maintenance portal, registry publication portal, and registry query manager. During the second phase, **CSISS will continue to operate, maintain, refine and augment the GEOSS component and service registry**. The new version will support extended registration of non-GEOSS-standard components.

2.2.3 BPEL workflow engine – BPELPower Engine

BPELPower is a standard BPEL execution engine developed in CSISS. It has been evolved over years of demonstrations and operations in several research projects and OGC OWS demos. It supports accessing to WPS, WFS, WCS, SOS, and WMS. Currently, it relies on standard Web Service Description Language (WSDL) since BPEL requires WSDL to describe inputs/outputs of a Web service. Data types are described in schema. However, the current version still lacks the support of parsing and consuming of getCapabilities results of all OGC-compliant Web services. This needs to be extended and developed. We are working on a prototype and expect it to be tested in the GEOSS community. This would be a big contribution to GEOSS in general and the AIP2 in particular by leveraging industrially-popular BPEL and related technologies for integrating geospatial services and resources.

2.2.4 GeOnAS portal

GeoBrain Online Analysis System (GeOnAS) is a function-rich lightweight portal. It was developed in CSISS. Advanced technologies have been adopted to support rich geospatial data handling in Web browsers without demanding requirements on user's side. Both Web service and Asynchronous Javascript And eXtensible markup language (AJAX) have been used in the implementation of GeOnAS. At presentation and user interface level, GeOnAS supports most browsers with dynamic HTML (DHTML), cascade style sheet (CSS), and JavaScript. GeOnAS is backed with standard geospatial Web services. It hides the complexity of geospatial Web services behind the simple user interfaces. It accesses to OGC WFS, WCS, WMS, CSW, and WPS, and provides online data management, visualization, analysis, and cataloging. It is simply a browser-based realization of desktop geospatial analysis functions. It directly connects the data and services distributed over the Internet, and gives the user the capability of "analyzing the data on-line immediately once the data over the Web are discovered".

GeOnAS can be adapted to use resources in the GEOSS Clearing House. It will be a portal accessible to users in the GEOSS community. This would better serve the GEOSS community with a functionally rich, standard-compliant, friendly portal.

2.2.5 OGC-compliant services

CSISS will continue to provide all existing OGC-compliant services and Sensor Web related services for scenario development in the Phase 2 of AIP. Different versions of WCS have been implemented and tested for several projects. The WCS at CSISS meets the specification of the newest version released by OGC beside it has backward compatibilities. More than 10 terabytes of archived satellite data and other geospatial data in CSISS servers can be a valuable addition to the GEOSS community.

CSISS will refine and register all the developed geospatial services in the GEOSS registry. This will be a huge contribution to the online, on-demand processing of geospatial data in a standard, open, and loosely coupled Web service environment. Geographic Resources Analysis Support System (GRASS) is a well-known, well-developed, rich-functional, open-source geographic information system. At CSISS, more than 200 of the geospatial processing functions in GRASS have been converted into standard Web services. These will be registered in the GEOSS Registry when it is revised to support standard Web service registration. They could be used in many applications, especially when workflow is combined into the integration of resources and services.

2.3 Architecture and Interoperability Arrangement Development

CSISS will continue on contributing to two aspects: **(1) to maintain GEOSS Registry, and (2) to expand the capabilities of workflow engine to embrace OGC standards.** GEOSS Registry follows the standards of OGC CS/W. However, information model can be developed to meet specific requirements of different communities. The GEOSS community needs to expand many aspects to include all the geospatial resources and support the registration of diverse existing and newly-emerged data services and processing services. The GEOSS Registry service will be maintained and updated to support the wide applications in the GEOSS community. Workflow engine needs to expand the support of all OGC-compliant Web services in breadth and depth. This will be one of the objectives to work on. This also relates to GEO Task AR-06-01 on embracing non-GEOSS standards, such as emerging XML-based Web services and workflow specifications.

CSISS is an active member in OGC. It will continue to contribute to the development of specifications and standards. CSISS is also a major player in developing ISO/TC211 standards. These memberships and activities will contribute to the perfection of GEOSS-endorsed standards and specifications.

3 Description of Responding Organization

3.1 CSISS

The Center for Spatial Information Science and Systems (CSISS), formerly known as the Laboratory for Advanced Information Technology and Standards (LAITS), George Mason University is an off-campus university research center located near NASA Goddard Space Flight Center (GSFC) at Greenbelt, Maryland. The center currently has 4 faculty members, 9 research faculty members, 2 post-doctoral research fellows, and 11 Ph.D. students/research assistants. Its operation is supported solely by research grants and contracts. CSISS is one of the leaders in developing advanced information technology and systems for applications in Earth Sciences and in setting federal, national, and international standards for geospatial information and interoperability. The center maintains close cooperation with NASA, NOAA, USGS, and NGA and support actively U.S. contributions to GEOSS. CSISS is a member of the OGC, a GEO participation organization. Prof. Liping Di, the director of CSISS, is the chair of data and archiving and distribution technical committee (DADTC) of IEEE GRSS, which is also a GEO participation organization. CSISS scientists has been involved in multiple OGC Web

Service initiatives and led or contributed the development of many OGC geospatial web service and sensor web enablement specifications. CSISS is one of the major players and technical contributors in GEOSS AIP I. The CSISS scientists will contribute to this Phase 2 of AIP in many capacities.

CSISS will make all necessary human resources available to AIP2. Dr. Liping Di will lead the CSISS AIP 2 efforts with participations of Drs. Yuqi Bai, Peisheng Zhao, Genong Yu, and several students. CSISS will provide excellent computing facilities to AIP 2. The flagship computing facility is an Apple G5 server cluster, which is connected to Abilene, the 1Gps high speed Internet 2. The server has a head node consists of dual 2.0GHz G5 processors, 4GB of DDR SDRAM and two 250GB Hard disks. There are six cluster nodes each having dual 2.0 or 2.3 GHz G5 processors with 2GB DDR DSRAM and 8GB hard disk. The storage system of the server consists of five RAID systems with total capacity of 32 Terabytes. Terabytes of geospatial data are serving through these servers in open standards, mostly OGC-compliant WCS and WFS. CSISS will dedicate several terabyte storage and adequate computing power to this AIP.

3.2 NOAA-NASA GOES-R

The Geostationary Operational Environmental Satellite R Series (GOES-R) Program is a collaborative effort between NOAA and NASA that will provide a key element of NOAA's operations. The GOES-R Ground Systems Project is supporting this activity to prototype enhanced access to GOES data currently held in NOAA's archives as a pathfinder to GOES-R data access services. The first launch of the GOES-R series satellite is scheduled for FY2015. On behalf of the GEOS-R Ground System Project, members of NOAA's Global Earth Observation Integrated Data Environment (GEO-IDE) initiative will coordinate this AIP effort and serve as the interface with related NOAA projects.

3.3 Contacts

Programmatic Contact:

Ken McDonald

NOAA Data Management Architect

1 301 713 2789 – ext 143

Kenneth.Mcdonald@noaa.gov

Technical Contact:

Prof. Liping Di

Center for Spatial Information Science and Systems

George Mason University

6301 Ivy Lane, Suite 620

Greenbelt, MD 20770, USA

Phone: 301-982-0795

Fax: 301-345-5492

Email: ldi@gmu.edu