OGC
Open Geospatial Consortium

OWS-4 Earth Observation Demo

December 2006

Background

- **The following OWS-4 demonstration was created by OWS-4 participants to showcase the applications of OGC standards within the Earth Observation community and to demonstrate the value of interoperability in that environment**
  - **OGC specifications used:**
    - Sensor Observation Service (SOS)
    - Sensor Planning Service (SPS)
    - Sensor Alert Service (SAS)
    - Web Processing Service (WPS)
    - Catalog Service (CSW)
    - Web Coverage Service (WCS)
    - Web Feature Service (WFS)
    - Web Map Service (WMS)

Participants

- **NASA/Vightel EO-1 team**
  - SPS, SAS and SOS access to the EO-1 system
- **NASA Geosciences Interoperability Office**
  - NASA Earth Science Gateway catalog & portal
- **Washington University**
  - Modeling/Analysis & Web Processing Services
- **George Mason University**
  - BPEL workflow execution & WCS
- **ESA/Spot Image/Spacebel**
  - BPEL workflow execution and tasking via SPS
- **Fraunhofer, Conterra**
  - Geo-Digital Rights Management

Scenario

It is hurricane season in the Eastern United States. Modelers and disaster response officials use interoperable data collection, modeling, and analysis systems to quickly create new information to assess flooding resulting from a hurricane.

- Meteorological model output is used to estimate location and time of landfall impact
- Satellites are tasked to collect new images of the area after hurricane impact
- Images are processed to identify flooded areas

Value Proposition

For Human Assistance and Disaster Recovery

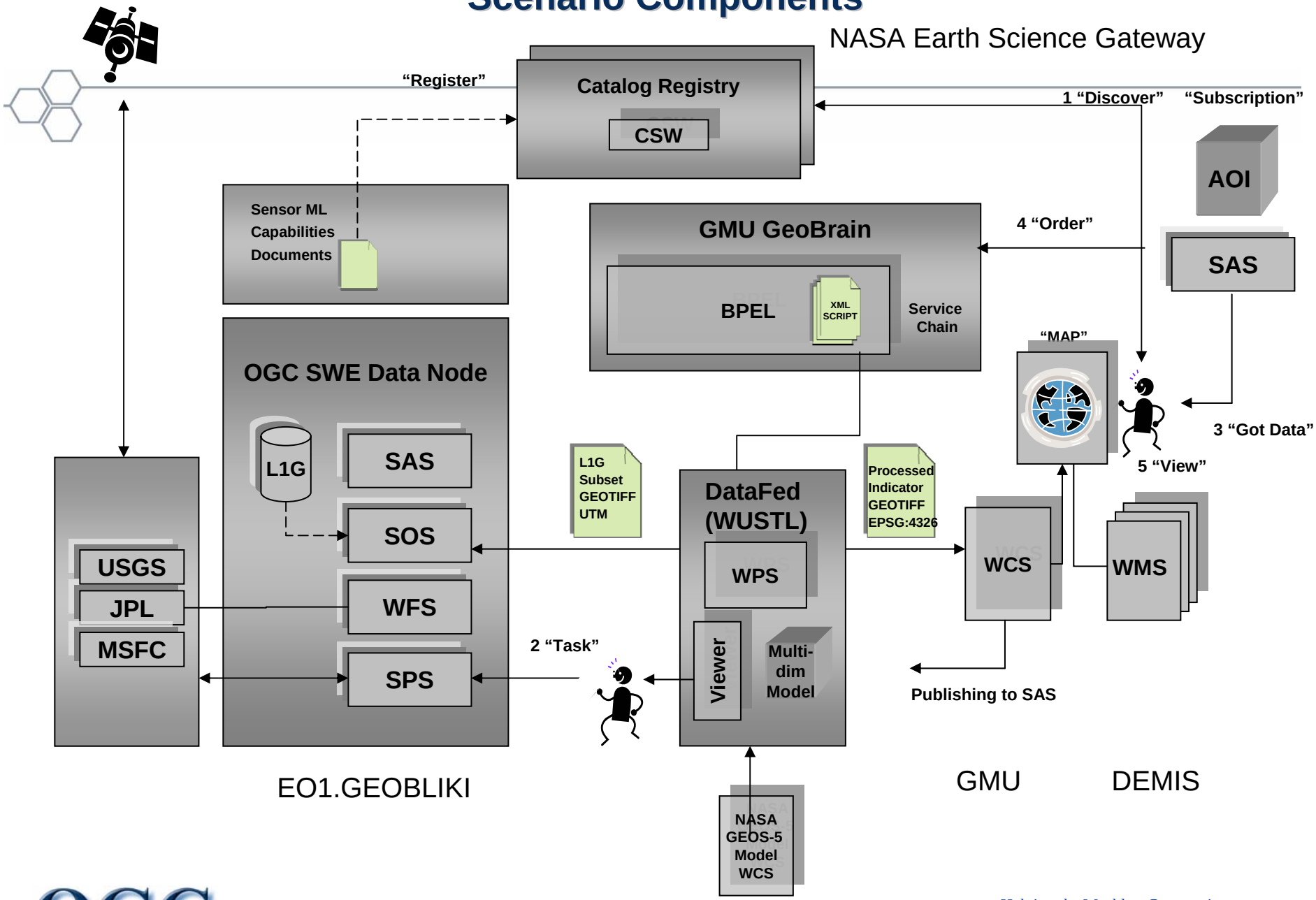
Hurricane, Wild Fires, Tsunamis…

- **DoD/NGO First Responders**
  - Quickly ***Discover*** Available Imagery, Imaging Services/space Assets
  - "***Order***" Real-time Custom Products With "Guaranteed Next Day "***Delivery***" to Their Location Anywhere in the World
    - Rich Mix of Capabilities/quality:
      - From 30m to 1m, Panchromatic, Color, Hyper-spectral, Multi-spectral, 3D…
    - Chinese Menu of Possible Products
      - Fire, Contaminants, Water/Flood Coverages…
  - ***Subscribe*** to Data and Get Real-time Notifications When It Becomes Available
  - ***Access*** From the Web For Free (Special Click-Through License Available to Trusted Identity Providers)

Scenario Steps

1. Data & Service Discovery
2. Model Output Processing
3. Satellite Tasking
4. Analysis Workflow Processing

Scenario Components

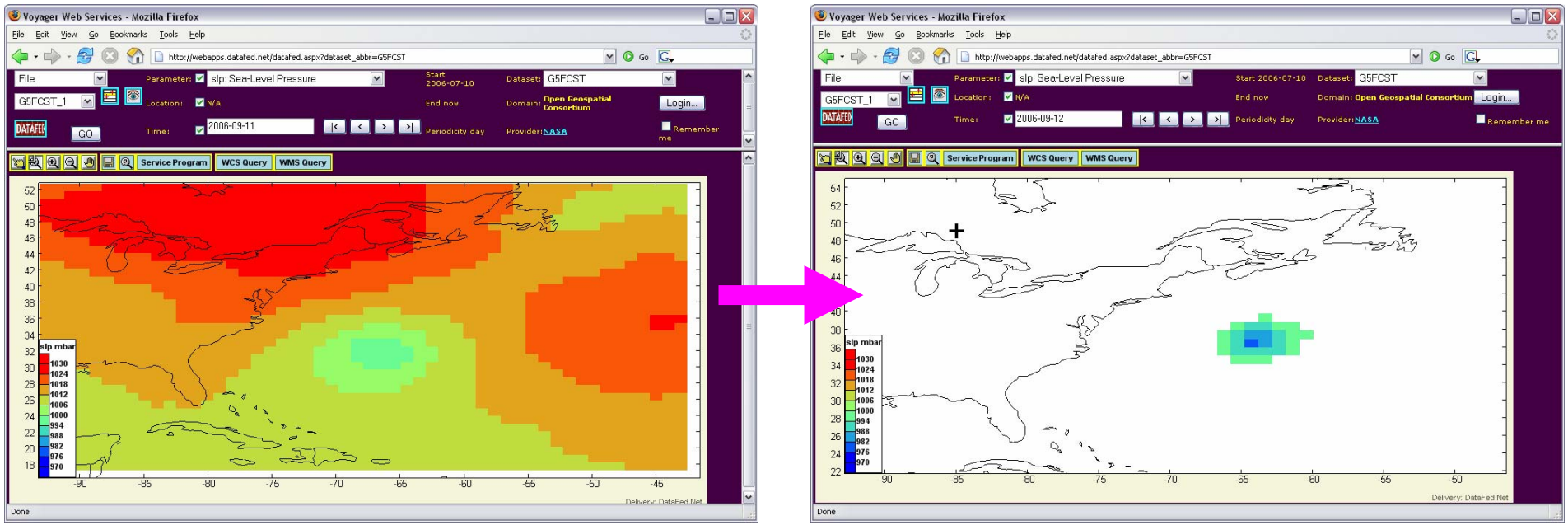


1. Data & Service Discovery

- Analyst searches NASA ESG CSW catalog for sea-level pressure forecasts and finds the GEOS-5 model accessible via WMS & WCS

2. Model Output Processing

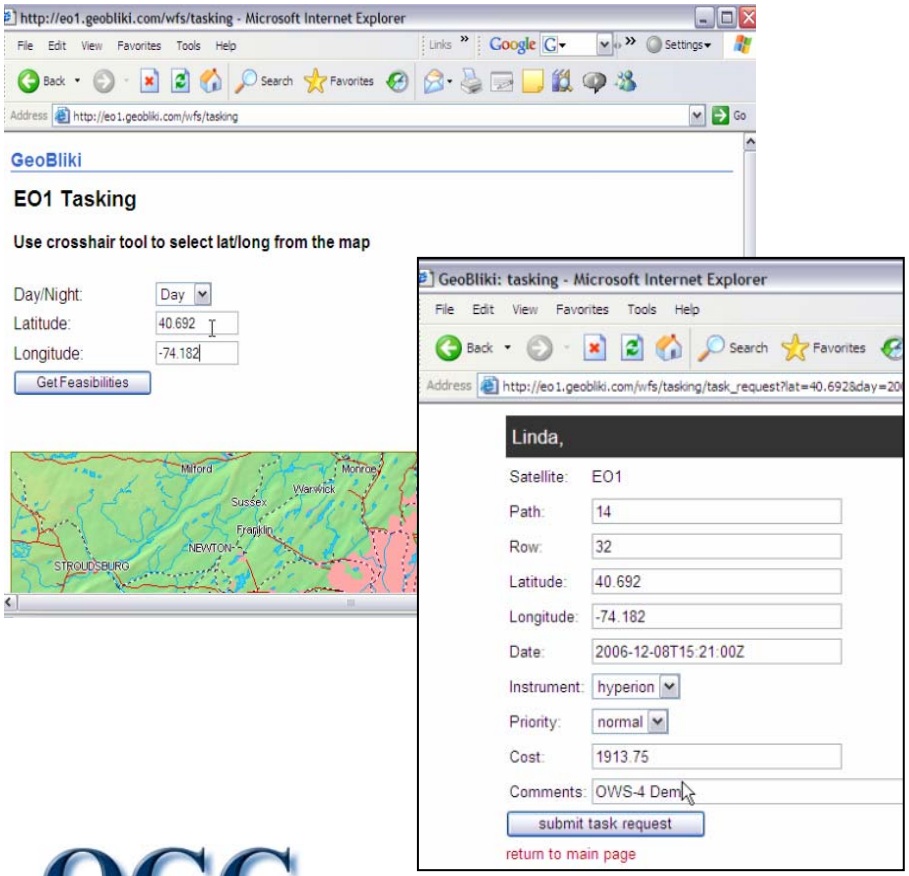
- Analyst uses a data filtering processing service in DataFed to analyze model sea-level pressure estimates for values below a specified threshold that serve as one input in determining potential hurricane landfall



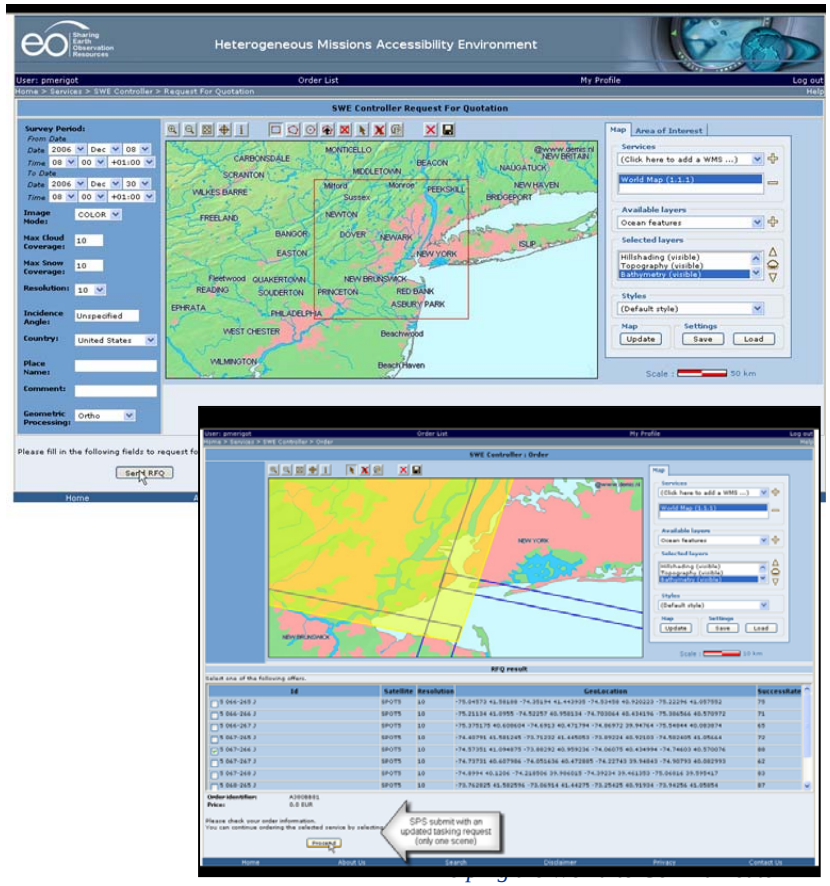
3. Satellite Tasking

- Two satellites, EO-1 and Spot, are tasked via SPS to capture imagery over potential hurricane landfall area

EO-1



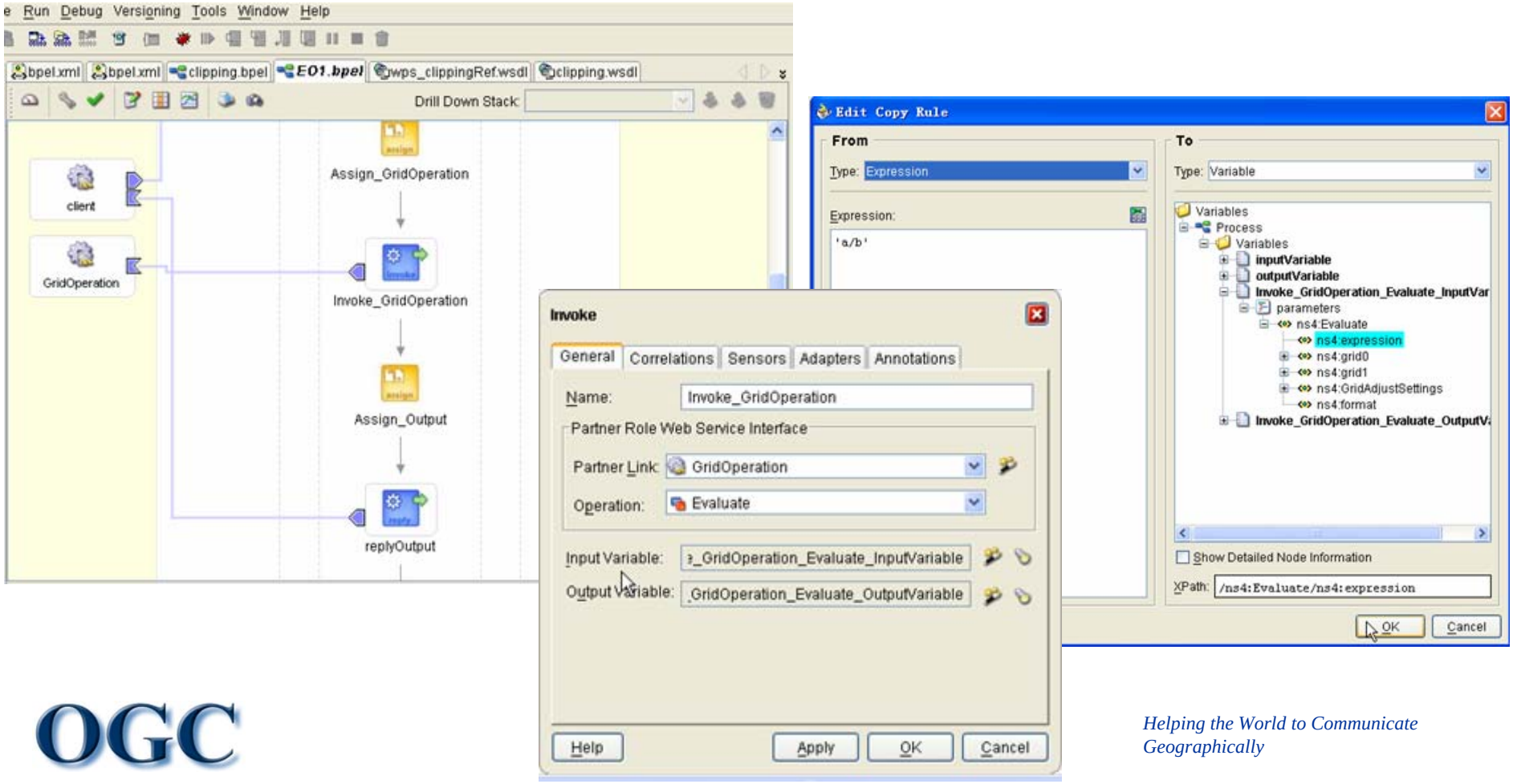
SPOT



Geographically

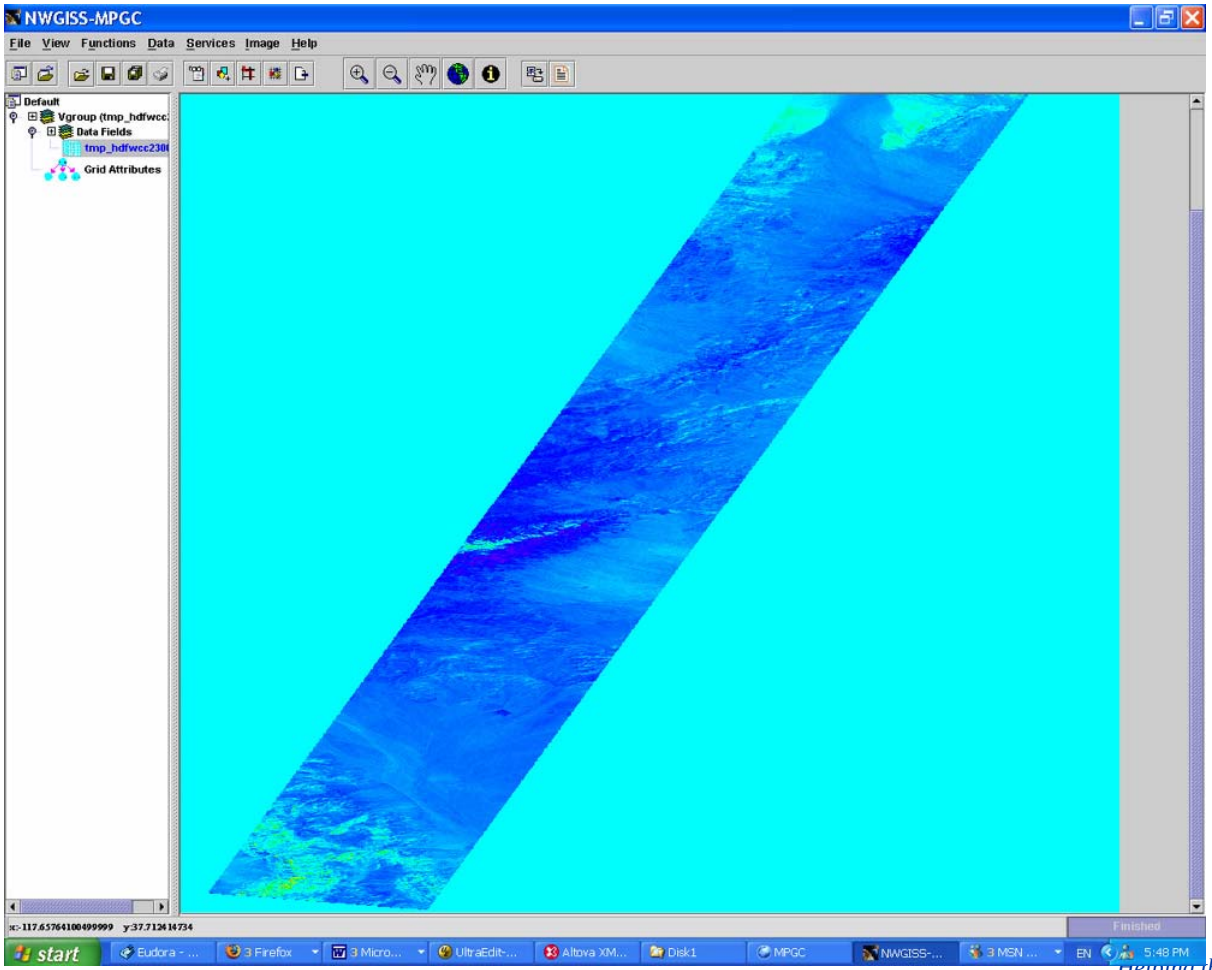
4. Analysis Workflow Processing

- Analyst executes GeoBrain BPEL workflow on EO-1 image to derive flood areas using DataFed MapGridOperator Web Processing Service

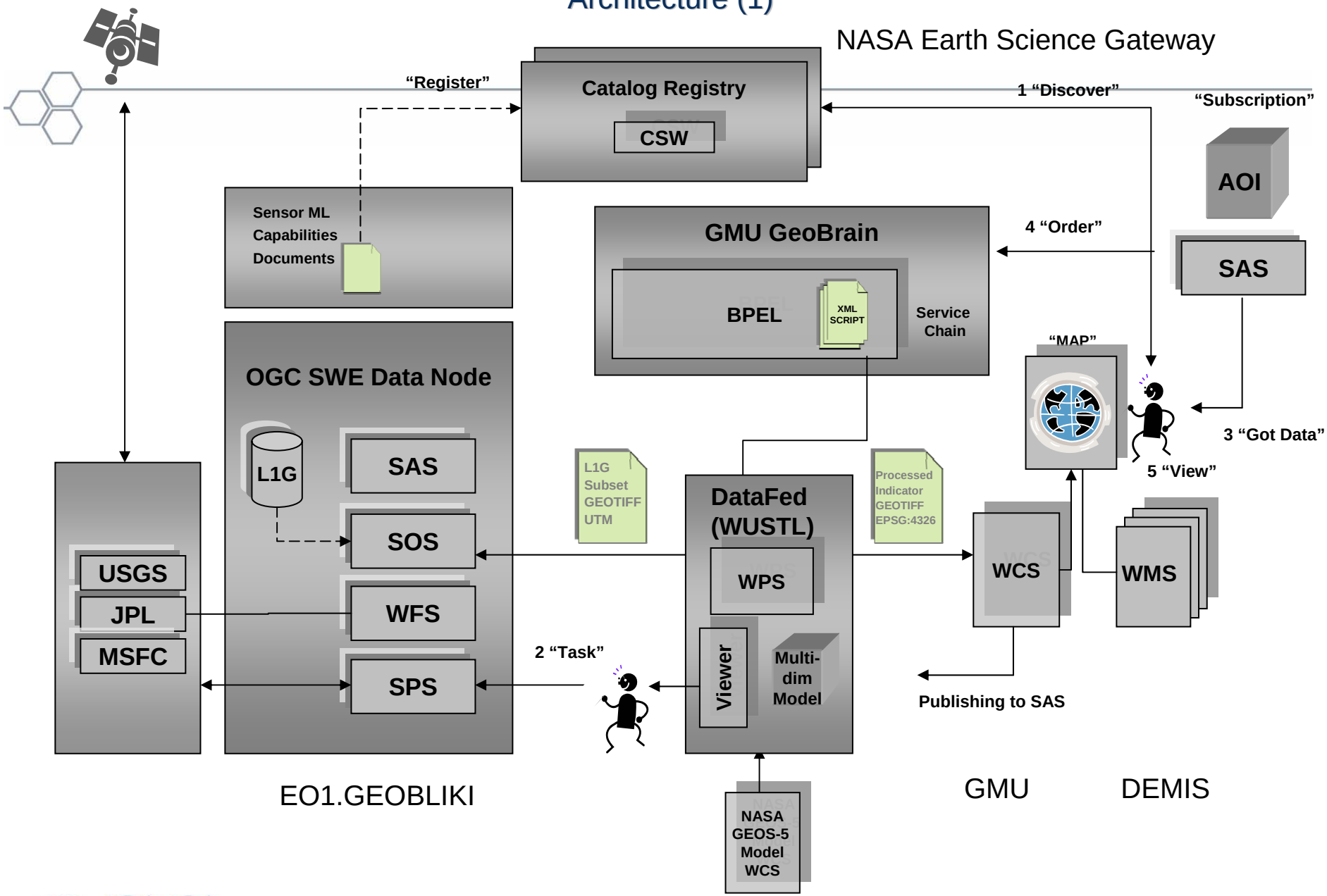


5. Decision Support System

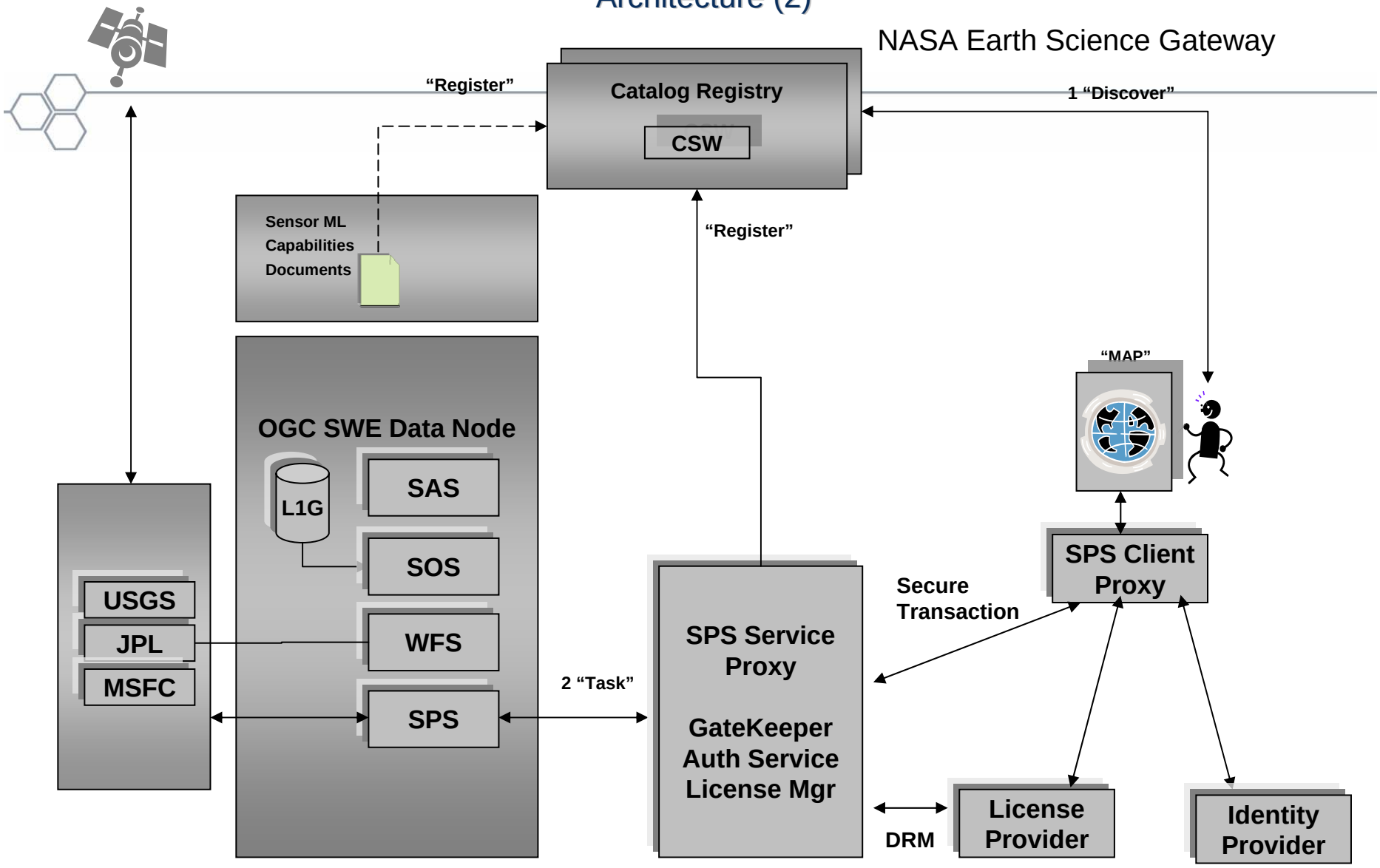
- Output of BPEL workflow is available as a Web Coverage Service (WCS)



Architecture (1)



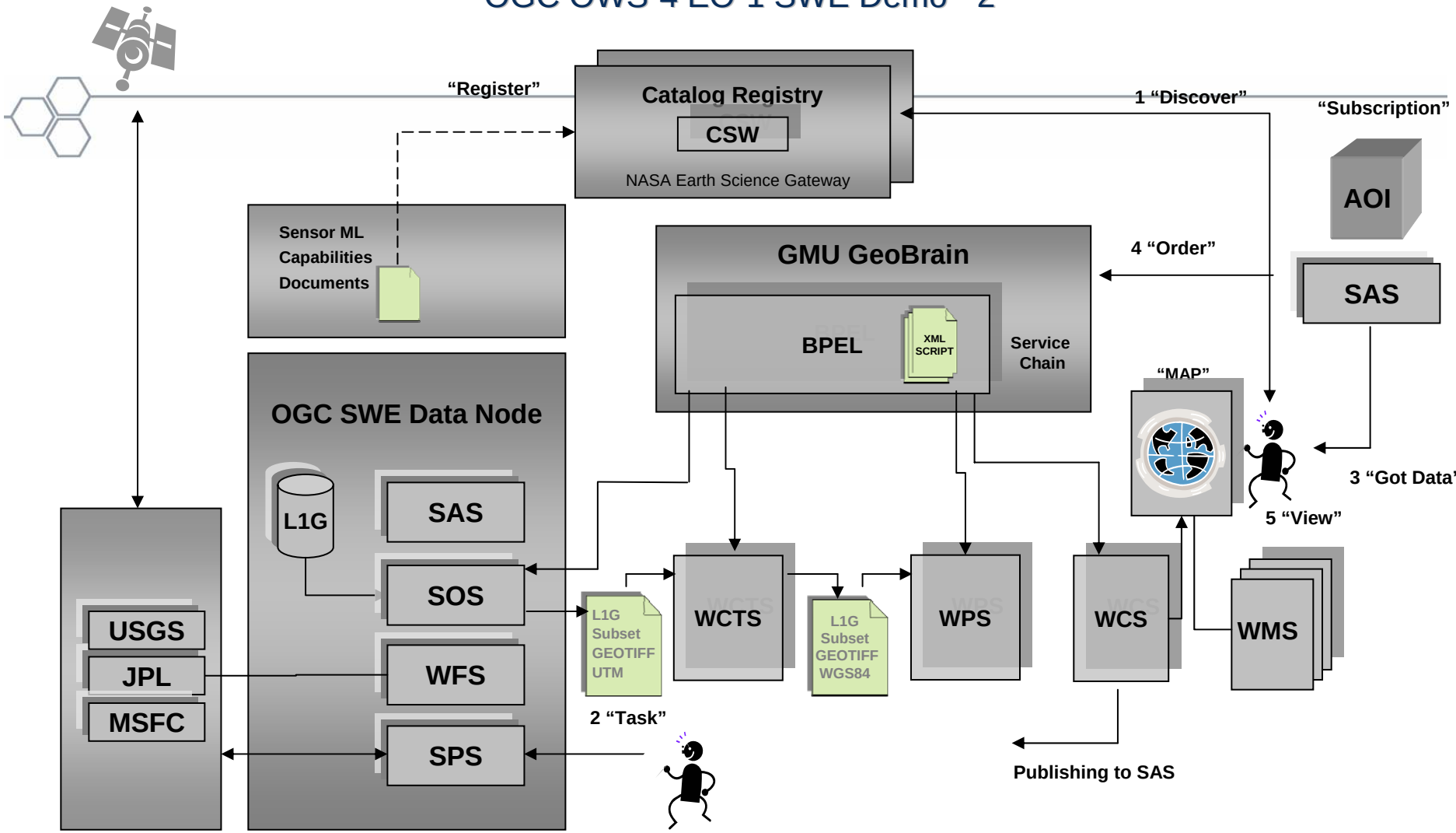
Architecture (2)



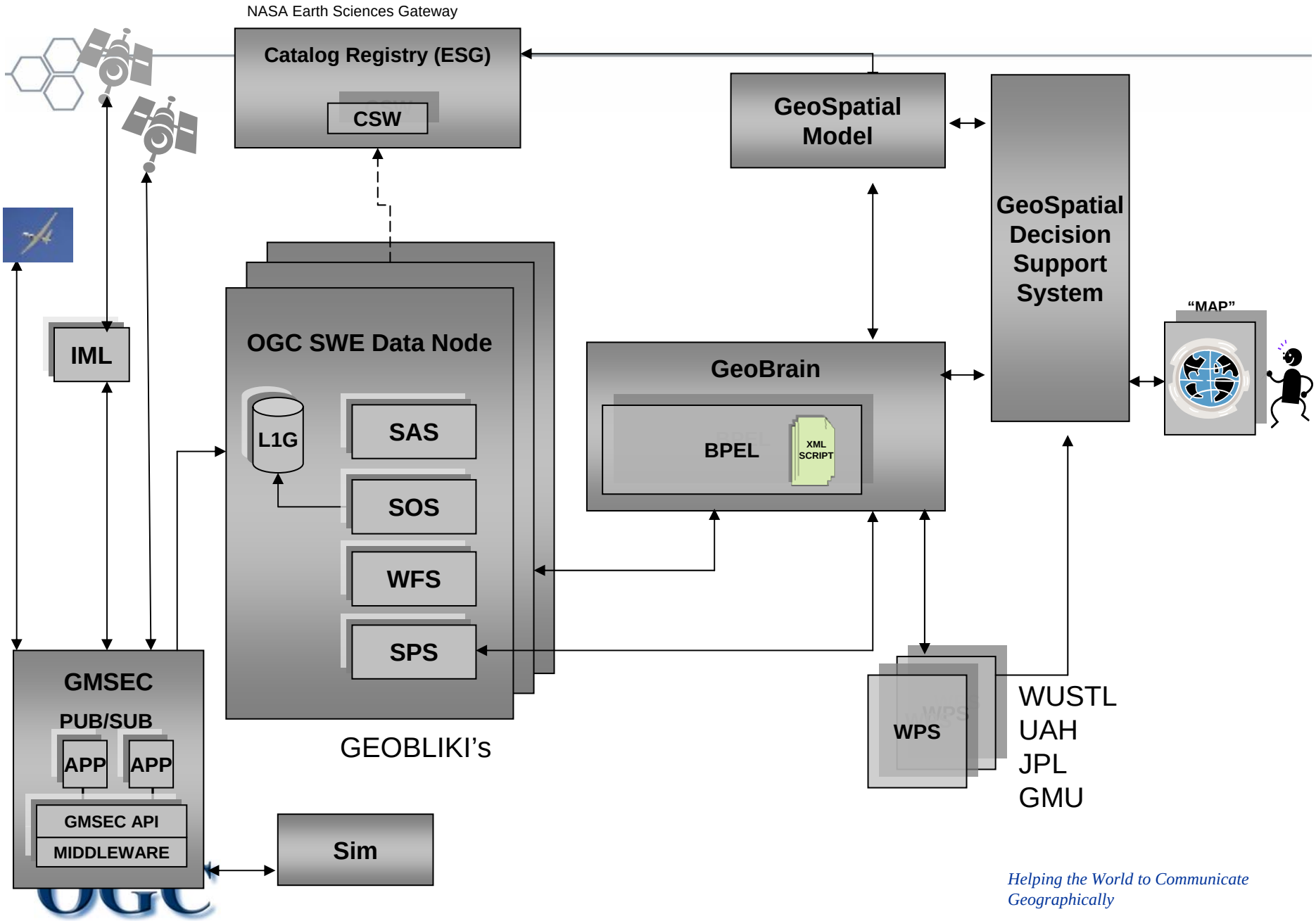
Future Work

- Applying Geodrm Standards in the Sensor Tasking Step
- Decoupling Services in BPEL Engine
- Parallel Tasking of Sensors (International Collaboration)
- On-demand Data Provision to Decision Support Systems

OGC OWS-4 EO-1 SWE Demo - 2



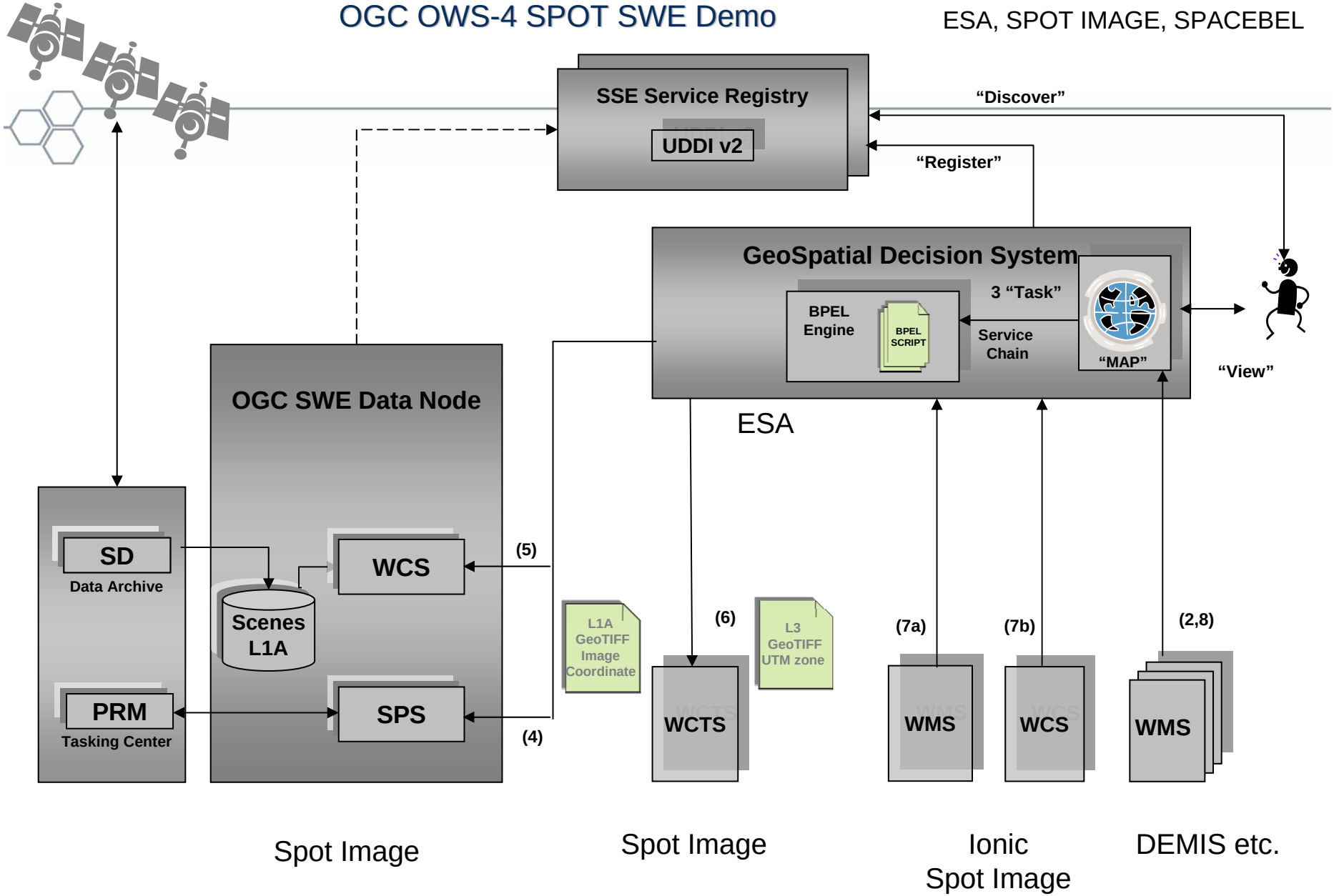
EO-1 SWE Demo - 3



Helping the World to Communicate Geographically

OGC OWS-4 SPOT SWE Demo

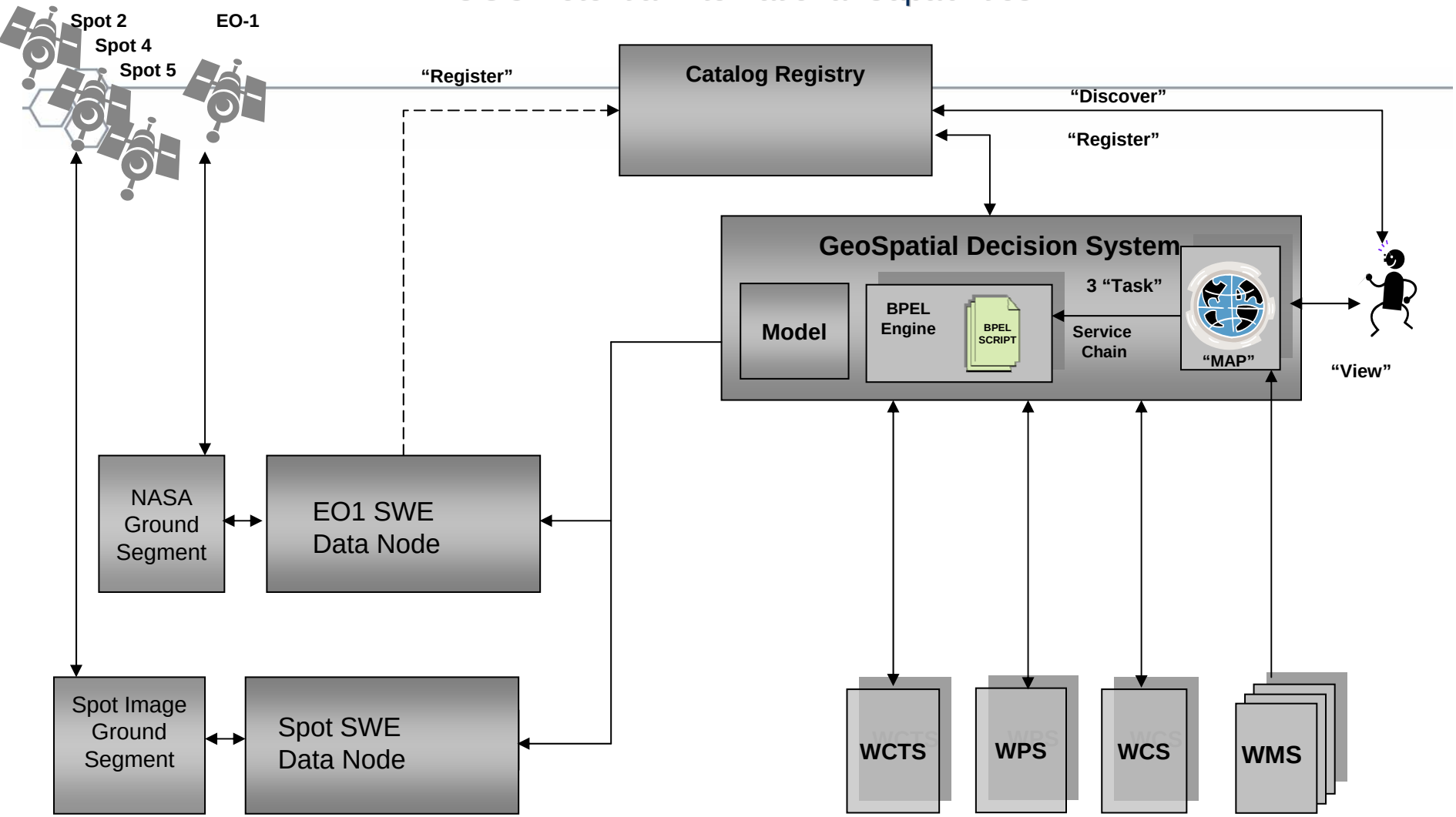
ESA, SPOT IMAGE, SPACEBEL



OGC

Helping the World to Communicate Geographically

OGC Potential International Capabilities



Links

- **GMU**
  - http://geobrain.laits.gmu.edu:8098/bpel.
- **NASA ESG**
  - http://esg.gsfc.nasa.gov
- **EO-1 SWE Data Node**
  - http://eo1.geobliki.com
- **DataFed WPS**
  - http://webapps.datafed.net/datafed.aspx?
  - http://webapps.datafed.net/datafed.aspx?page=OWS4/EODemo
- **Spot Tasking**
  - http://hma.eoportal.org
  - http://services.eoportal.org

NASA ESG Background Information

NASA Earth Science Gateway (ESG) Conceptual Overview

Standard Browser, Web Mapping

3D GeoBrowser

Workstation Applications, Thick Clients

ISO & OGC Interfaces

Earth Science Gateway

- Portrayal Services
- Processing Services
- Catalog Services

WMS

WFS

WCS

Catalog

Earth Science Components

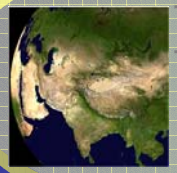
- Knowledge Base
- Digital Libraries
- Models
- ESMF
- Grid Resources
- Mission Data Products
- EOS Catalogs

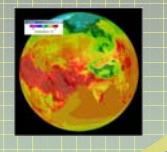
Extensible, open service-oriented architecture

OGC

Helping the World to Communicate Geographically

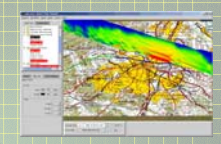
Visualization Tools
-NASA Worldwind
-Google Earth





Query Clients

Decision Support Tools
-National Apps DSTs
-Space-Time Toolkit


NASA Earth Science Gateway

Service-Oriented
Platform for Interoperability

Support for Domain-specific Ontologies

Support for Geo-Collaboration

Services
-Transformation
-Simulation & Modeling
-Mediation
-Workflow/chaining
-etc


Resources: Data, Services, Models, Documents, etc

Catalogs/Clearinghouses
-GSDI, NSDI, GOS, GCMD, ECHO
-etc

NASA Earth Science Gateway (ESG)
Catalog Features

- **Registering** variety of resources including OGC services (WMS, WFS, WCS, context documents) and earth science resources (documents,contexts, etc).
- **Harvesting** metadata from OGC services by mapping a service's GetCapabilities response to the latest OGC ebRIM profile.
- **Describing** resources using FGDC and ISO 19115 metadata.
- **Harvesting** Z39.50-enabled clearinghouse nodes such as the Global Change Master Directory (GCMD) & the Global Spatial Data Infrastructure (GSDI).
- **Querying** other CS-W catalogs such as NASA ECHO.
- **Accepting queries** (both publish and search) from external software components or services via the OGC CSW interface.
- **Supporting different classification schemes**: including the ISO 19119 topic categories, the NASA national applications, and science research areas.

NASA Earth Science Gateway (ESG)
Portal Features

- **Discovery interface** allowing users to search for geoscience data and services based on resource types (Web services; models;, etc.); topic categories (e.g., agriculture, oceanography); keywords; time and date; or geographic location (specified as a place name, or as a place on a map). ESG allows searches not only against its own list of resources, but the GSDI Clearinghouse as well.

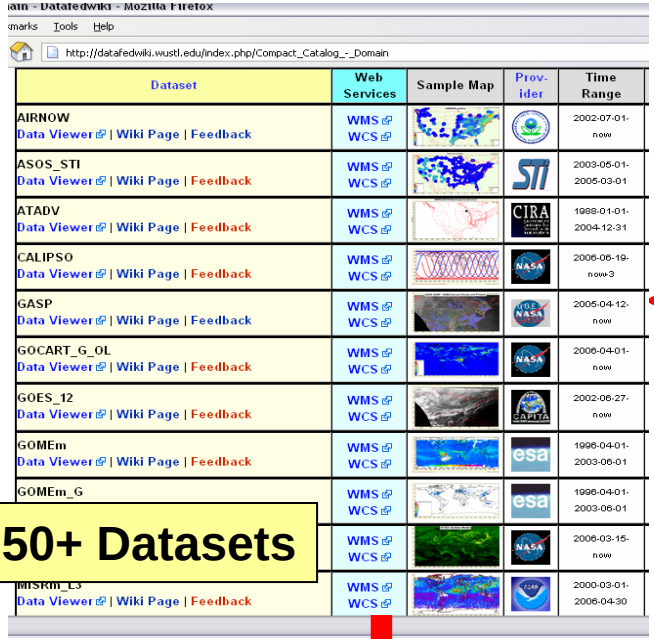
- **Publishing interface** allowing users to advertise resources. For each resource, the publishing process assembles one or more metadata records from the online service description; from a metadata record referred to by a URL; or from user input.

- **Viewer interface** providing controls to zoom and pan; manipulate layers; identify data values behind the view; transform the view to a variety of coordinate reference systems; and others. The viewer exercises the OGC Web Map Service (WMS) to retrieve visual “layers” from remote servers and to display them in a single view.

DataFed Background Information

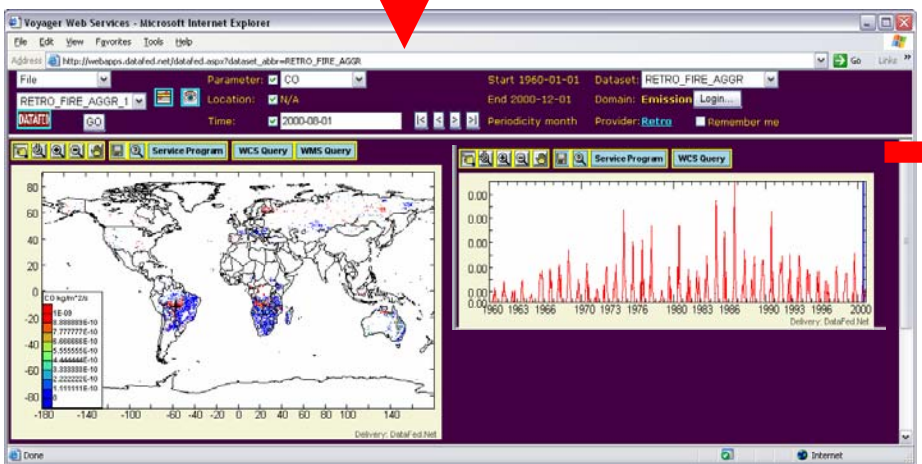
Federated data system - DataFed

The Data Federation is a web-based infrastructure for distributed data access and collaborative processing/analysis of air quality and atmospheric data. (Husar et al., 2004)



50+ Datasets

http://datafed.net



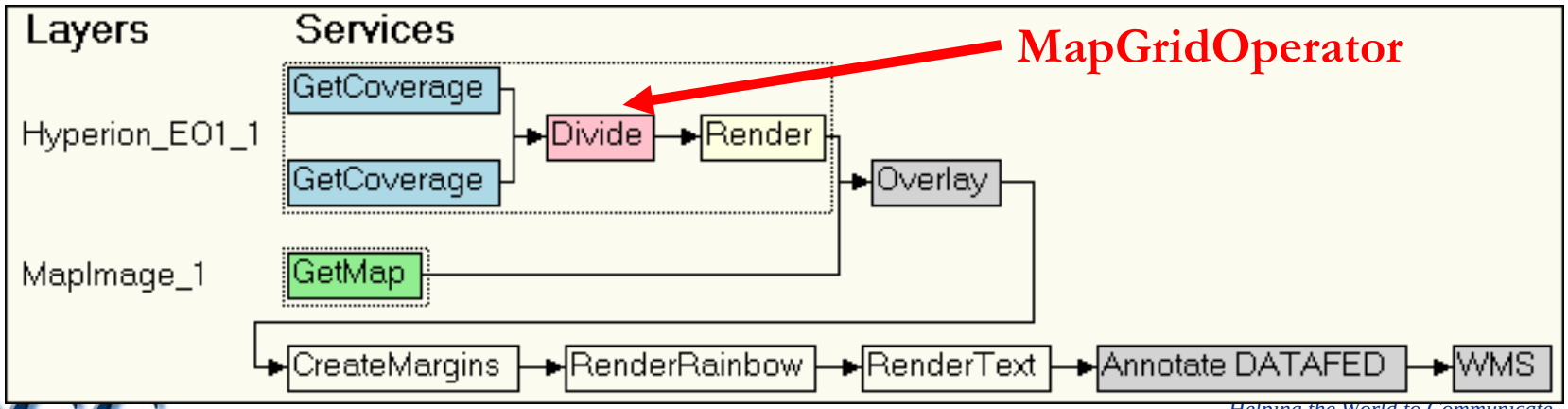
Process, export or connect to other web services

WCS URL Params	URL Parameter Values
http://	http://webapps.datafed.net/ogc_Retro
SERVICE=	wcs
REQUEST=	GetCoverage
VERSION=	1.0.0
CRS=	EPSG:4326
COVERAGE=	CO
TIME=	2000-08-01
BBOX=	Lon Min/Max -180 180 Lat Min/Max -90 90 Elev Min/Max 0 0
WIDTH=	361
HEIGHT=	181
DEPTH=	-1
FORMAT=	CSV Table
Filters:	Location: BBOX Time: Time Instance Value: All Values

Helping the World to Communicate Geographically

DataFed Processing Services

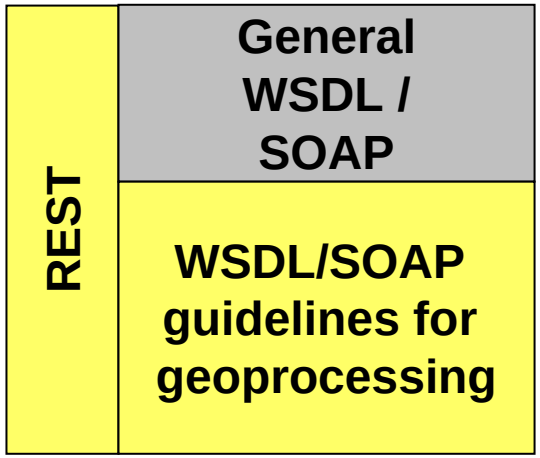
- MapGridOperator - conducts a mathematical operation on two input grids and generates a third grid as output
  - **Process Service Inputs**
    - Grid 1 (GeoTiff, netCDF, …)
    - Grid 2 (GeoTiff, netCDF, …)
    - Selected Operation (add, subtract, …) or user defined expression
    - Spatial bounding box in which operation should be executed
    - Spatial resolution of the output grid (# rows, columns)
  - **Process Service Output**
    - Grid (GeoTiff, netCDF, …)



DataFed Processing Services

- OGC WPS interface is built on top of SOAP/WSDL processing service

REST extension to WSDL
-GetCapabilities
-DescribeProcess
-Execute



WPS components shown in yellow

Geoprocessing “application profile” for WSDL/SOAP
-provide WSDL restrictions
-standardized schemas for data types (for example, might define a GML for WSDL, specify that netCDF files using the CF 1.0 convention, etc.)

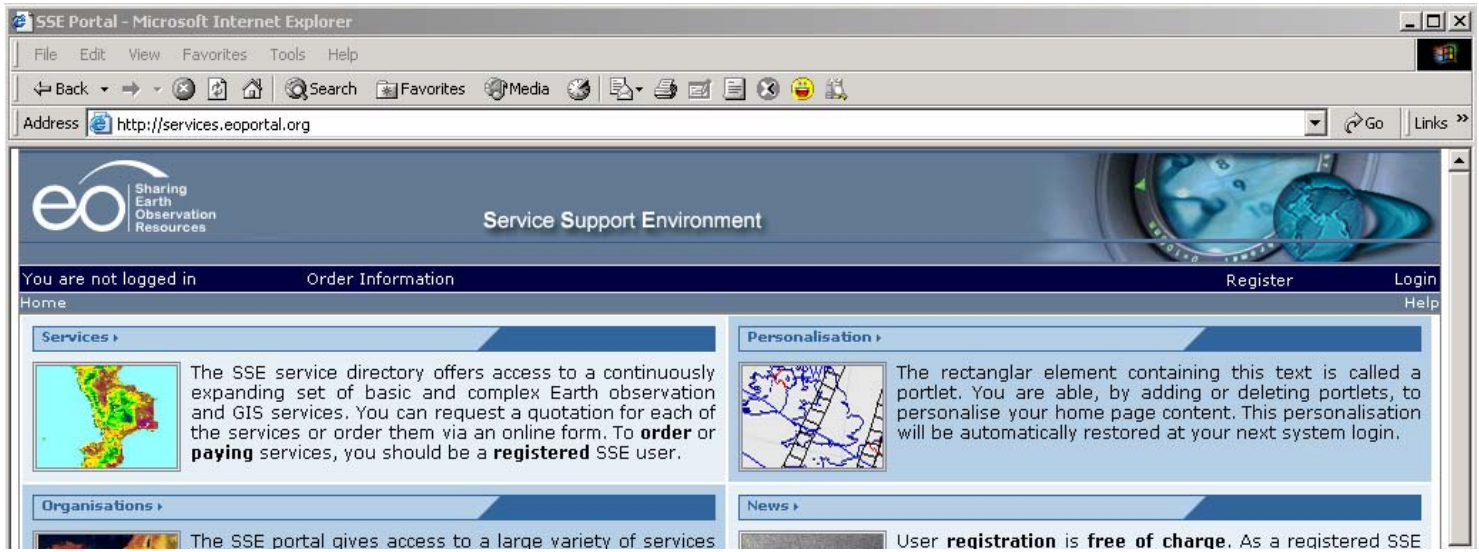
SPOT Background Information

SSE BPEL SWE Controller

- Built on the Service Support Environment (SSE) (http://services.eoportal.org):

  SWE Controller Service (Virtual SPS):

  - implements the service chain SPS→ WCS → WCTS → WMS.
  - is accessible via the SSE portal web pages and a separate SOAP-binding Web service interface.



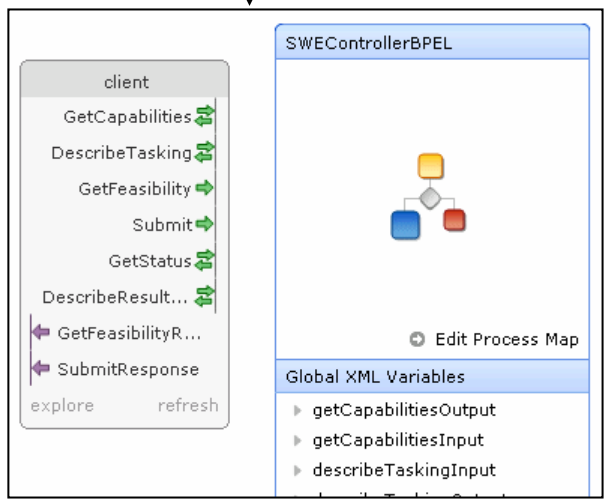
Deployment Architect

SSE Users

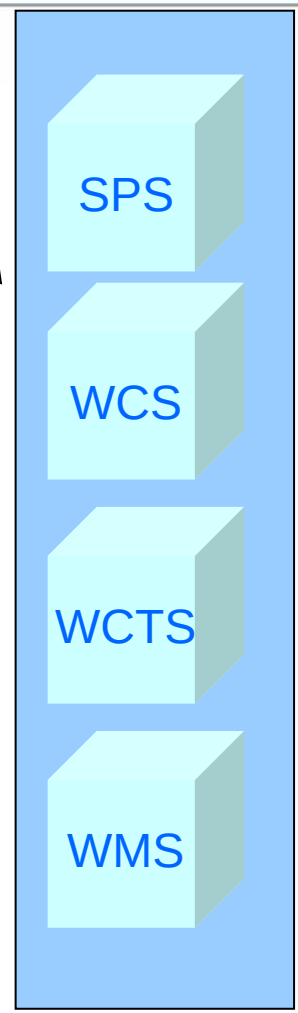
- GetFeasibility
- Submit

External
SPS Clients

- GetCapabilities
- DescribeTasking
- GetFeasibility
- Submit
- GetStatus
- DescribeResultAccess



BPEL SWE Controller



Spot Image
Services

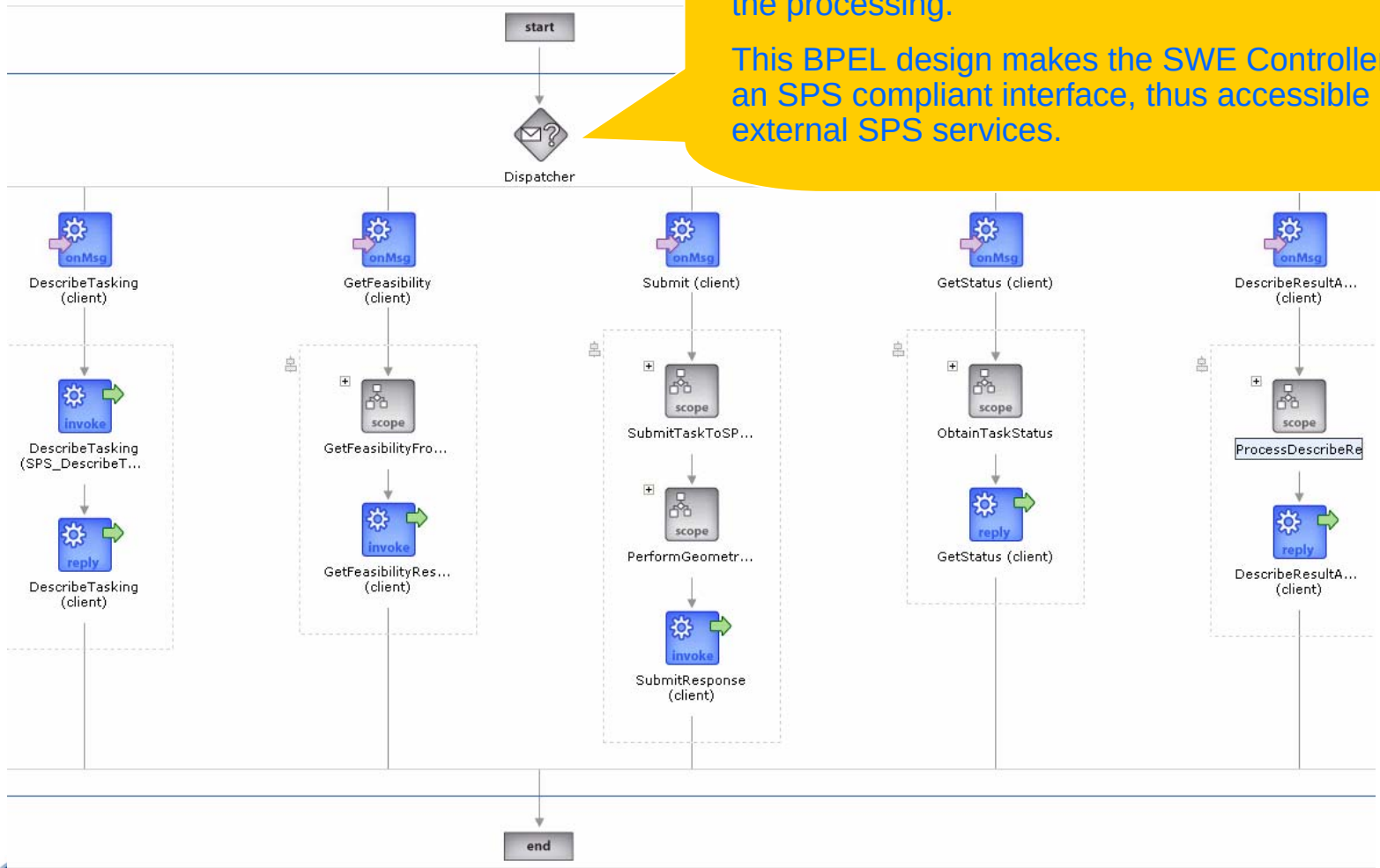
OGC

Helping the World to Communicate Geographically

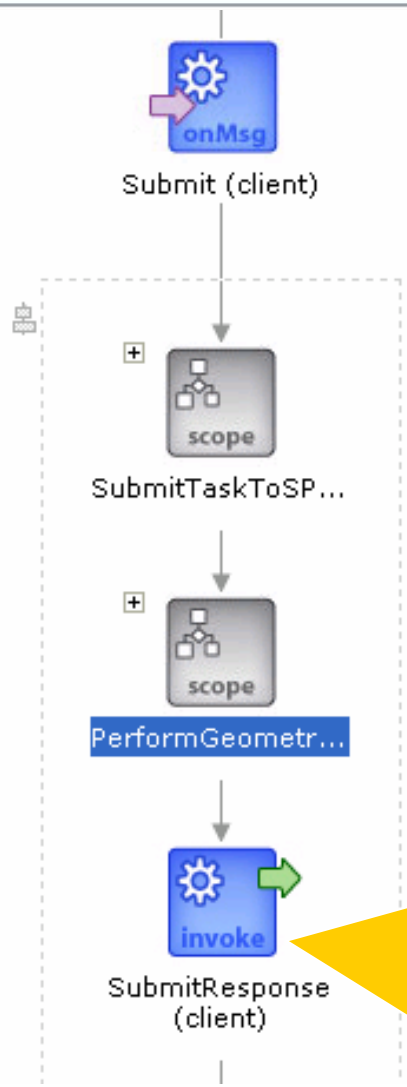
Service Chain BPEL Diagram

Requests sent to the SWE Controller BPEL are dispatched to the corresponding workflow during the processing.

This BPEL design makes the SWE Controller have an SPS compliant interface, thus accessible by the external SPS services.



Service Chain BPEL Diagram

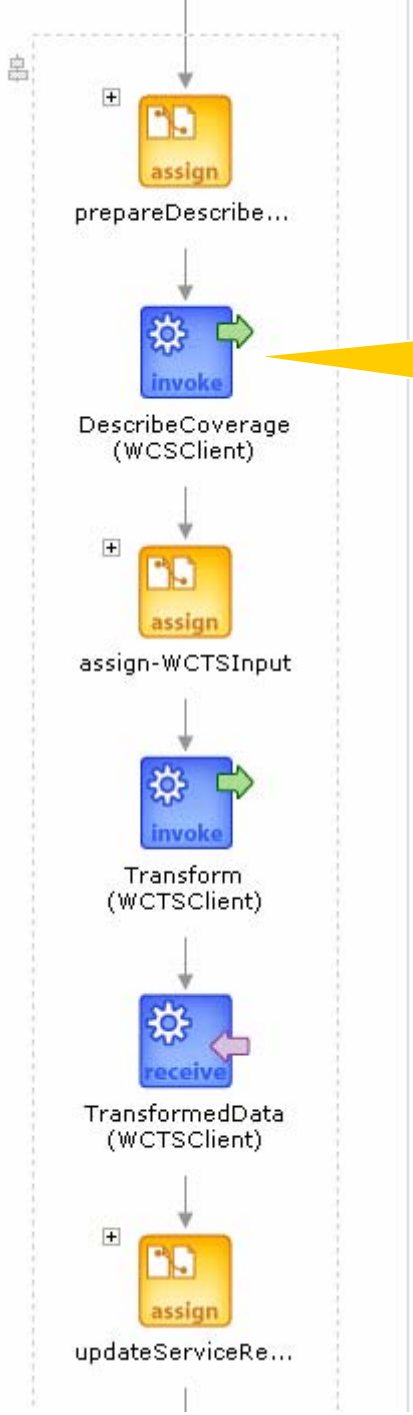


On reception of a Submit request that requires geometric processing on the planning image, the SWE Controller BPEL will firstly submit a plan to the SPS service. And when the plan finishes, it requests the WCTS service for the geometric processing on the image.

Notes:

- Geometric processing is performed asynchronously. This means the Submit requester receives the SubmitResponse as soon as the plan is accepted by the SPS service.
- GetStatus and DescribeResultAccess requests are applied to get known when the final image is available and how it can be accessible.

Service Chain BPEL Diagram



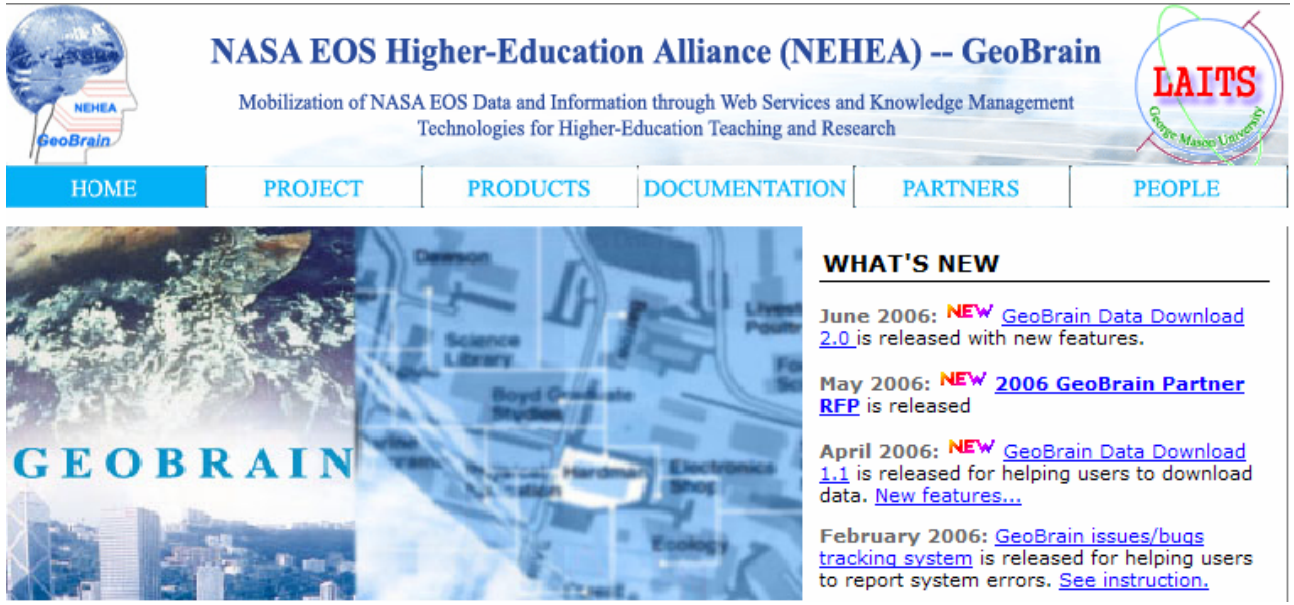
Accessing the WCS service for the image coverage description.

The description is then used to prepare the request to send to the WCTS service

GeoBrain Background Information

GeoBrain

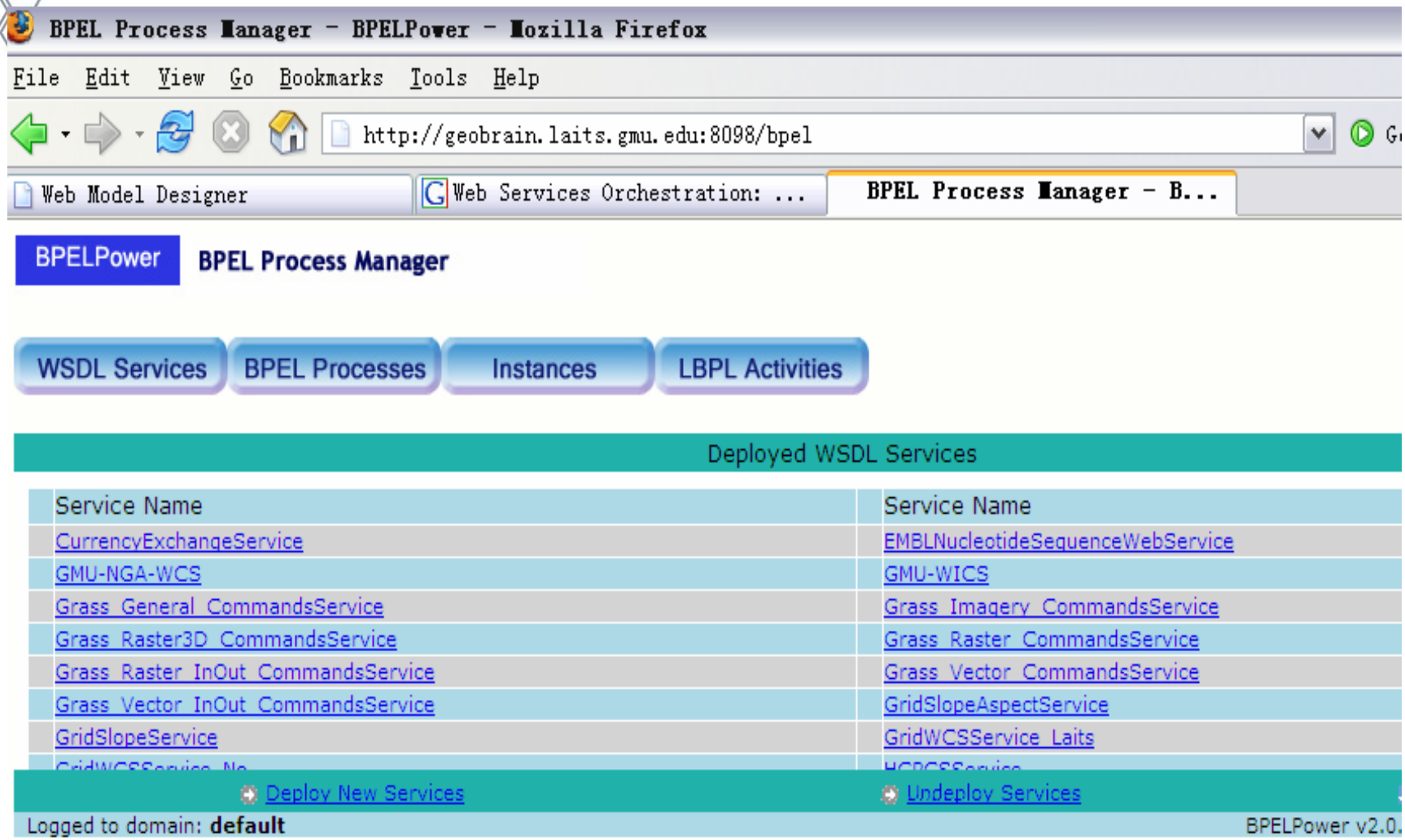
- GeoBrain (http://geobrain.laits.gmu.edu)
  - A Web Service based geospatial knowledge system
    - Produce the user specific data products by creating and executing geospatial process models (service chain/workflow)



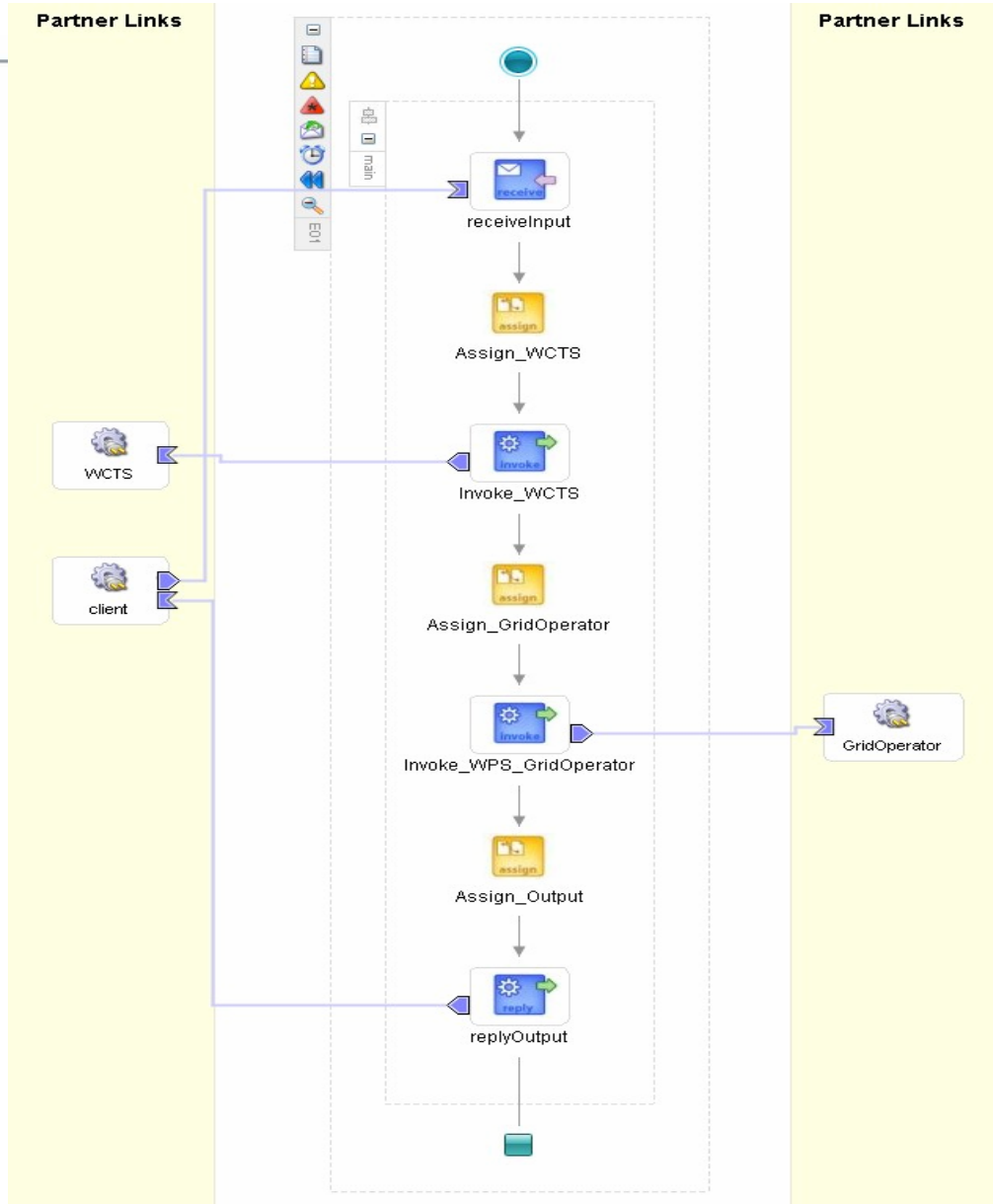
BPELPower – Service Chain Engine

- Based on the mainstream standards
  - BPEL, WSDL, WSIF, Xalan, Xerces, UDDI, AXIS, SOAP, JNDI, J2EE (servlets/EJBs/JSPs), Jetspeed (Portlets) and JMX. It runs on top of popular application servers, such as Tomcat, J2EE, JBoss, Weblogic and WebSphere.
- “Deploy it".
  - WSDL-based web services and BEPLE-based web services chain can be deployed in BPELPower, where their validations are checked.
- “Try it".
  - WSDL-based web services and BEPLE-based web services chain can be executed in BPELPower dynamically. Different invocations (e.g., HTTP POST/GET, SOAP document/rpc, etc.) are well supported.
- See detail at http://geobrain.laits.gmu.edu:8098/bpel.

BPELPower – Service Chain Engine



BPEL Diagram of OWS4 SWE Demo

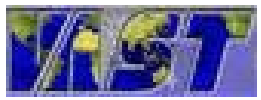


EO Demo Participants

GeoBliki

Innovative Solutions

Vightel Corporation



UAH VAST

GMU