



# OWS-4 Earth Observation Demo

December 2006



# Background

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- **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

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- **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

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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

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*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)

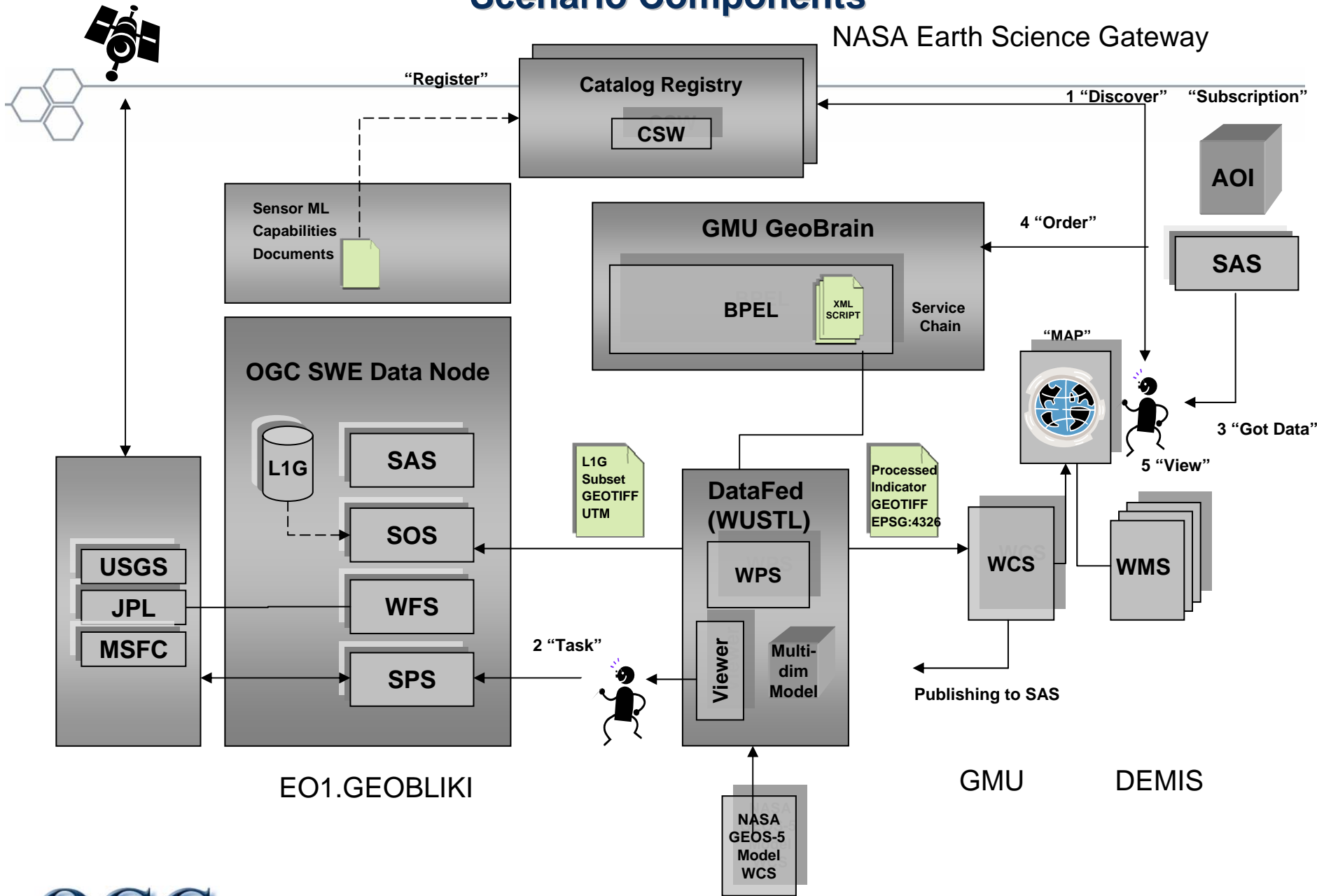


# Scenario Steps

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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

The screenshot displays the NASA Earth Science Gateway interface. The top navigation bar includes the NASA logo and the text "Earth Science Gateway National Aeronautics and Space Administration". Below this, there are tabs for "Home", "Find/View", and "Browse". The "Find/View" tab is active, showing a search results panel on the left and a metadata information section on the right.

The search results panel on the left includes a "WES Assistant" section with a "What do you want to do?" menu. The menu items are: Home, Locate, Search, Login, Save, and Print. The "Search" item is selected, and the search results are displayed in a map view.

The metadata information section on the right includes the following details:

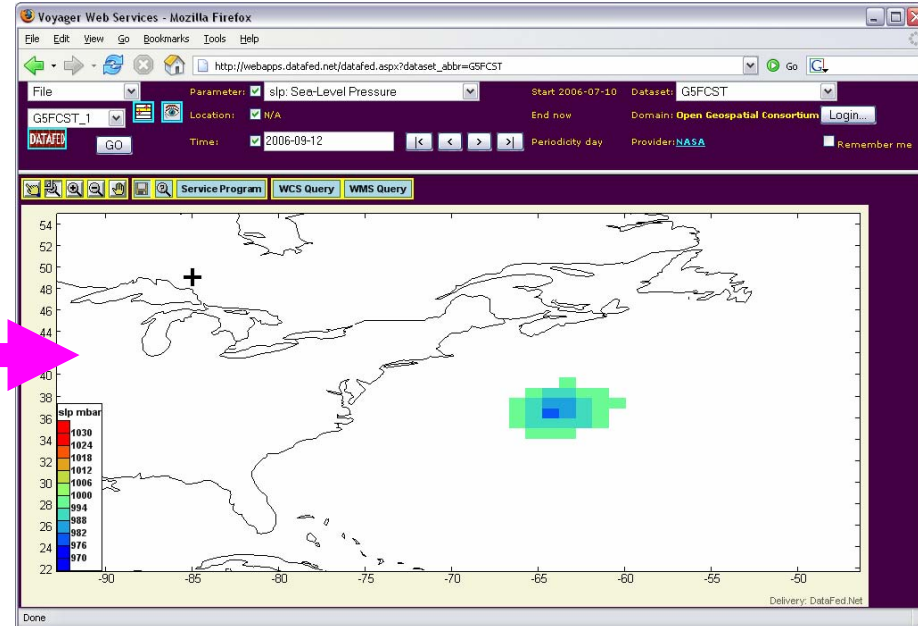
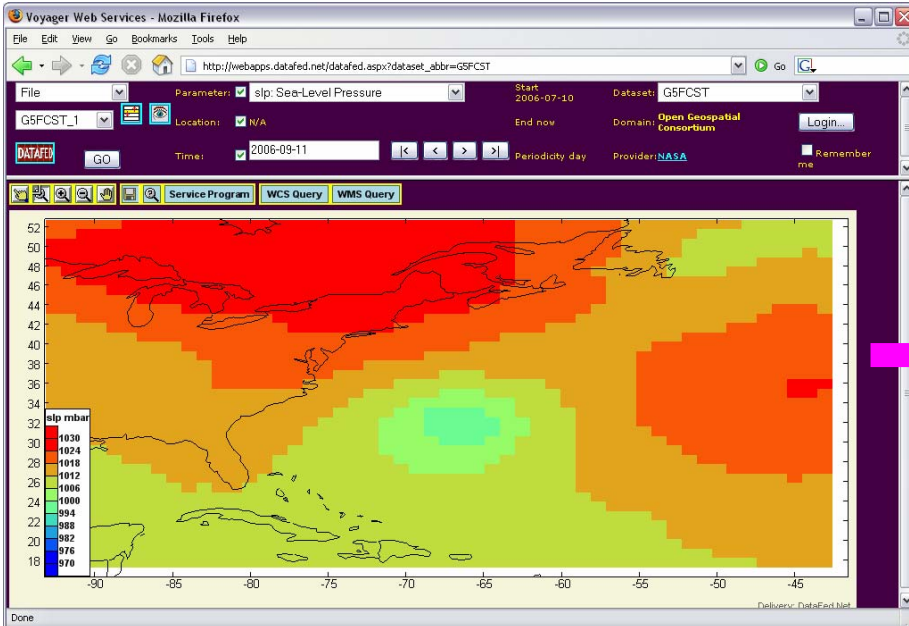
- ContextDocument ID:** 43F0379C-D93C-D7EC-1532-7C173C8398A7
- Title:** SIVO WMS - G5FCST
- Description:** The MAP 06 Project so named for its affiliation with NASA's Modeling, Analysis, and Prediction (MAP) program, applies NASA's advanced satellite remote sensing technologies and earth system modeling capabilities to improve our understanding of tropical cyclones that develop in and move across the Atlantic basin. MAP 06 implements the most recent version of the Goddard Earth Observing System (GEOS) fifth-generation global atmospheric model and the Grid point Statistical Interpolation (GSI) analysis system under development as a collaboration between NOAA's National Centers for Environmental Prediction (NCEP) and the Global Modeling and Assimilation Office (GMAO) at GSFC. In addition, the capability to initialize the Weather Research and Forecast (WRF) regional model using GEOS-5 was developed and implemented. The project began in the early portion of the 2006 hurricane season and continued through late autumn.
- Originator:** NASA Science Visualization Studio
- Rank:** 0.0
- Last Updated:** 2006-12-08 17:45:35

The metadata information section also includes a "View Details" button and a "Preview" button. The "Preview" button is highlighted in a red box. The "Preview" button is located in the bottom right corner of the metadata information section.



## 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

GeoBliki: EO1 Tasking

Use crosshair tool to select lat/long from the map

Day/Night: Day

Latitude: 40.692

Longitude: -74.182

Get Feasibilities

Linda,

Satellite: EO1

Path: 14

Row: 32

Latitude: 40.692

Longitude: -74.182

Date: 2006-12-08T15:21:00Z

Instrument: hyperion

Priority: normal

Cost: 1913.75

Comments: OWS-4 Demo

submit task request

return to main page

Heterogeneous Missions Accessibility Environment

User: pmerigot

Order List

My Profile

Log out

SWE Controller Request For Quotation

Survey Periods:

From Date: 2006 Dec 08

To Date: 2006 Dec 30

Incidence Angle: Unspecified

Country: United States

Place Names:

Geometric Processing: Ortho

Please fill in the following fields to request for quotation

Submit RFQ

ID	Satellite	Resolution	Geolocation	SuccessRate
1006-249.2	SPOTS	10	-75.04373 41.96168 -74.35114 41.43209 -74.51409 43.20222 -75.22274 41.05792	79
1006-249.2	SPOTS	10	-75.21214 41.00991 -74.52297 40.98024 -74.76924 40.41676 -75.26264 40.57972	79
1006-249.2	SPOTS	10	-75.27517 40.00004 -74.58243 40.47574 -74.50972 39.94764 -75.54044 40.00074	65
1007-249.2	SPOTS	10	-74.40796 41.98245 -75.71232 41.44803 -75.89224 40.92520 -74.86248 41.05624	72
1007-249.2	SPOTS	10	-74.97351 41.09475 -75.84292 40.95924 -74.46075 40.43494 -74.74633 40.57076	88
1007-249.2	SPOTS	10	-74.79792 40.40786 -74.81626 40.47285 -74.27743 39.94643 -74.50792 40.00000	82
1007-249.2	SPOTS	10	-74.8944 40.1204 -74.21896 39.94628 -74.39214 39.44230 -75.24324 39.93417	83
1008-249.2	SPOTS	10	-75.74282 41.58295 -75.04514 41.44275 -75.25425 40.59354 -75.44254 41.00054	87

SPS submit with an updated tasking request (only one scene)

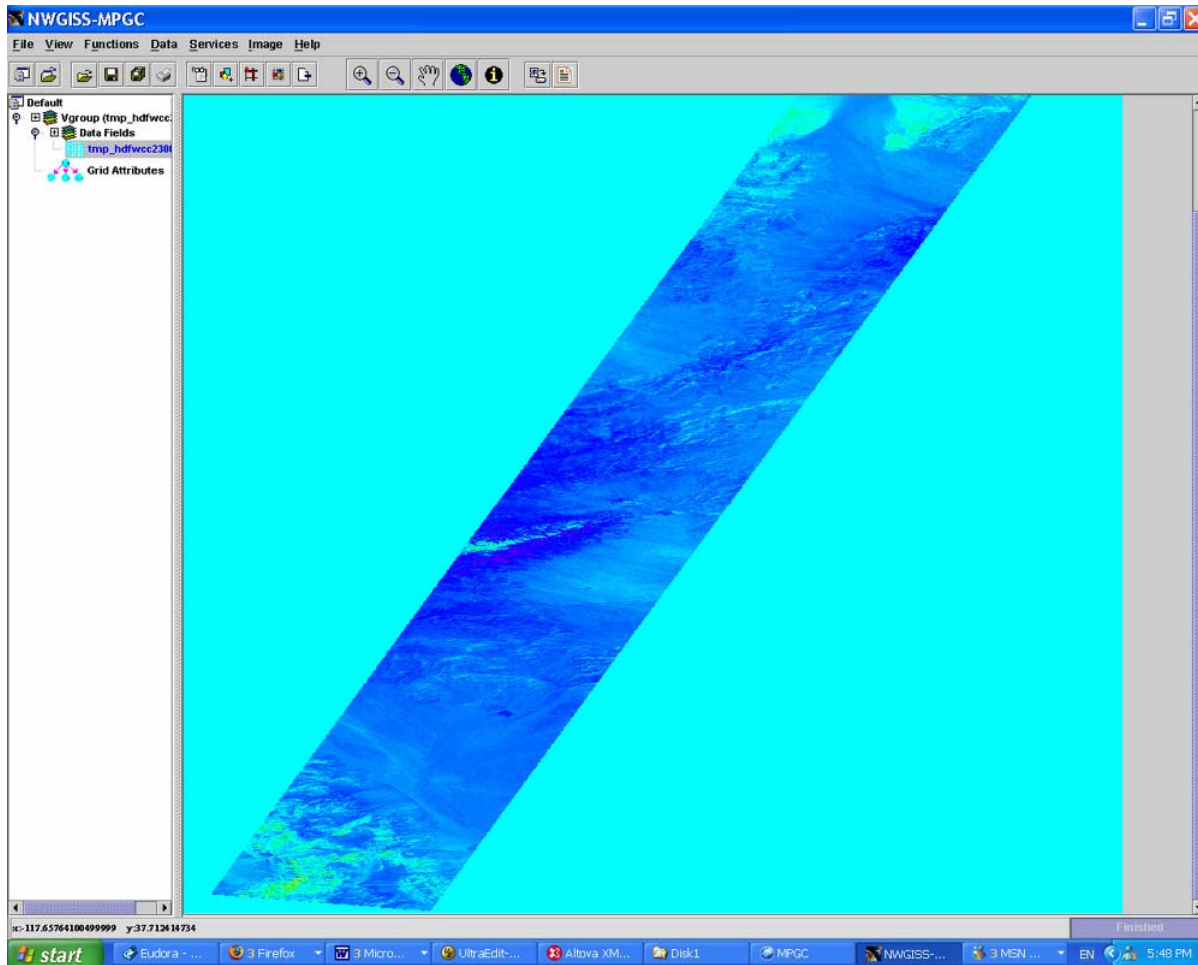
# 4. Analysis Workflow Processing

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

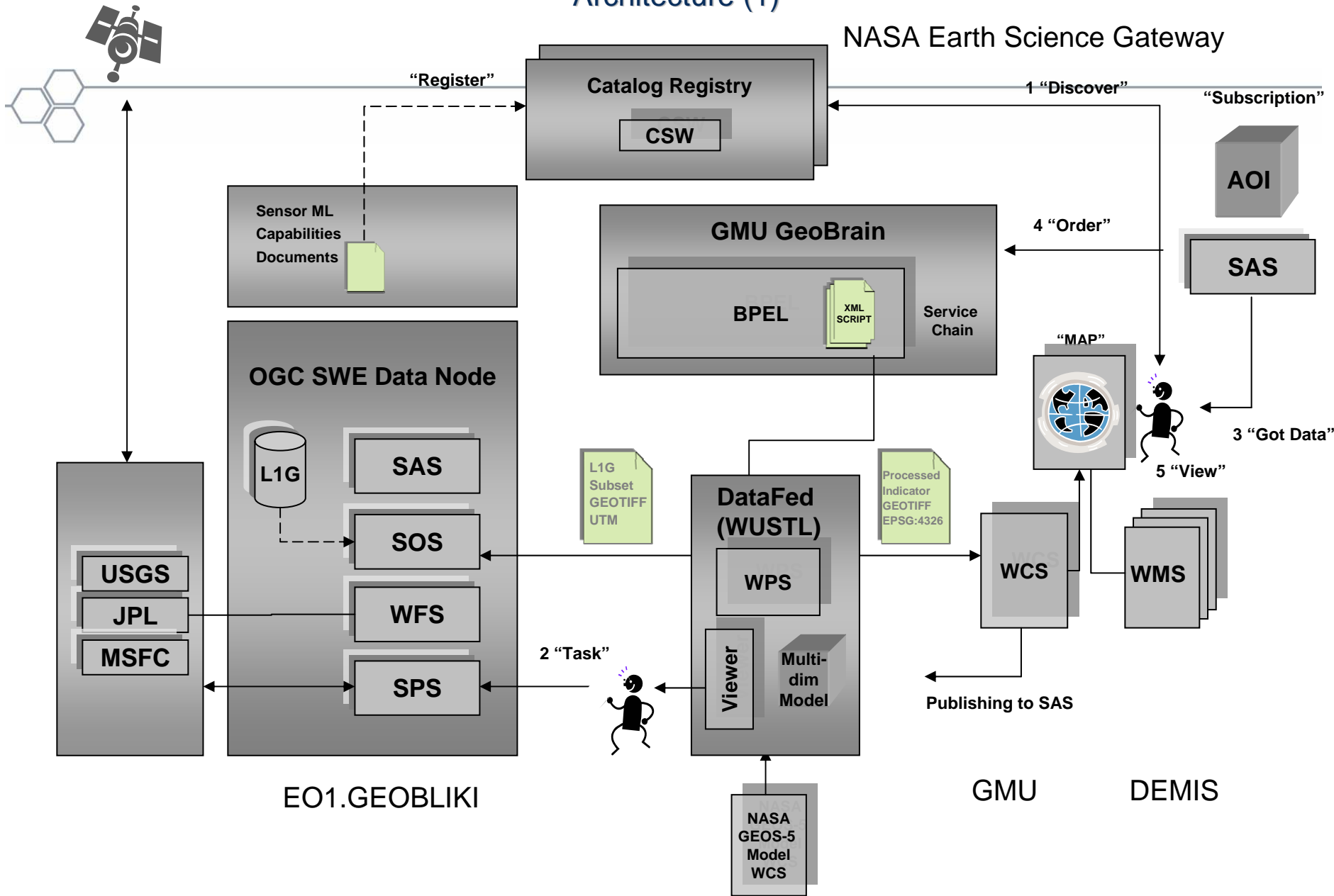
The screenshot displays a BPEL workflow editor interface. The main workspace shows a workflow diagram with the following steps: 'client', 'GridOperation', 'Assign\_GridOperation', 'Invoke\_GridOperation', 'Assign\_Output', and 'replyOutput'. The 'Invoke\_GridOperation' step is highlighted, and an 'Invoke' dialog box is open over it. The 'Invoke' dialog has the following fields: Name: 'Invoke\_GridOperation', Partner Role Web Service Interface: 'GridOperation', Operation: 'Evaluate', Input Variable: '\_GridOperation\_Evaluate\_InputVariable', and Output Variable: '\_GridOperation\_Evaluate\_OutputVariable'. The 'Edit Copy Rule' dialog is also open, showing the 'From' expression as 'a/b' and the 'To' variable as 'ns4:expression'. The 'Invoke' dialog has buttons for 'Help', 'Apply', 'OK', and 'Cancel'. The 'Edit Copy Rule' dialog has buttons for 'OK' and 'Cancel'. The OGC logo is in the bottom left corner, and the text 'Helping the World to Communicate Geographically' is in the bottom right corner.

# 5. Decision Support System

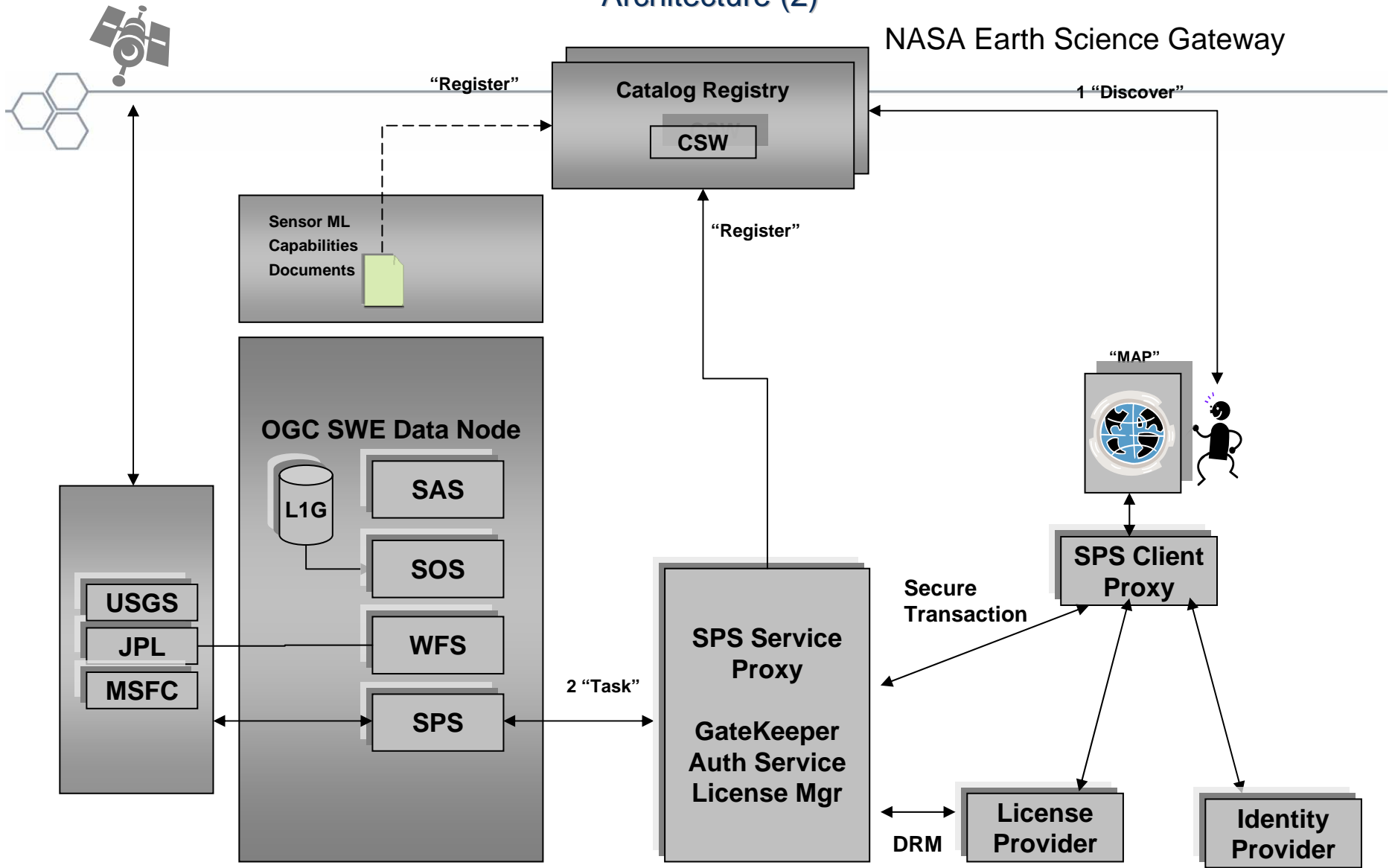
- Output of BPEL workflow is available as a Web Coverage Service (WCS)



# Architecture (1)



# Architecture (2)



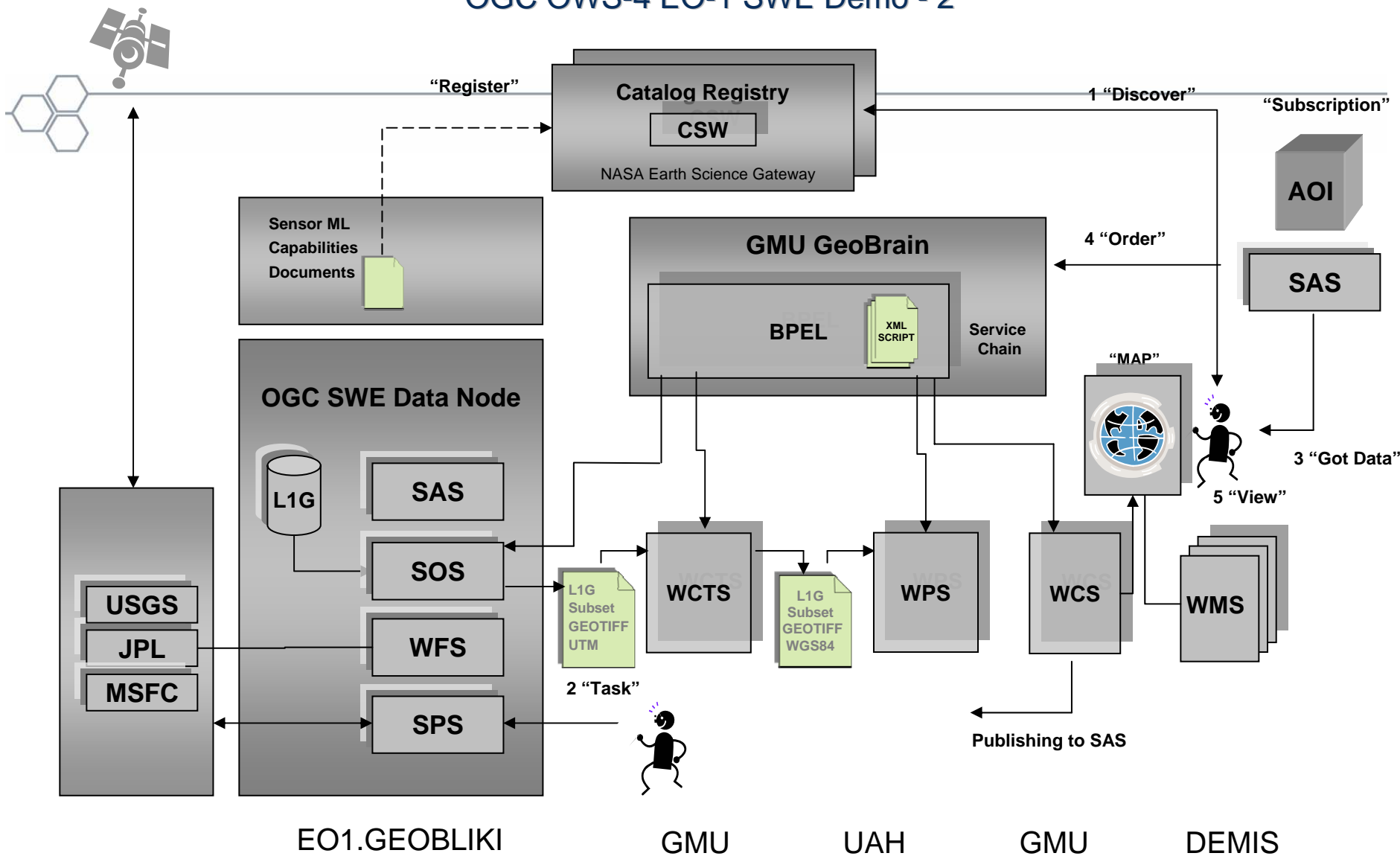
# Future Work

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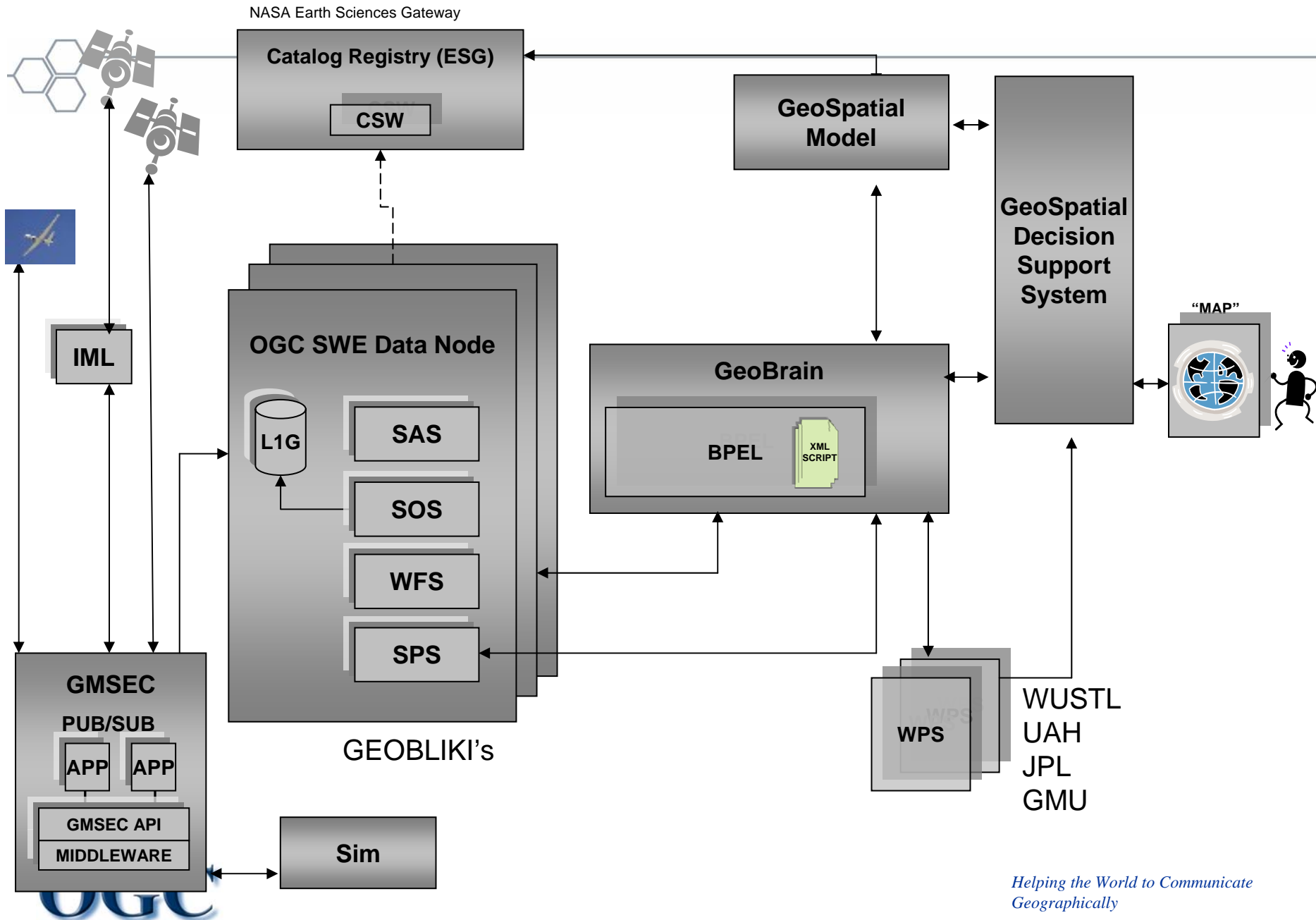
- Applying Geodrm Standards in the Sensor Tasking Step
- Decoupling Services in BPEL Engine
- Parallel Tasking of Sensors (International Collaboration)
- On-demand Data Provision to Decision Support Systems

# OGC OWS-4 EO-1 SWE Demo - 2



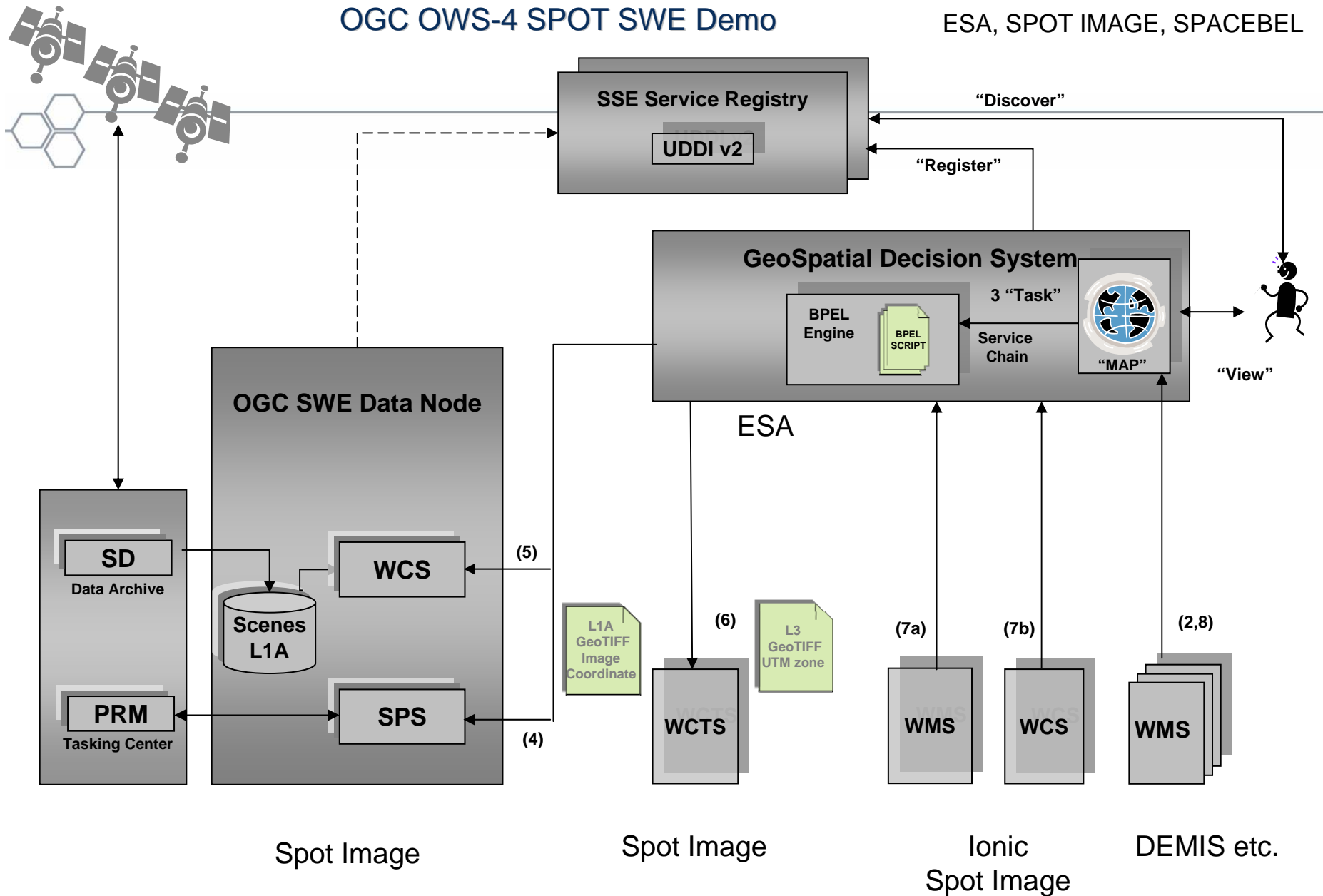


# EO-1 SWE Demo - 3

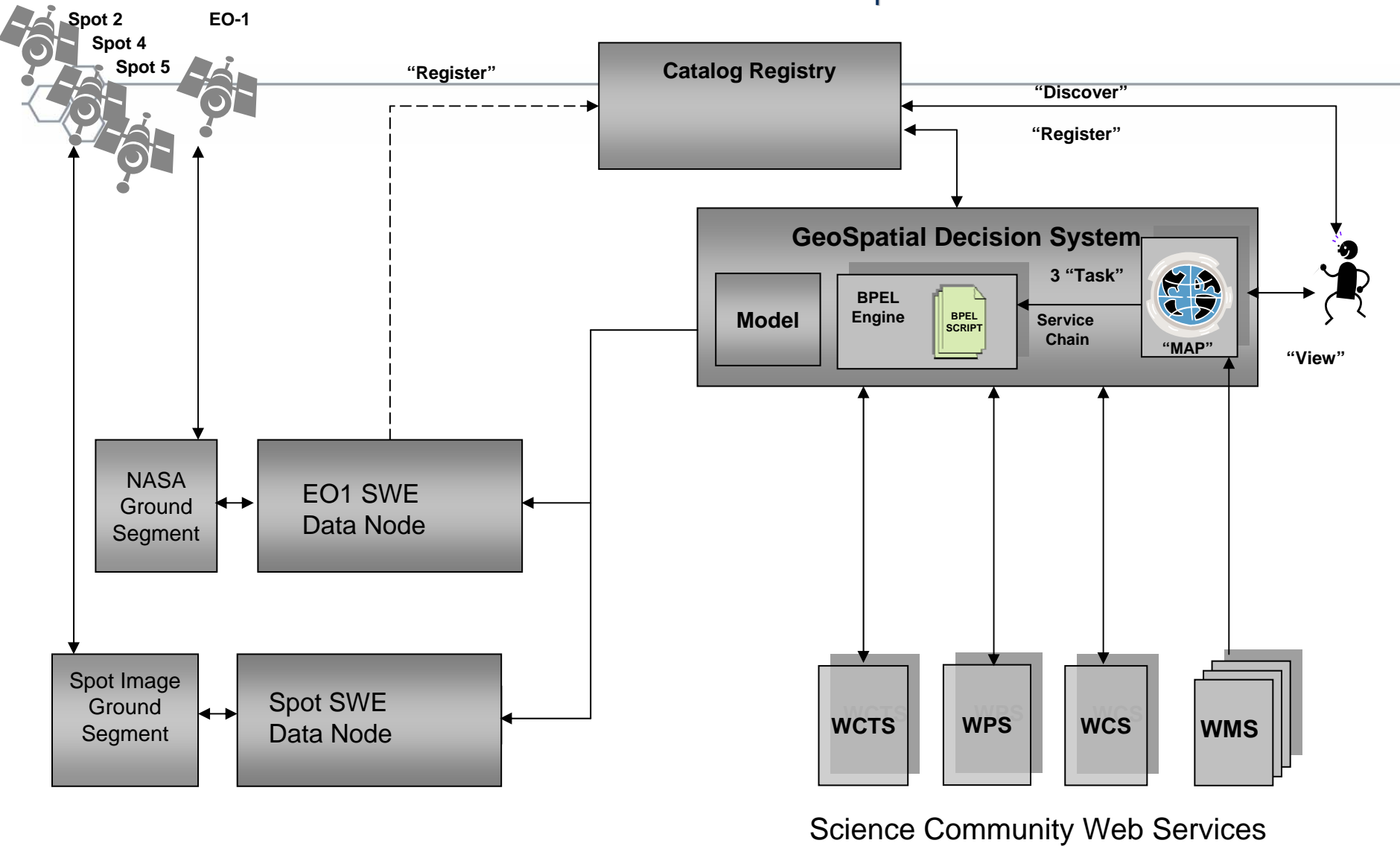


# OGC OWS-4 SPOT SWE Demo

ESA, SPOT IMAGE, SPACEBEL



# OGC Potential International Capabilities



# Links

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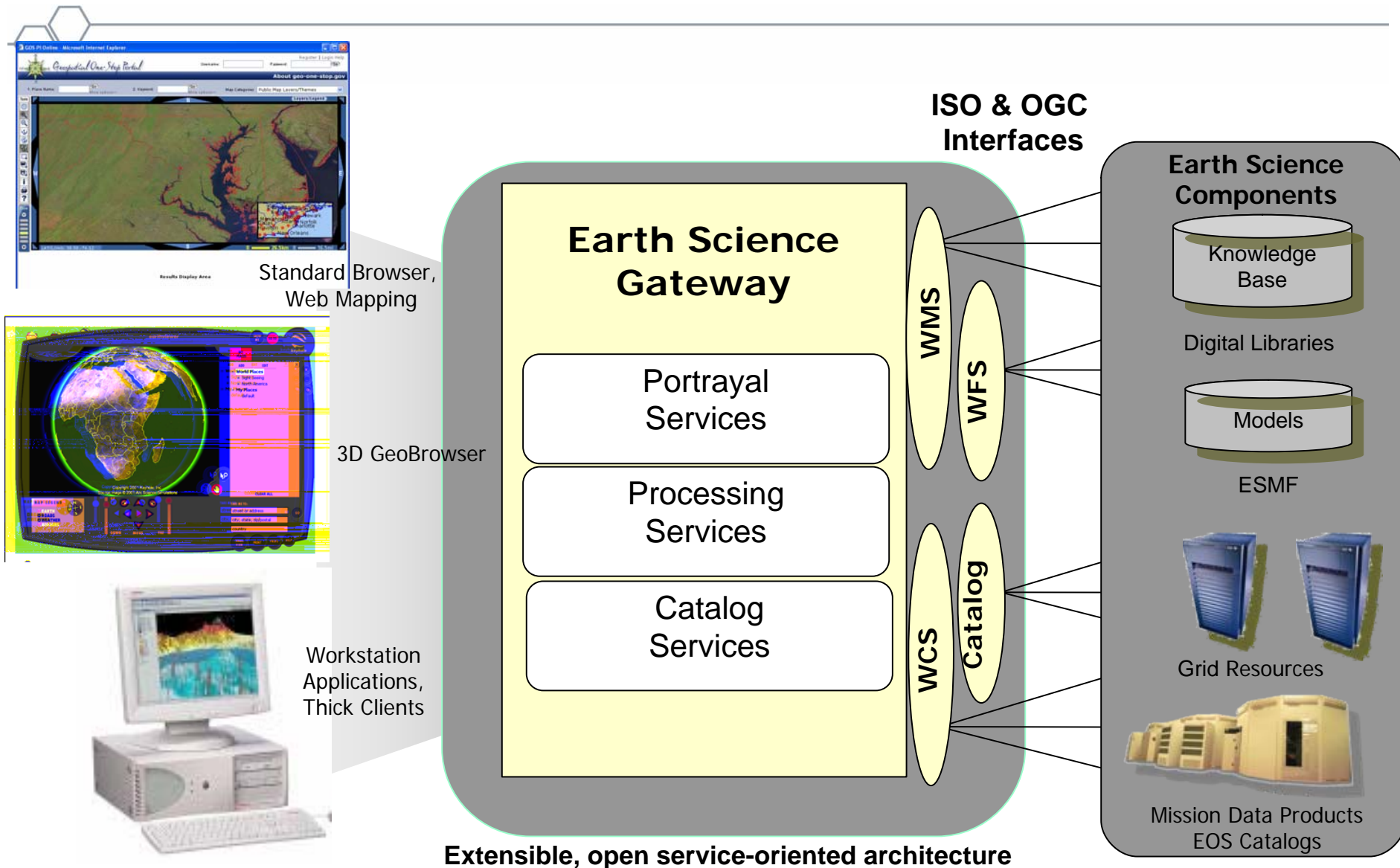


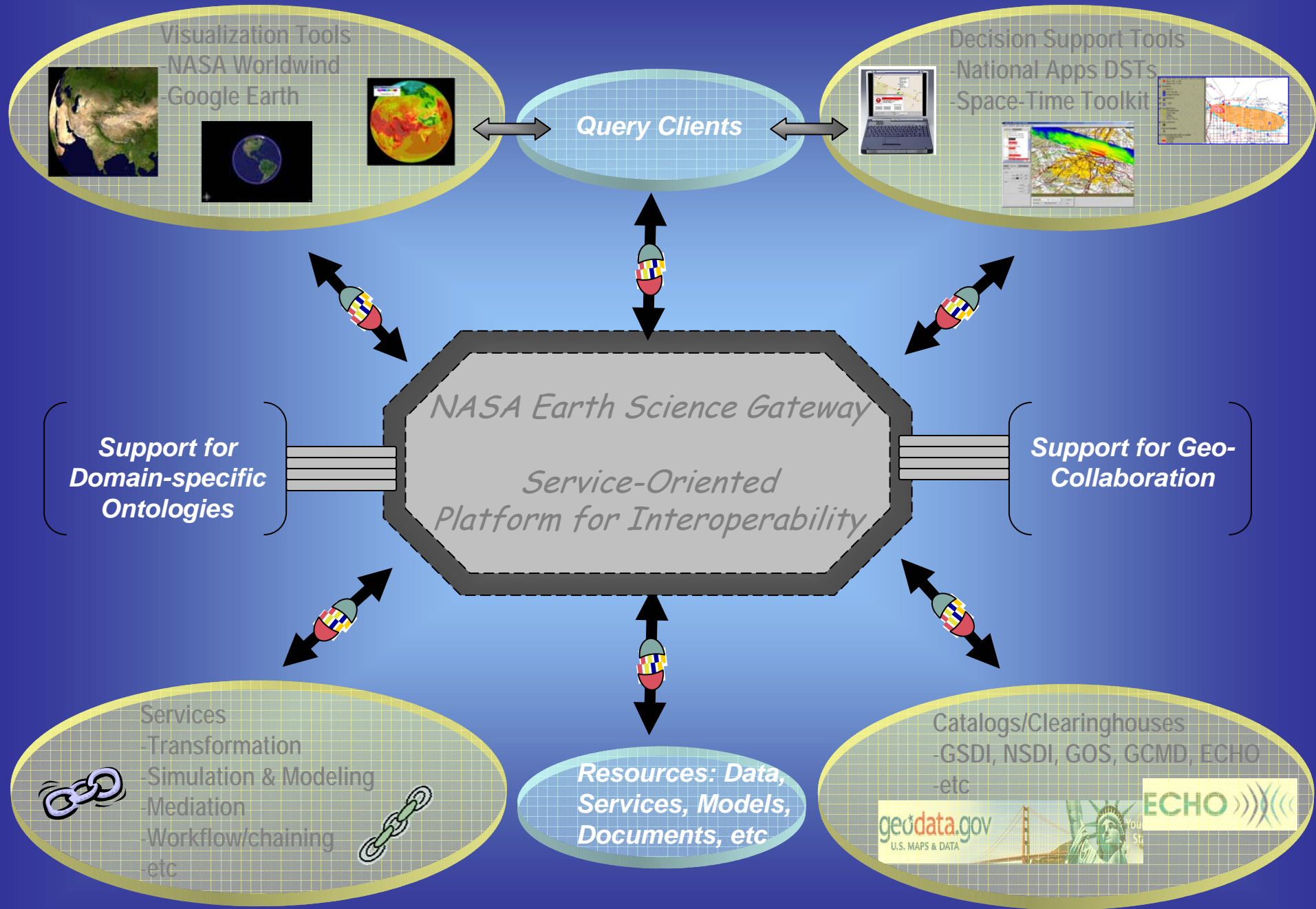
- **GMU**
  - <http://geobrain.laits.gmu.edu:8098/bpel>
- **NASA ESG**
  - <http://esg.gsfc.nasa.gov>
- **EO-1 SWE Data Node**
  - <http://eo1.geoblivi.com>
- **DataFed WPS**
  - <http://webapps.datafed.net/datafed.aspx?>
  - <http://webapps.datafed.net/datafed.aspx?page=OWS4/EODemo>
- **Spot Tasking**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



## NASA ESG Background Information

# NASA Earth Science Gateway (ESG) Conceptual Overview





# NASA Earth Science Gateway (ESG) Catalog Features

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- **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

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- **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](#))

min - DataFedwiki - Mozilla Firefox

marks Tools Help

http://datafedwiki.wustl.edu/index.php/Compact\_Catalog\_-\_Domain

Dataset	Web Services	Sample Map	Prov. Idet.	Time Range
AIRNOW <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2002-07-01- now
ASOS_STI <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2003-05-01- 2005-03-01
ATADV <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			1988-01-01- 2004-12-31
CALIPSO <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2006-06-19- now=3
GASP <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2005-04-12- now
GOCART_G_0L <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2006-04-01- now
GOES_12 <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2002-06-27- now
GOMem <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			1996-04-01- 2003-06-01
GOMem_G <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			1996-04-01- 2003-06-01
MISRIM_L3 <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2006-03-15- now
MISRIM_L3 <a href="#">Data Viewer</a>   <a href="#">Wiki Page</a>   <a href="#">Feedback</a>	<a href="#">WMS</a>   <a href="#">WCS</a>			2000-03-01- 2006-04-30

**50+ Datasets**

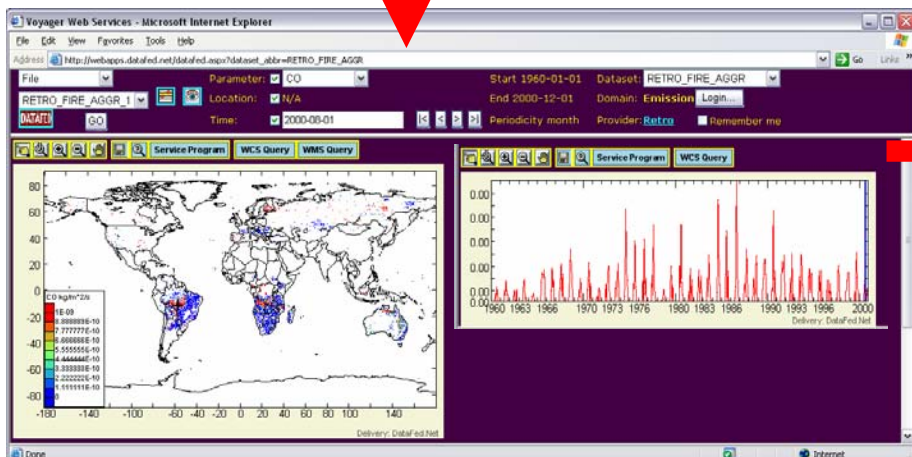


<http://datafed.net>

**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

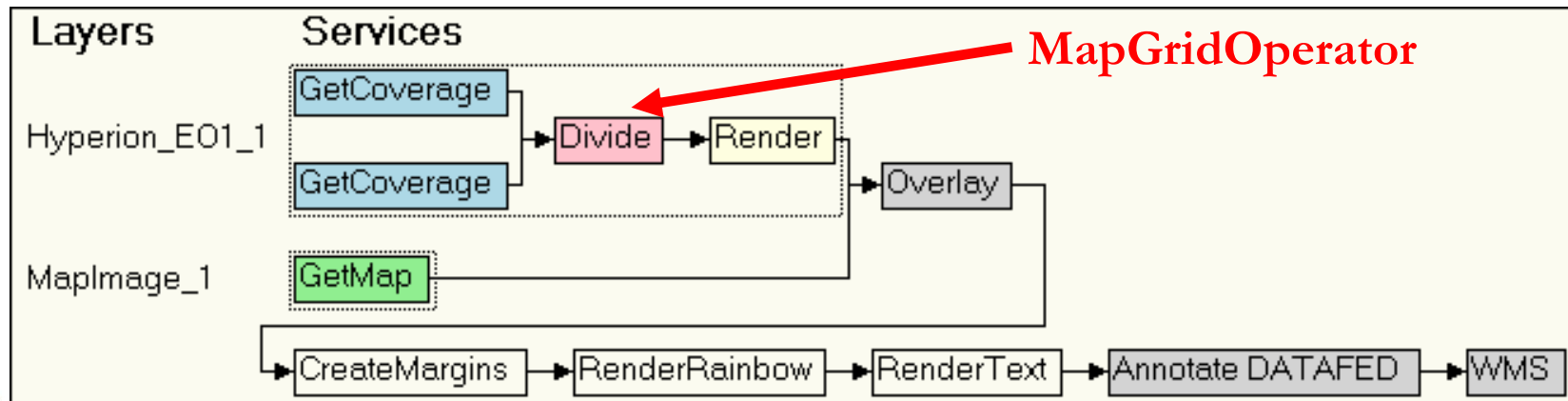
*Helping the World to Communicate Geographically*



# 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, ...)

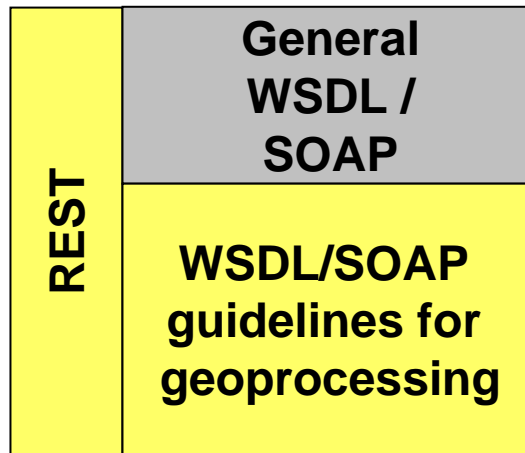




# DataFed Processing Services

- 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

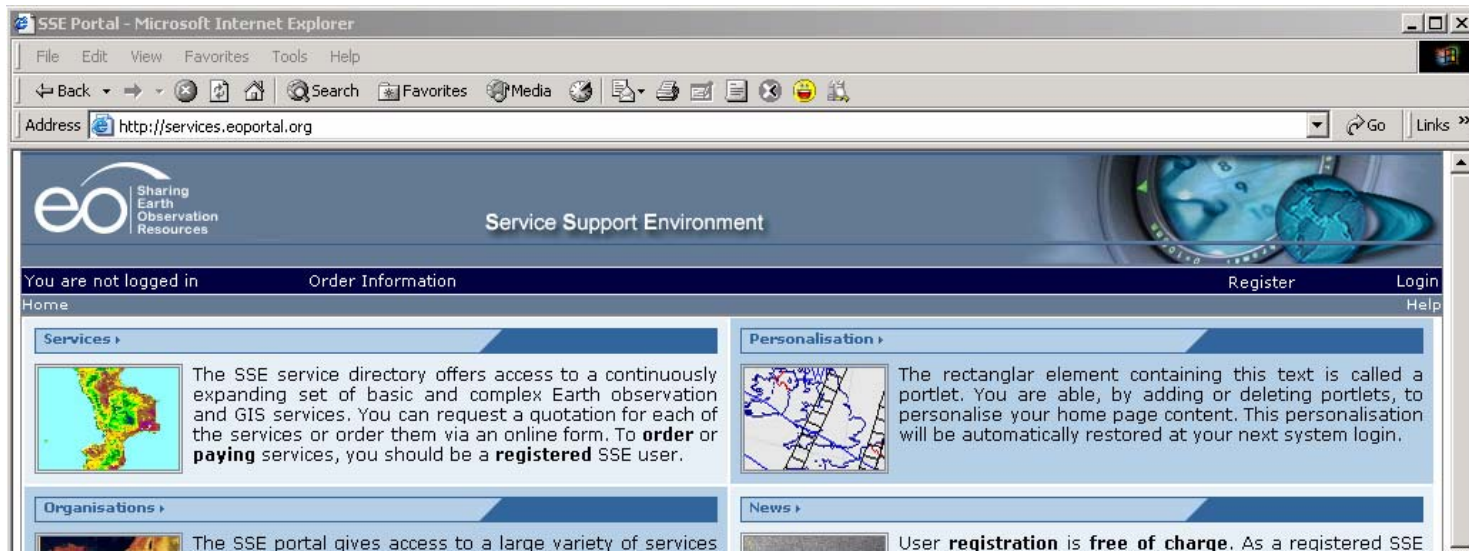


- Built on the Service Support Environment (SSE)

(<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



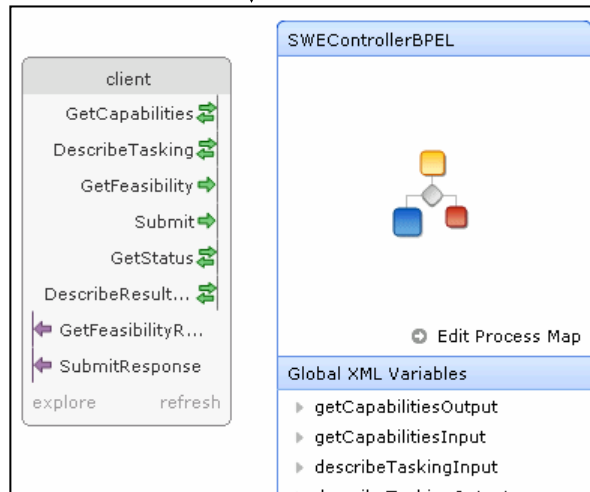
SSE Users

- GetFeasibility
- Submit

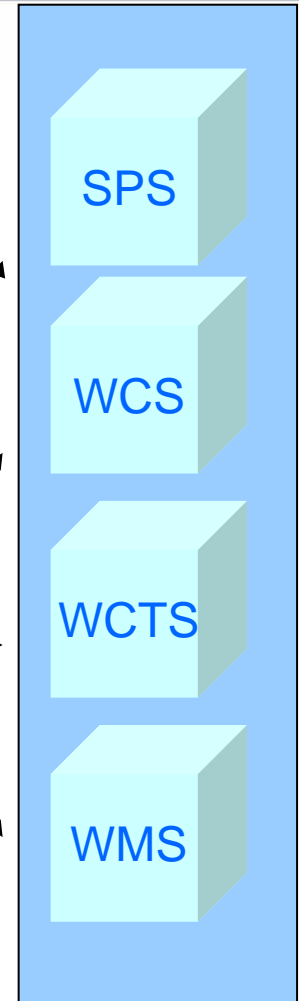


External SPS Clients

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



BPEL SWE Controller



SPS

WCS

WCTS

WMS

Spot Image Services

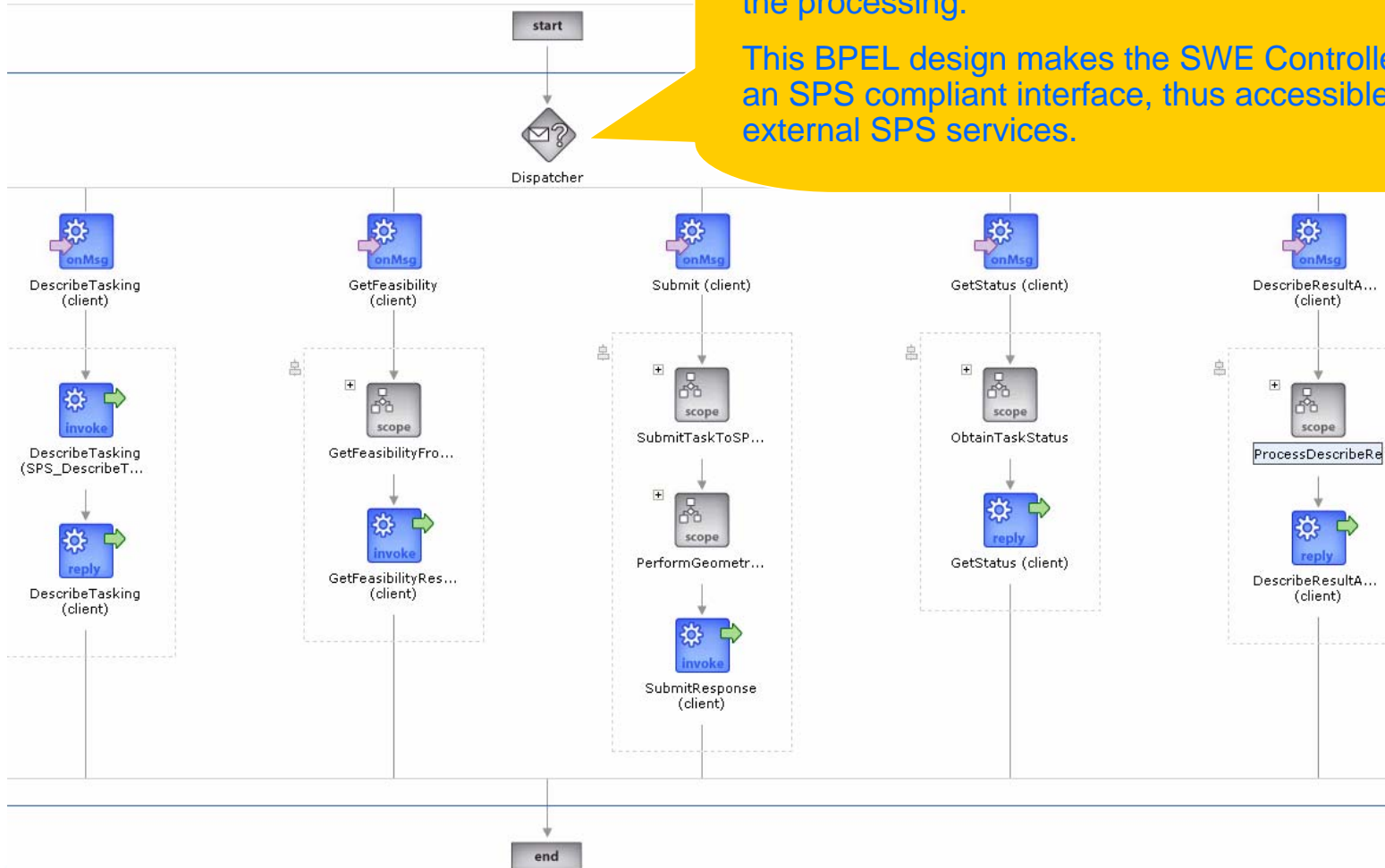


# Service Chain BPEL Diagram

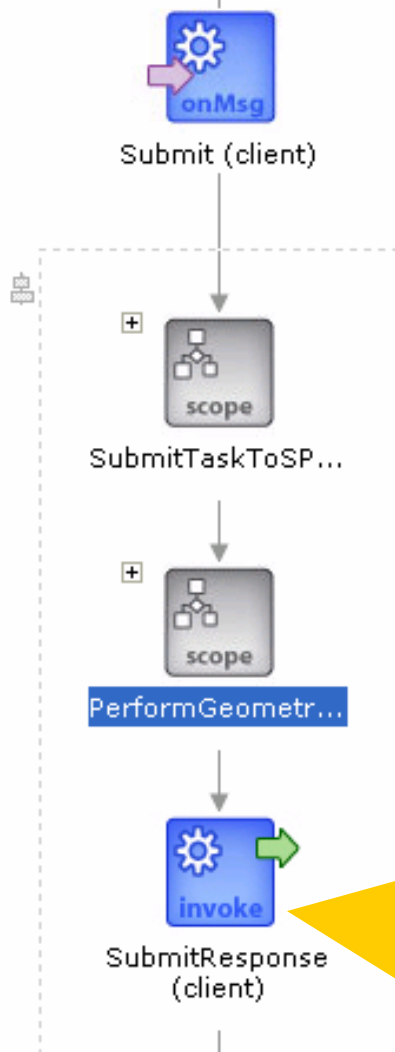


Requests sent to the SWE Controller BPEL are dispatched to the corresponding workflow during the processing.

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.

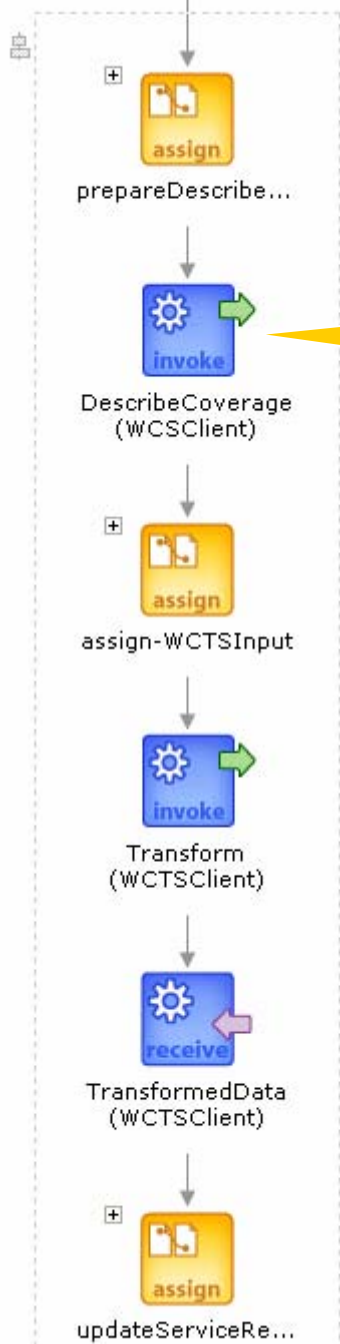
## Notes:

- 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

OGC



Accessing the WCS service for the image coverage description.  
The description is then used to prepare the request to send to the WCTS service

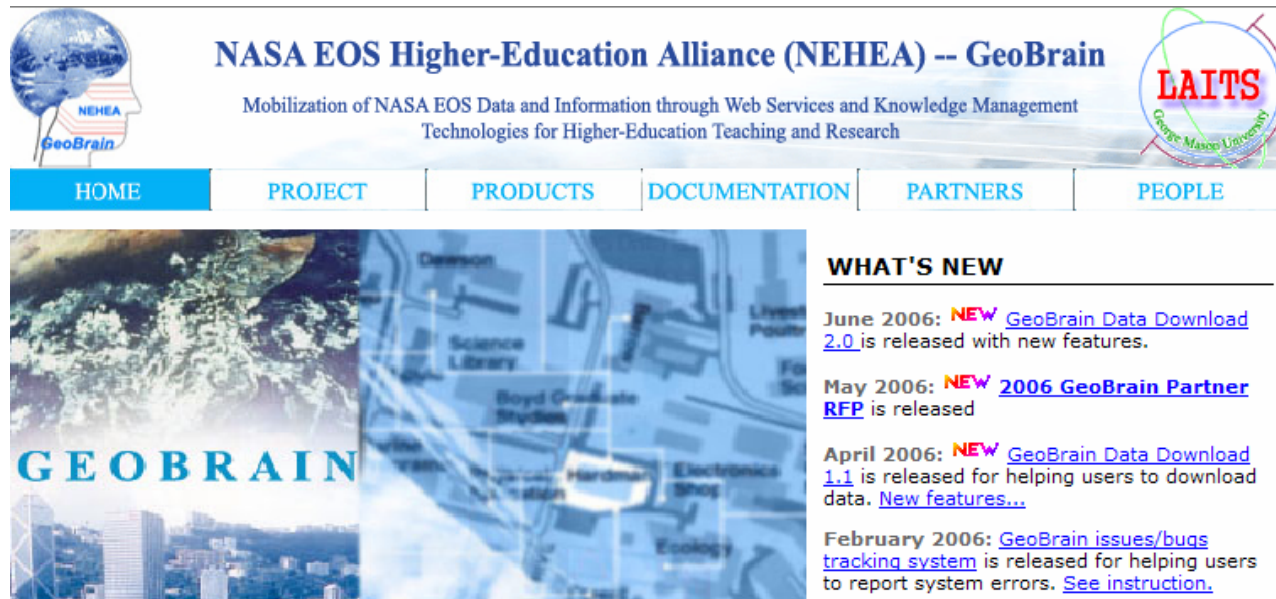


## GeoBrain Background Information



# 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)



The screenshot shows the GeoBrain website header and navigation menu. The header includes the NEHEA GeoBrain logo on the left, the title "NASA EOS Higher-Education Alliance (NEHEA) -- GeoBrain" in the center, and the LAITS logo on the right. Below the title is the tagline: "Mobilization of NASA EOS Data and Information through Web Services and Knowledge Management Technologies for Higher-Education Teaching and Research". The navigation menu consists of six blue buttons: HOME, PROJECT, PRODUCTS, DOCUMENTATION, PARTNERS, and PEOPLE. Below the navigation menu is a banner image with the word "GEOBRAIN" overlaid. To the right of the banner is a "WHAT'S NEW" section with the following updates:

- June 2006: **NEW** [GeoBrain Data Download 2.0](#) is released with new features.
- May 2006: **NEW** [2006 GeoBrain Partner RFP](#) is released
- April 2006: **NEW** [GeoBrain Data Download 1.1](#) is released for helping users to download data. [New features...](#)
- February 2006: [GeoBrain issues/bugs tracking system](#) is released for helping users to report system errors. [See instruction.](#)

# BPELPower – Service Chain Engine

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- 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

**BPELPower** **BPEL Process Manager**

WSDL Services | **BPEL Processes** | Instances | LBPL Activities

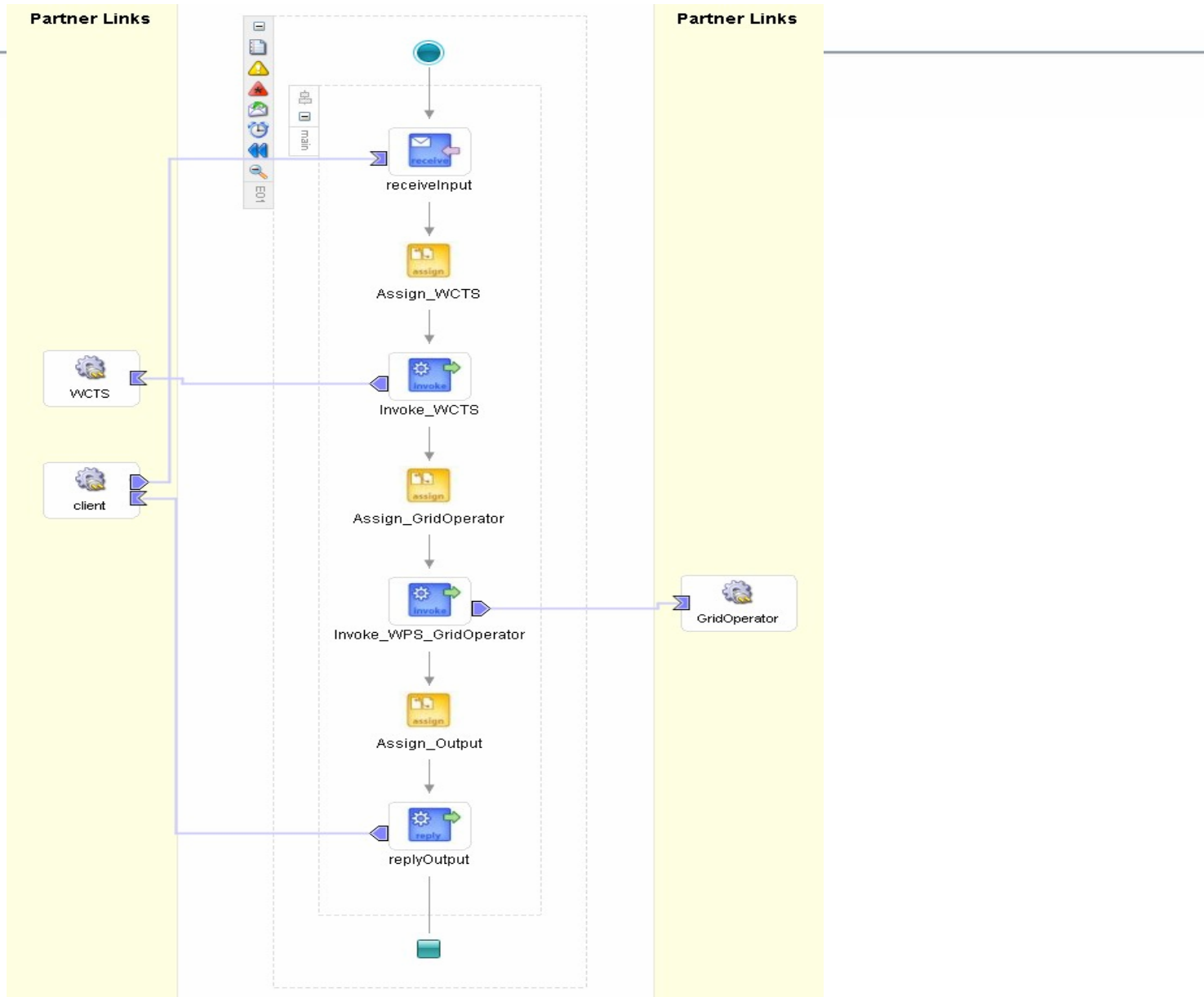
### Deployed WSDL Services

Service Name	Service Name
<a href="#">CurrencyExchangeService</a>	<a href="#">EMBLNucleotideSequenceWebService</a>
<a href="#">GMU-NGA-WCS</a>	<a href="#">GMU-WICS</a>
<a href="#">Grass_General_CommandsService</a>	<a href="#">Grass_Imagery_CommandsService</a>
<a href="#">Grass_Raster3D_CommandsService</a>	<a href="#">Grass_Raster_CommandsService</a>
<a href="#">Grass_Raster_InOut_CommandsService</a>	<a href="#">Grass_Vector_CommandsService</a>
<a href="#">Grass_Vector_InOut_CommandsService</a>	<a href="#">GridSlopeAspectService</a>
<a href="#">GridSlopeService</a>	<a href="#">GridWCSService_Laits</a>
<a href="#">GridWCSService_Ma</a>	<a href="#">GridWCSService</a>

[Deploy New Services](#) | [Undeploy Services](#)

Logged to domain: **default** BPELPower v2.0

# BPEL Diagram of OWS4 SWE Demo





# EO Demo Participants



GeoBliki



Innovative  
Solutions



Vightel  
Corporation



UAH VAST



Open Geospatial Consortium, Inc.



GMU

