NORTHROP GRUMMAN

RESPONSE TO CALL FOR PARTICIPATION (CFP)

ON

GEOSS Architecture Implementation Pilot – Phase II (AIP-II)

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PROVIDER

NORTHROP GRUMMAN CORPORATION

AIR QUALITY SCENARIO

LEAD ENGINEER

Stefan Falke

314-259-7908

Stefan.Falke@ngc.com

DISASTER RESPONSE SCENARIO

LEAD ENGINEER

Morris Brill

310-813-2638

Morris.Brill@ngc.com

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Northrop Grumman Response to the GEOSS AIP-II CFP

1 Overview and Approach

Northrop Grumman Corporation is pleased to take this opportunity to respond to the GEOSS Architecture Implementation Pilot (AIP) Phase II Call for Participation (CFP). Northrop Grumman is responding to implement two scenario-based use cases on Air Quality and Disaster Response. NGC seeks to participate in the GEOSS AIP by collaborating with the Group on Earth Observations (GEO) Societal Benefit Areas (SBAs) working groups and external agencies. Northrop Grumman will apply open standards for interoperability to achieve user objectives in environments of operational use for GEOSS.

Our interest in GEOSS and the AIP is to advance the state of technology and architecture and to evaluate standards to meet use-case driven requirements. We intend to add persistent GEOSS components, data, and product providers to the GEOSS Common Infrastructure established during Phase I. Northrop Grumman will use its experience working with customers in applying web services to application development and integration; using our leadership in compliance testing of Open Geospatial Consortium specifications to enhance use of these specifications with the scenario communities; using our experience in Service Oriented Architectures (SOA) to contribute to the OGC GEOSS AIP objectives; and sharing our experience as integrators, architects, providers, and operators of enterprise-class environmental systems. Our contributions in AIP-Phase II will focus on two out of the four SBAs and we will also contribute to the overall AIP architecture development.

Northrop Grumman will contribute services, components, and data from our collaborative network of United States Group on Earth Observation (USGEO) agencies in the air quality and disaster response SBA scenarios. Northrop Grumman also plans to participate in the review of the AIP process. Northrop Grumman is uniquely qualified to participate because of our experience and expertise that spans sensor collection, processing of data and information, and development of decision support systems. We will work with Pilot participants in examining the suitability and performance of OGC service implementations in AIP-II.

The approach Northrop Grumman proposes is to contribute in the development and implementation of two SBA scenarios: **Air Quality** and **Disaster Response**. Northrop Grumman will reference multiple parties that are collaborating on this CFP to provide persistent data and product exemplars, services, and applications that benefit one or more GEO SBAs. Northrop Grumman will build upon and augment the GEOSS Initial Operating Capability (IOC) previously established in Phase I by collaborating to develop scenarios with realistic features and events that include persistent data, product, and service providers. These are described in the air quality and disaster response scenarios outlined in Sections 2 and 3, respectively.

2 Contribution Part I: Air Quality Scenario

2.1 Societal Benefit Area Alignment and Support

The air quality scenario as outlined in the OGC GEOSS AIP CFP identifies 3 types of decision makers:

1. A policy-maker, needing synthesized information on the importance of intercontinental pollutant transport
2. An air quality manager, who needs to assess whether a regional pollution event was caused by an "exceptional event"
3. The public, needing information about air quality now and in the near future to make activity decisions

Each of these users has unique data and analysis requirements but the underlying data and analysis services are shared and available through the GEOSS Common Architecture. The unique needs are addressed through the configuration and execution of distributed web services that access, process and visualize information suitable for the user's particular decision support activity. In many cases, standards-based interfaces for air quality data access are available, such as through DataFed and Giovanni, and activities within the air quality community, such as the EPA Air Quality Data Summit and ESIP Air Quality Cluster, are working collaboratively to develop standard interfaces more comprehensively across the air quality community. Efforts are underway in user-driven workflows for assembling customized series of access, processing and visualization services for particular uses and applications. It is anticipated that the OGC GEOSS AIP, Phase II will increase the number of data access services available in GEOSS and the Air Quality Community as well as advance the ability of air quality analysts and managers to analyze and compare multi-source observations and prediction models. Northrop Grumman's contributions in the air quality scenario will primarily address needs for accessing model output and comparing models with observation data, including data from sensor webs, focused on a wildfire smoke scenario.

2.1.1 Wildfire Smoke Event Assessment Scenario

We propose the air quality scenario, as outlined in the AIP-Phase II Call for Participation, include a smoke event assessment. The activities involved in monitoring, assessing, predicting and responding to wildfire smoke events involve a diverse set of government agencies, industrial organizations and university groups supporting a variety of decision support needs, thereby providing elements for the type of scenario suitable for demonstrating the principles and benefits of GEOSS.

A potential smoke event assessment might include the following sequence of activities:

a. Fires are detected through satellite and surface observations
b. Based on fire locations, smoke forecasts are run to predict downwind impacts 1-3 days in the future which indicate a regional smoke pollution event
c. Multiple smoke forecast products are available to the manager/analyst through OGC WCS
d. Multiple smoke observation products are available to the manager/analyst through OGC WCS or OGC SOS
e. The air quality manager/analyst uses spatial-temporal comparison services to analyze differences and similarities in the forecast products
f. The air quality manager/analyst uses the smoke forecasts to issue public health alerts
g. The air quality manager/analyst issues sensor tasking requests to satellite and UAV based sensors to collect new data over the predicated smoke impacted areas before, during and after the event
h. The air quality manager/analyst uses the smoke forecasts to anticipate "exceptional event" waiver requests by States

i. After the smoke event, the air quality manager/analyst uses spatial-temporal comparison services between the forecast and observation data (from satellite and surface sensors) to assess the accuracy of the models
j. The air quality manager/analysts uses multi-source observation data to determine whether "exceptional event" waiver requests should be approved.

An important consideration for the smoke event scenario is whether it will be run retrospectively as a simulated scenario (e.g., for the Oct 2007 S. Cal Wildfires) and/or whether any live (e.g., real-time) elements are desired. The timing of the 2008 Pilot demonstration (in Winter 2008-09) places it in the off-season for wildfires in North America. If the scenario is set in another location in the world, many of the smoke models used by US agencies are likely not to be accurate or applicable since they were designed for North American regions.

2.1.2 Air Quality SBA Architecture

The OGC GEOSS AIP, Phase II Call for Participation (CFP) outlines a desire for the implementation of an architecture that supports multiple data sources undergoing multiple data processing and analysis steps that support multiple decision support needs across the information value chain. Along this sensor-to-decision information flow, Northrop Grumman is proposing to contribute to making smoke forecast model inputs and output available through standard web services, providing services and clients for integrating and analyzing observations and models, and the generation and dissemination of event analysis and near real time information products using standards-based web services (Figure 2-1).

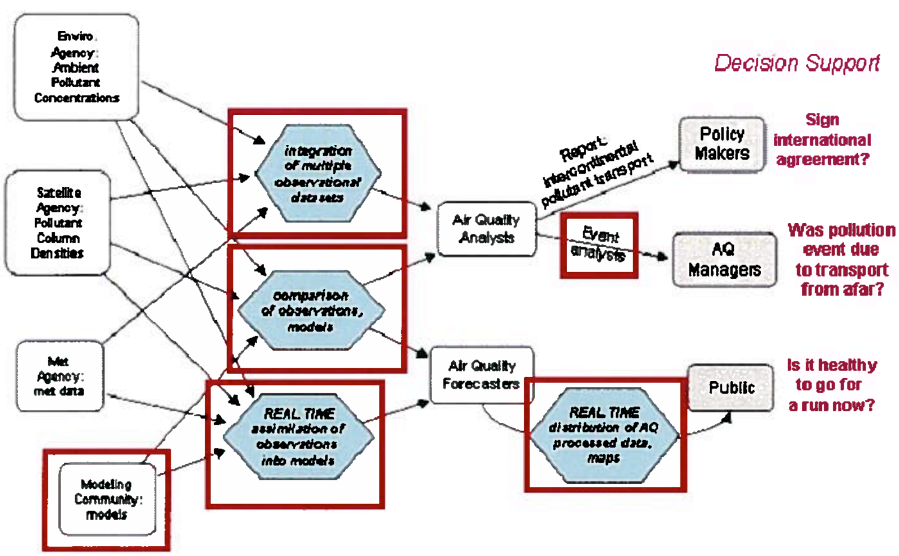

Figure 2-1. Air quality information flow and areas of proposed Northrop Grumman contribution (red rectangles)

Figure 2-2 places the information flow within the context of the GEOSS Common Infrastructure (GCI) as envisioned through an evolving diagram based on the GCI diagram in Appendix B of the CFP and its augmentation by Rudolf Husar (Washington University) as presented to the ESIP Air Quality Cluster. In addition to the GEOSS common components (portals, clearinghouse, registries), community-specific components are incorporated to provide entry points to GEOSS that are geared toward air quality uses and make it easier to both provide services to GEOSS as well as discover and use services within GEOSS. Northrop Grumman anticipates contributing services and clients that are used in analysis and decision support workflows. Northrop Grumman is also interested in working with the rest of the air quality community in developing portals that connect GEOSS and air quality components.

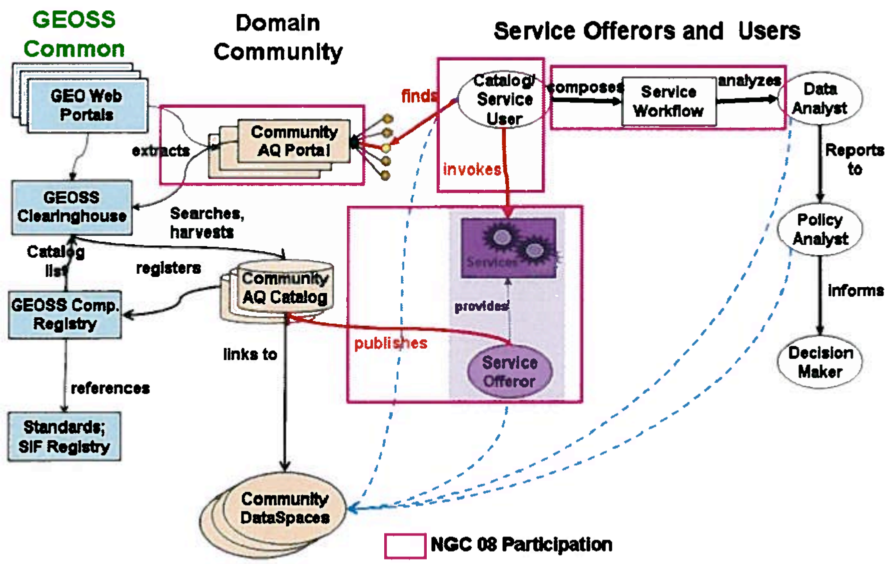

Figure 2-2. Air quality components within the context of GEOSS Common Infrastructure.

The smoke event scenario is placed within the context of the GCI and community components in Figure 2-3. Sensor Observations acquired through sensor web interfaces are used as inputs by smoke forecasts whose smoke output is compared with observations and models, ultimately supporting decision makers. A key aspect of the smoke event scenario is the feedback pathways that register the standard interfaces for sensor web, forecast and analyzed products (through sensor observation services, web coverage services) with the community and GEOSS components. The feedback also plays a special role in the sensor web information flow decision support actors may request new sensor observations based on the forecasts and analyses.

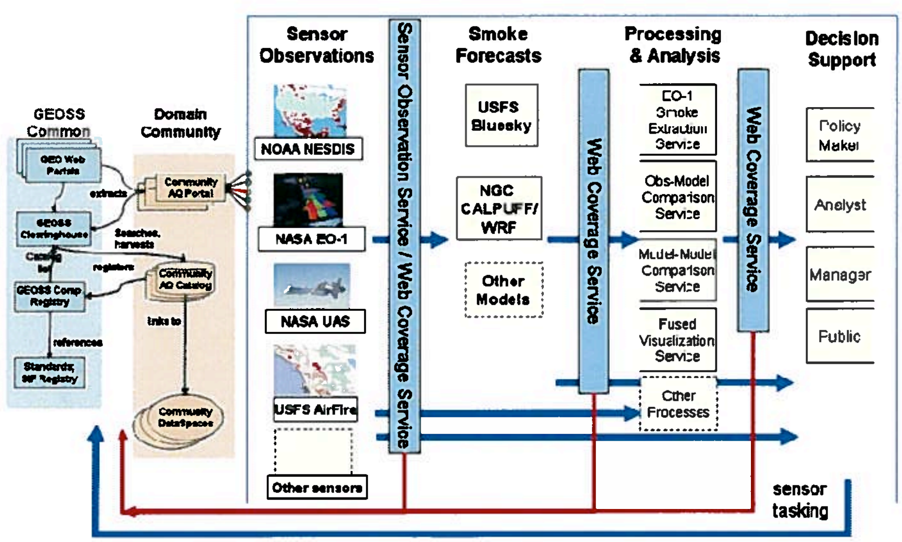

Figure 2-3. Smoke event scenario within context of GEOSS and Community components.

We plan to work with the rest of the air quality scenario group along with the GEOSS Pilot system engineering team to refine and develop architecture models that capture the air quality interoperability processes and relationships among GGI, Community components, services, and workflows.

2.1.3 Participation in air quality SBA Activities

Northrop Grumman has been actively involved in air quality societal benefit area activities over the past few years.

- Participation in ESIP Air Quality Cluster (proposed to be GEOSS Community of Practice for Air Quality), including support for the development of the AIP, Phase II air quality scenario
- NASA sensor web project related to smoke forecasts and air quality
- Through the NASA Sensor Web project, we participate in the ongoing EO-1 Wildfire and smoke sensor web demonstrations that have been part of OGC OWS testbeds and other interoperability demonstrations

2.1.4 Participation in Pilot AQ Scenario Activities

Northrop Grumman plans active participation in the AI Pilot in refining the air quality scenario and implementing and demonstrating web service and client components of the scenario. Northrop Grumman will

- Participate in the AIP kick-off in Boulder, CO
- Work to attain cross-project/program/pilot participant interoperability coordination through the ESIP Air Quality Cluster (GEOSS CoP for AQ)
- Develop interoperability arrangements with other Pilot participants in the AQ scenario
- Coordinate with NASA, EPA, NOAA and Forest Service representatives on ensuring Pilot components and demonstration align with their needs
- Participate in the development of the RM-ODP viewpoints for the AQ scenario

2.2 Component and Service Contributions

Northrop Grumman proposes to register services and components as part of GEOSS CGI. These include data access services, through WMS, WCS, SOS, and WFS, data processing services, through WPS and SOAP/WSDL, data comparison services through WPS and SOAP/WSDL, and clients to execute service requests and visualize and manipulate results. The services and components will be implemented into the air quality and disaster response scenarios but are more generally applicable to other, future uses of the services within GEOSS applications.

2.2.1 PULSENet OGC Sensor Web Enablement (SWE) Client

As part of its PULSENet™ project and investment, Northrop Grumman has developed a .NET 2.0 based client application utilizing Skyline's TerraExplorer Pro v5.0.1 3D visualization product (see Figure 2-4). The client allows a user to:

- Discover sensors within a specified area of interest by retrieving sensor location information directly from SOS and SPS instances, as well as from CS-W instances.
- Subscribe to (by automated polling of SOS instances) and retrieve observations from discovered sensors through SOS instances
- Task sensors through SPS instances (with advanced functionality provided for video sensors)
- Subscribe to and be notified of sensor alerts from SAS instances using CAP over XMPP.
- Create Event Initiated Procedures (EIPs) that automatically task a particular sensor when an observation or alert from a particular sensor is encountered (i.e. task a camera to point at an UGS sensor when that sensor generates an alert).

The PULSENet™ client runs on the Windows operating systems and currently supports interacting with many of the SWE services and encodings as well as other OGC services and external standard encodings (summarized in the table below).

Service/Encoding	Version	Notes
SOS	1.00.0.31	Supports SOS instances that serve SensorML/O & M or TML data
SPS	1.0, 0.0.30	Full support
SAS	0.2.0	Some support
WNS	0.1.1	Support for reading and displaying capabilities and users and adding/removing users
WMS	1.1.1	Provided natively by Skyline TerraExplorer Pro
WFS	1.0.0	Provided natively by Skyline TerraExplorer Pro
WCS	1.1	Supports translation between SOS GetObservation and WCS GetCoverage requests
CS-W	2.0.1	Support for viewing entries in a catalog
SensorML	1.0.30	Support for System and Sensor, reading location and orientation, identification, classification, contact, and several other major elements
O & M	1.0, 0.11.0	Support for CommonObservation, CategoryObservation, Observation, and several other observation types
TML	1.0	Support for some TML streams
CAP	1.1, 1.0	Full support
Cursor on Target (CoT)	2.0	Full support for main schema and support for several sub-schemas
GML	3.11	Provided natively by Skyline TerraExplorer Pro through WFS support. Support for GML embedded in SensorML and O & M

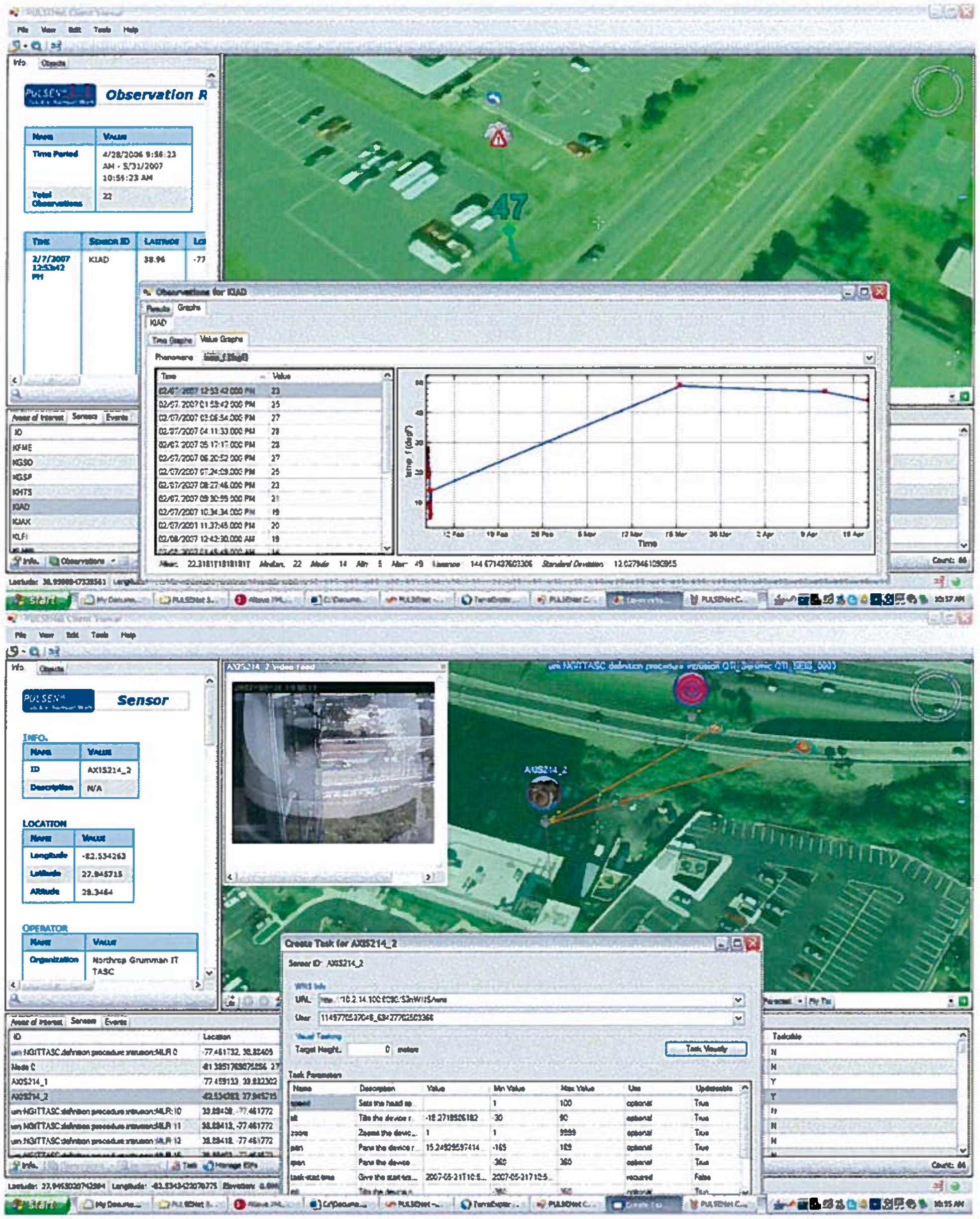

Figure 2-4. PULSENet™ Client - Retrieving Observations and Tasking a Video Camera

The PULSENet thick client application requires a license to Skyline TerraExplorer Pro v5.0.1 C2MP; therefore, it is unlikely that we can provide evaluation copies of the application for use by other pilot participant servers. However, Northrop Grumman has demonstrated the use of common visualization tools, such as GoogleEarth, with the PULSENet framework and would be willing to work with Pilot participants to create secondary interfaces to PULSENet. Northrop Grumman is also developing a thin client interface using OpenLayers for the mapping interface.

Northrop Grumman has utilized the following SWE service implementations as part of the the PULSENet development:

SOS - based on 52North's open source Java implementation utilizing PostgreSQL as the backend database platform. The PULSENet™ team updated 52North's implementation to include support for O & M CommonObservation format and SOS-T methods (RegisterSensor and InsertObservation). The

PULSENetTM IRAD team is currently in the process of rewriting the SOS in .NET using Oracle 10g as the backend database platform.

SPS - 52North's open source Java implementation. The PULSENet™ team has two Axis 214 PTZ network cameras to which the SPS provides a tasking interface.

WNS - 52North's open source Java implementation.

SAS - custom implementation developed in .NET to work in conjunction with the SOS, allowing users to define alert conditions for incoming SOS data. The Northrop Grumman SAS generates alerts in CAP (published over XMPP) or CoT formats (published over TCP).

2.2.2 Smoke Forecast Output through WCS

CALPUFF and WRF model outputs

This task will demonstrate the ability to create ensemble wildfire smoke forecasts using WRF-ARW and CALPUFF models and disseminate the output through OGC WCS. The Weather Research Forecast model (WRF) will be used to produce high-resolution mesoscale weather forecasts, with initial conditions and lateral boundary conditions from the National Weather Service NAM model. For each case, WRF will be run several times using different physics configurations (PBL, radiation, cloud microphysics, and land surface) to create ensembles. CALPUFF will then produce air quality ensemble forecasts using WRF ensemble input data and smoke emissions data. A post-processor will collect the CALPUFF output and generate probabilistic forecast products. The output format will likely be netCDF and served through OGC WCS. All programs will be run on the Northrop Grumman 'Argo' Linux cluster.

Northrop Grumman will work with the AIP air quality scenario group to identify locations and times for the CALPUFF runs. The number of case studies examined will depend upon data availability and complexity of the cases considered.

Bluesky Gateway Experimental Model Output

The US Forest Service has made available its Bluesky Smoke Forecasting Framework and is presently publishing the model output as netCDF files. We are developing a WCS interface for the Bluesky output and will work with the US Forest Service in registering the service with the GEOSS Common Infrastructure. The Bluesky model is run twice daily for 24 and 48 hour forecasts on a national grid.

2.2.3 Analysis and Processing Services

Northrop Grumman has developed geoprocessing and analysis services for point and grid data. During the OGC OWS-5 testbed, Northrop Grumman was the editor of the WPS for Earth Observations Engineering Report. Northrop Grumman has developed point analysis services with OGC WPS and SOAP/WSDL interfaces. The processing algorithms are executed in Oracle Spatial. We also propose grid analysis services based on ongoing development effort at Northrop Grumman to use Oracle Spatial with netCDF grid files. We will coordinate with the AIP AQ Scenario team to define and implement any new analysis services needed for particular implementations of the scenario.

In particular, we propose to work with the NASA EO-1 Hyperion hyperspectral imagery, available through a EO-1 SOS, to derive a usable smoke extraction algorithm. During OGC OWS-5, we used a smoke algorithm defined in the literature and created a web processing service interface for it. However, the algorithm did not accurately produce smoke patterns from the imagery. A hyperspectral derived smoke product will be useful during the AIP for validating smoke forecasts.

2.2.4 Sensor Description Services

Northrop Grumman proposes to contribute an SOS service for DescribeSensor requests. Most data access services that follow an OGC interface in the air quality domain use the WCS interface. The WCS does not include a request for retrieving metadata from the sensor. We propose to use the SOS DescribeSensor coupled with the WCS for retrieving sensor descriptions in SensorML format. We also propose to couple the DescribeSensor request with a WFS GetFeature request to access surface monitoring network locations.

We will work with the AQ Scenario team to create SensorML implementation profiles that highlight the needed sensor metadata for air quality applications, including categorization as surface, aerial, or satellite sensors, spatial and temporal resolution, and monitoring network association.

Use of Internet2

Northrop Grumman has been conducting research in using Dynamic Circuit Network (DCN) technology to provide high-bandwidth communications over optical networks. We can leverage this research, together with our partnership with Internet 2 to establish on-demand, end-to-end network connection with any node connected to the Internet 2 DCN at up to 10Gbps bandwidth. It is also possible to collaborate with international participants in the AIP if they have access to Internet 2 DCN services.

This task will leverage this technology to provide high speed transfers of GEOSS data with collaborators either on Internet 2 DCN or other DCN networks connected to Internet 2. We will work with selected AIP participants to apply the technologies developed by Northrop Grumman to provide high speed communications of data to support aspects of the air quality scenario. This effort could be used to demonstrate the potential of Internet2 in supporting future GEOSS implementations.

2.2.5 Visual Integration of NWP Products

NOAA / NWS generate terabytes of numerical weather prediction (NWP) on a daily basis. This data is the basis for all forecasts which are developed by local NWS offices as well as commercial forecasting firms (e.g., WSI). Since the operational forecaster does not have time to effectively synthesize all the numerical guidance, he/she typically uses heuristics based on local experience to derive the forecast. This is sub-optimal. One way to increase the fidelity of the forecasts is to use the relatively recent ensemble NWP data. The forecast ensemble provides a distribution of forecasts that can be presented in a way that maximizes the information content to the user. For example, major airports in the mid-Atlantic and Northeast are responsible for removing snow/ice from runways. In order to minimize the amount of time their personnel are on the clock they require a probabilistic forecast of what time the 1st inch of snowfall will occur. Data from a forecast ensemble, such as the Short Range Ensemble Forecast (SREF) system, can be leveraged to provide such a forecast thereby saving money to airport authorities. Another example would be to drive other models, such as CALPUFF with the meteorological data from the SREF ensemble members and present the user with a logical overlay of CALPUFF products. We will coordinate with the AIP air quality scenario group to identify relevant visual overlays.

2.2.6 Relationship to GEOSS AIP Architecture

The components and services described in this proposal relate to both client and service providers of the GEOSS AIP Architecture as they support multiple OGC service standards and support multi-source data access and integration. From the perspective of the AIP air quality scenario, some suggested connections of Northrop Grumman services and components are listed in the table below.

Service/Component	Suggested Air Quality Scenario Uses
PULSENet Client	Discovery, access, visualization and tasking of sensors

Smoke Forecast WCS	Comparison of models with observations, generation of health alerts, tasking of sensors based on regions of interest, exception event analysis
Data Analysis Services	Comparison of models and observations
Sensor Description Services	Discovery of sensors, relationship among sensors and models
Use of Internet2	Dissemination of input files to models; dissemination of model output files to clients; dissemination of model comparisons/analysis
Visual Integration of NWP Products	Complement smoke forecaster efforts in both forecasting and model validation and assessment.

2.2.7 Use in the GEOSS Common Infrastructure (GCI)

We plan to register our OGC services and OGC service clients with the AQ Community catalog (anticipated contribution from ESIP) and the GEOSS service registry.

The OGC WCS and OGC SOS GetCapabilities response document would be harvested and parsed by the registry, catalogs and clearinghouse. The OGC WPS is not yet a common service for registries and catalogs and we work with Pilot participants to define the registration process during the Pilot.

The PULSENet clients will discover and exploit SWE and WCS services from the GEOSS clearinghouse.

We plan to be actively involved with the GEOSS Air Quality Community of Practice (i.e., the ESIP Air Quality Cluster) in developing and using the Air Quality Community portal, catalog and workspaces and in the architectural considerations for interoperable interfaces between the community components and the GEOSS components.

2.2.8 Performance and Availability of Components

Our OGC services for the air quality scenario, including the Web Coverage Service and OGC SWE services, will be hosted on Northrop Grumman servers within our virtual machines environment in St. Louis.

We expect the services to be available and persistent during the 2008 Pilot and through at least September of 2009. We plan to work with our colleagues in EPA, NASA, NOAA and USFS on transitioning the services to operational systems.

2.3 Architecture and Interoperability Arrangement Development

Northrop Grumman is a strategic member of OGC and has a leadership role in the SWE and WMS standards groups. Northrop Grumman is also involved in the WCS standards revisions and implementation activities. Northrop Grumman has played a central role in the OGC OWS testbeds and is the lead on the OGC compliance test engine.

We anticipate our Interoperability Arrangements with other Pilot participants to involve OGC standards. We are in a unique position to explore non-OGC interfaces, such as the portal-to-portal interoperability both from the perspective of connecting community portals with GEOSS portals and in connecting multi-domain portals, such as the Disaster Response Community Portal and the Air Quality Community Portal. We expect the portal interoperability to involve specific portlet standards, such as JSR-286 and WSRP, as well as more general standards, such as RSS.

The pilot provides an opportunity to test multiple implementations of OGC standards in operational relevant environments. Our experiences in the successes and gaps of the present standards will be captured and provided to the OGC standards revisions groups.

3 Contribution Part II –Disaster Response Scenario

3.1 Societal Benefit Area Alignment and Support

Northrop Grumman proposes to execute the Disaster Cycle, depicted in the CFP and shown in Figure 3-1. Northrop Grumman proposes to apply this cycle for a hurricane and flooding scenario that incorporates multiple user communities and demonstrates how communities of practice (COP) may be applied to extend information sharing in response to disasters.

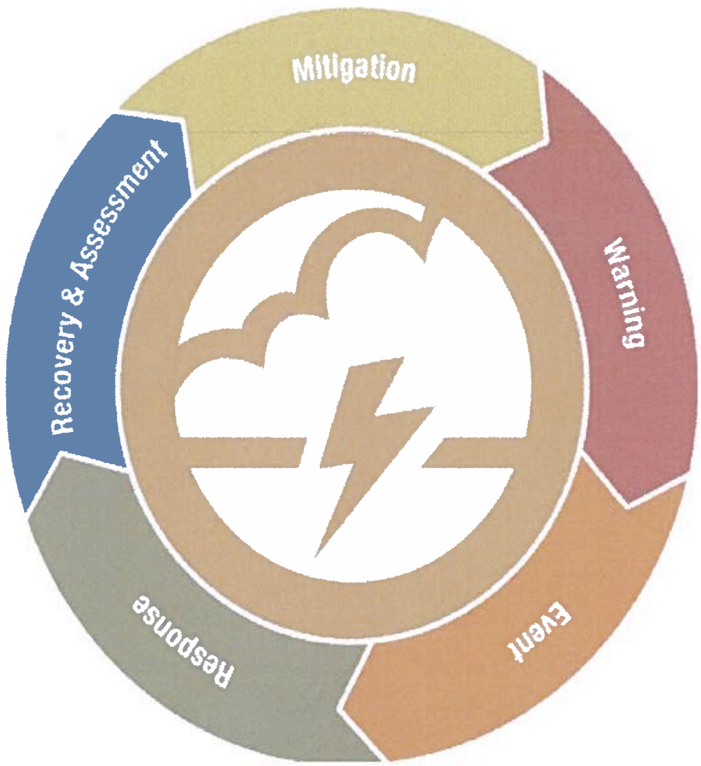

Figure 3-1. Disaster Cycle (from GEOSS AIP Phase II CFP, Issuance 26 June 2008).

3.1.1 Disaster Response Scenario

The disaster response scenario will be user driven and will utilize data and products derived from:

- Existing earth observable systems,
- Other existing sensor systems as applicable to the scenario, and
- Existing data and service providers.

Northrop Grumman will execute on interoperability agreements and data and product provider arrangements, as well as integrate new and existing data providers into GEOSS to execute the disaster response scenario listed in Tables 3-1 and 3-2. These data and product providers are the persistent exemplars that comprise the operational building blocks necessary for the system-of-systems GEOSS objectives. These opjectives have been established for Phase II to augment the GEOSS Phase I Initial Operating Capability.

Tables 3-1 and 3-2 align with the Disaster Cycle depicted in Figure 3-1. Northrop Grumman has aligned the activities of the cycle with the events, users, data, products, and services that Northrop Grumman expects to demonstrate in a major hurricane and flooding disaster response scenario. Northrop Grumman is coordinating its efforts with the Disaster Response SBA working groups, particularly those of GEO task DI-06-09, on the development of user needs and coordination of demonstrations to ensure interoperability. Furthermore, we propose to:

1. Enhance the disaster response scenario depicted in the CFP by using all of the activities of the Disaster Cycle. We propose to step through the events of a Category 4 hurricane strike on the Port of Houston, Texas, as well as, the storm and flooding events left in the wake of the storm. Figure 3.2 depicts the path of "Hurricane Victoria" used in our scenario.

2. Demonstrate the central role the Disaster Response SBA Community Portal plays in facilitating information sharing among Disaster Response players.

3. Integrate the contributions of our NOAA data and product providers into the Disaster Response scenario, and demonstrate them as persistent examplars S.

4. Provide and highlight the integration required between the GEOSS Common Infrastructure (GCI) and external data and service providers through community portals.

Figure 3-2. Path of Hurricane Victoria depicted in the scenario (a Category 5 storm in the Gulf of Mexico, which downgrades to a Category 4 storm shortly before landfall).

Activity	Event(s)	Time (+/-)	Actor(s) / Role/ User	Scenario Description	Products, Information, Data Used	Data Providers	Services Proposed
Mitigation	■ Planning for hurricane season	Pre-Event	■ Forecaster (NHC) ■ Community Data Provider (NDMC, RCC) ■ Decision Maker (RDSC) ■ Regional Civil Protector	■ Forecaster releases prediction of upcoming Atlantic hurricane season activity ■ Community Data Providers investigate and monitor area drought, flooding, and climate conditions ■ Decision Maker identifies and monitors areas susceptible to flooding as a result of hurricanes and storms ■ Authorities at all levels coordinate for integrated information flow and readiness to enable improved responses to and from Decision Maker	■ Satellite images ■ River, bayou, flood, drought, and climate data ■ Floodplain data ■ Harris County emergency data	■ RCC ■ NDMC ■ Harris County ■ WGRFC ■ LMRFC	■ WMS ■ WCS
Warning	■ Tropical depression detection	- 6 days	■ Forecaster (NHC) ■ Decision Maker (RDSC)	■ Forecaster analyzes satellite and sensor images, models, and data to determine a tropical depression has formed in the Atlantic ■ Forecaster begins tracking storm and posts projected track, watches, and warnings	■ Satellite images ■ Model data	■ NHC ■ RCC	■ WMS ■ WCS
Event: Tasking	■ Storm upgraded ■ Tasking of sensor grid to track storm	- 5 days	■ Forecaster (NHC, NWS) ■ Decision Maker	■ Storm gathers strength resulting in an upgrade of storm to a CAT I storm ■ Sensors are tasked (examples: satellites; buoys; UAS)	■ Satellite images ■ Buoy Data	■ NHC	■ SOS ■ SPS
Event: Tracking & Response Preparation	■ Storm continues to strengthen ■ Storm tracking ■ Storm path and landfall cone of uncertainty predicted	- 4 days	■ Forecaster (NHC, SWPC) ■ Regional Civil Protector ■ Decision Maker ■ Public User	■ Forecaster upgrades storm to CAT 3 storm ■ Forecaster monitor projected path and Loop Current ■ Decision Maker at Regional Decision Support Center (RDSC) engages Response Team COP including Regional Civil Protector, Forecaster ■ Decision Maker, Regional Civil Protector checks current and predicted solar activity to verify solar weather does not impact response team high frequency communications ■ Public Users follow storm and emergency guidance	■ Satellite images ■ Buoy data ■ Airborne sensor data	■ NHC ■ SWPC ■ NOAAPort ■ NASA	■ WMS ■ WCS
Event: Disaster Prediction & Response Preparation	■ Storm category upgraded ■ Flood modeling ■ Planning for first responders ■ Storm landfall prediction ■ Retasking of sensor grid	-3 days -> 0	■ Forecaster (NHC) ■ Public User ■ Decision Maker ■ Regional Civil Protector (FEMA, National Guard)	■ Forecaster upgrades storm to CAT 4 ■ Forecaster predicts most probable landfall near Port of Houston ■ Forecaster predicts a high storm surge (using tidal data and wind patterns) in the Bay of Houston area and heavy rainfall with storm landfall ■ Forecaster determines that climate data shows Houston area already saturated from recent storms ■ Civil Protection Agencies monitoring water levels and flood plain infrastructure in anticipation of heavy flooding ■ Decision Maker alerts COP of space weather detection of a solar flare--prediction of wide-area blackouts of HF radio communications ■ Decision Maker convenes COP to coordinate Civil Protector first responders ■ Public Users track storm, warning, and evacuation orders	■ Satellite images ■ Buoy data ■ Airborne sensor data ■ Space weather predictions of RF outages ■ Population Density Data ■ Windspeed, Precipitation ■ River/Flooding Data	■ NHC ■ RCC ■ NOAA ■ NASA ■ WGRFC ■ SWPC	■ WMS ■ WCS

Table 3-1: Hurricane Disaster Response Scenario Part I

Activity	Event(s)	Time (+/-)	Actor(s) / Role/ User	Scenario Description	Products, Information, Data Used	Data Providers	Services Proposed
Response	■ Hurricane makes landfall ■ High storm surge, extensive rainfall ■ Flood monitoring, severe flooding ■ First responders execute	0 -> 24 hrs	■ Forecaster ■ Regional Civil Protector (first responders) ■ Public User	■ Forecaster track storm as it hits the Port of Houston area after demolishing Galveston ■ Evacuation orders were mostly followed but extensive coastal damage and flooding of oil refinery areas occurred as extensive flooding occurs in area ■ Civil Protector first responders (e.g., local authorities, National Guard) arrive and contact the COP regarding flooding impacts ■ Public User continues to view updates on the progress of storm and civil protection efforts	■ Satellite images ■ Bayou and Flood data ■ Windspeed, Precipitation	■ NHC ■ RCC ■ WGRFC	■ WMS ■ WCS
Recovery & Assessment	■ Regional Civil Protector first responders and Forecaster continue to execute ■ Remnants of storm tracked ■ Extent of flooding and other damage assessed	Post-Event	■ Regional Civil Protector ■ Forecaster (NHC)	■ Forecaster tracks the storm as it passes over the area and heads northward ■ Flooding, recovery, cleanup, response, and workforce issues are addressed	■ Satellite images ■ Geospatial flooding examples ■ Precipitation Data	■ RCC ■ NHC ■ WGRFC	■ WMS ■ WCS
Mitigation	■ Generate template or baseline for future disasters ■ Integration of lessons learned into coastal and flood plain zoning and infrastructure codes ■ Integration into land use planning/zoning for critical facilities ■ Integration into plans for future expansion of critical regional infrastructure ■ Improvement of decision support systems for warning and evacuations ■ Critical eval of resource allocation for all phases of disaster ■ Regional Decision Support Center coordinated tracking of affected assets--charting progress	Post-Event	■ Regional Civil Protector ■ Decision Maker (RDSC) ■ Forecaster (NHC)	■ Post-evaluation of data and products by Community Data Providers ■ Mitigation events after the disaster focus on critical reviews to improve future responses ■ Mitigation step spawns reviews of not only damage of hurricanes but benefits such as drought relief	■ Satellite images ■ Flooding damage ■ Climate and Space Weather data ■ Drought Data ■ Windspeed, Precipitation ■ Complete Hurricane Track	■ WGRFC ■ RCC ■ NDMC ■ NASA	■ WMS ■ WCS

Table 3-2: Hurricane Disaster Response Scenario Part II

The users or actors participating in the disaster response scenario include the users identified in the CFP:

- Decision Maker
- Regional Civil Protector
- Public User

In addition, Northrop Grumman is proposing to address the needs of the following users:

- Forecaster
- Community Data Providers

The roles played by these actors are described in the scenario as outlined in Tables 3-1 and 3-2, and the specific roles are described in Table 3-3. Each actor will be able to access data unique to its role through the common and standard interfaces and services provided through the GCI as well as the SBA services that will be registered through the GEOSS Registry for access by the GEOSS Clearinghouse and Portal.

Actor / User	Description
Community Data Provider	■ Provide raw data and products necessary for the execution of the scenario ■ Includes weather and climate data providers ■ May include regional, national, and commercial providers
Decision Maker	■ Acts as emergency manager ■ Coordinates and manages resources necessary for disaster response ■ Tasks the sensor web ■ Coordinates and ensures the delivery of data to requesters ■ Determines any impact to operations due to space weather (jointly with forecaster) ■ Determines any impact to operations due to terrestrial weather (jointly with forecaster) ■ Includes roles played by emergency managers and decision makers
Forecaster	■ Tracks and predicts path of storm ■ Determines probable flooding locations ■ Includes actors from NHC, RCC, SWPC, NDMC, and regional and commercial weather concerns ■ Includes the role of climatologist and meteorologist
Public User	■ Desires information on storm status ■ Desires information on response activities
Regional Civil Protector	■ Planning first response strategies ■ Determine assitance locations ■ Includes actors from Red Cross, FEMA, National Guard, and other civil protection agencies

Table 3-3 Disaster Response Scenario Actors

In keeping with the regional nature of the scenario, we introduce the concept of a regionally focused Decision Maker by locating the Decision Maker at a Regional Decision Support Center (RDSC). The RDSC is included in the scenario outline shown in Tables 3-1 and 3-2. This center can be envisioned as a virtual concept, as enforced by a Community of Practice (COP) set up by the Decision Maker to respond to an impending disaster. The concept works equally as well as a physical construct.

3.1.2 Enterprise Model

The enterprise model for our proposed hurricane and flooding scenario depicts an end-to-end approach to executing a disaster response. We use the context diagram depicted in the CFP as the model for the Disaster Response context diagram of Figure 3-3. The centrality of the Community Portal in creating a coordinated response to a disaster cannot be overstated and is depicted as such in the context diagram shown in Figure 3-3. Our proposed Disaster Response SBA Community Portal will be provided for accessing the services and information required for the implementation of the scenario.

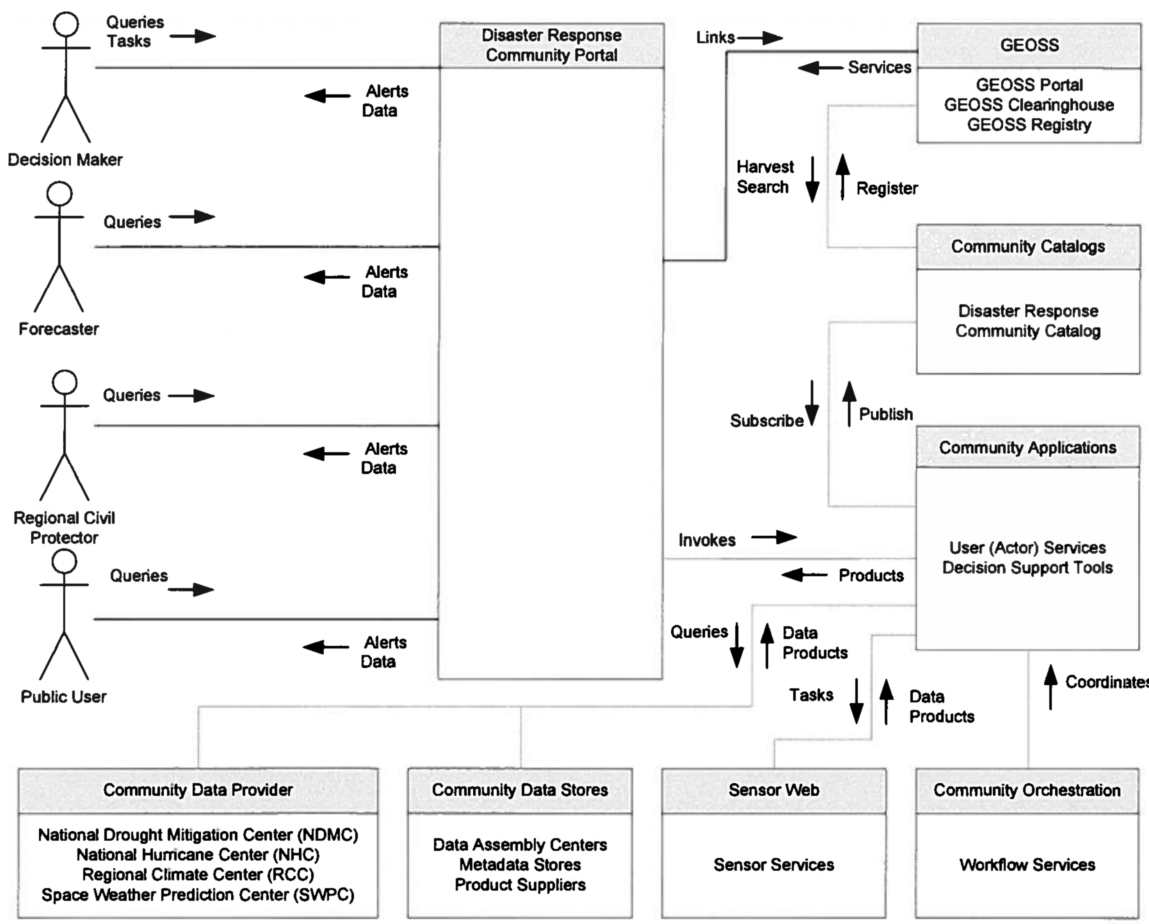

Figure 3-3: Disaster Response Scenario Context Diagram

The context diagram forms the framework for the sub-scenarios depicted by the activity diagrams illustrated by Figures 3-4 through 3-6. The mitigation activities depicted by the activity diagram of Figure 3-4 are focused on determining areas susceptible to flooding triggered by the impact of hurricanes. This includes flooding due to precipitation, storm surges, and failure of man-made structures (levees, dams, etc.). Such information can be made available to Regional Civil Protectors (first responders) to facilitate emergency planning.

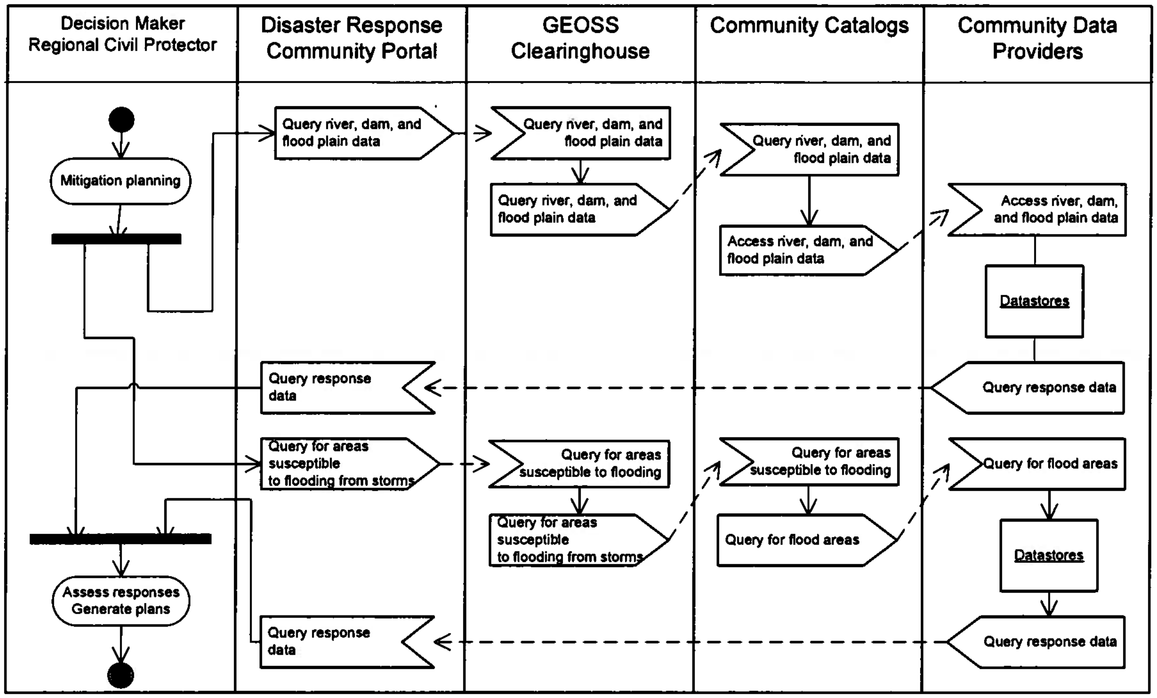

Figure 3-4: Disaster Cycle Mitigation Phase Activity Diagram

The Warning and Events activities of the Disaster Cycle include detecting the formation of storms and the tracking of storms. This ongoing activity is depicted by the activity diagram shown in Figure 3-5. The key actor executing this activity is the Forecaster. The products generated by the Forecaster are used by Civil Protectors and the Public Users to be able to formulate response strategies. Much of the data used by the Forecaster is provided by the Community Data Providers.

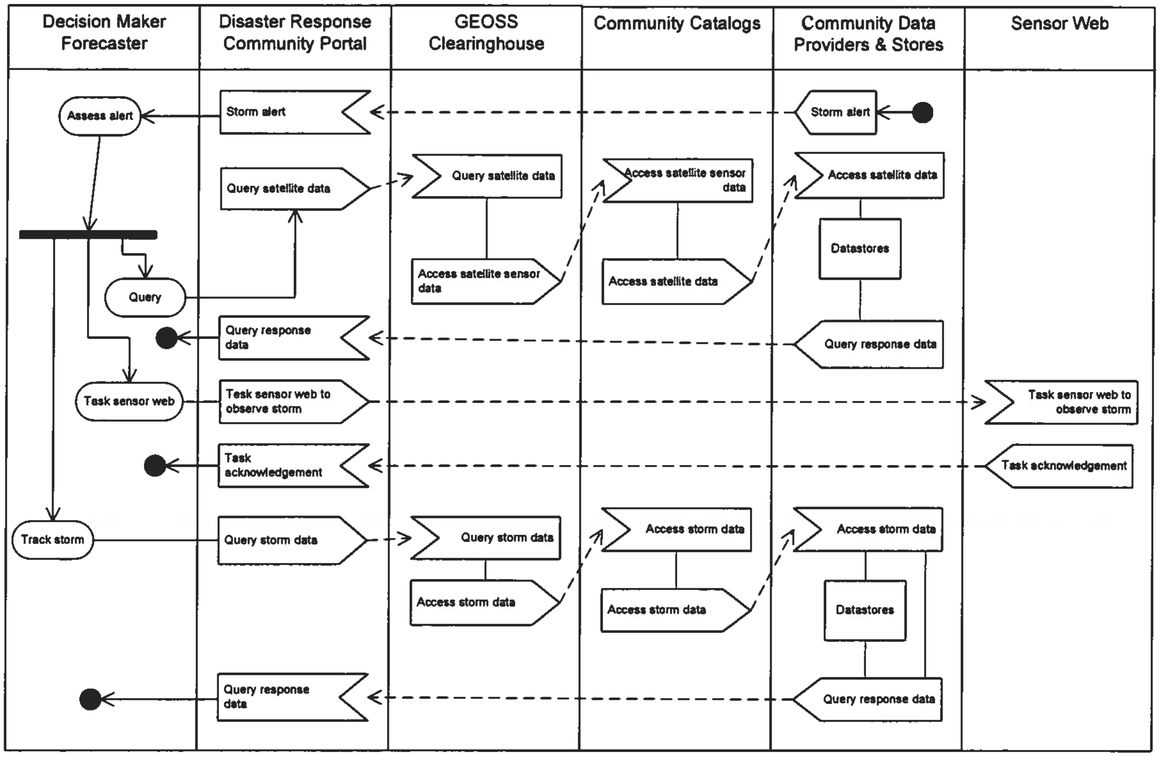

Figure 3-5: Detection and Tracking of Storms Activity Diagram

A key activity of the Forecaster is to be able to predict the landfall of a storm. This important role is critical for the timely and directed response by Civil Protection agencies. This is an ongoing activity and is depicted by Figure 3-6. The scenario is focused on the Louisiana and Texas regions of the United States. The Forecaster generates the prediction and it is the Decision Maker, in this scenario, then who coordinates the resources and response.

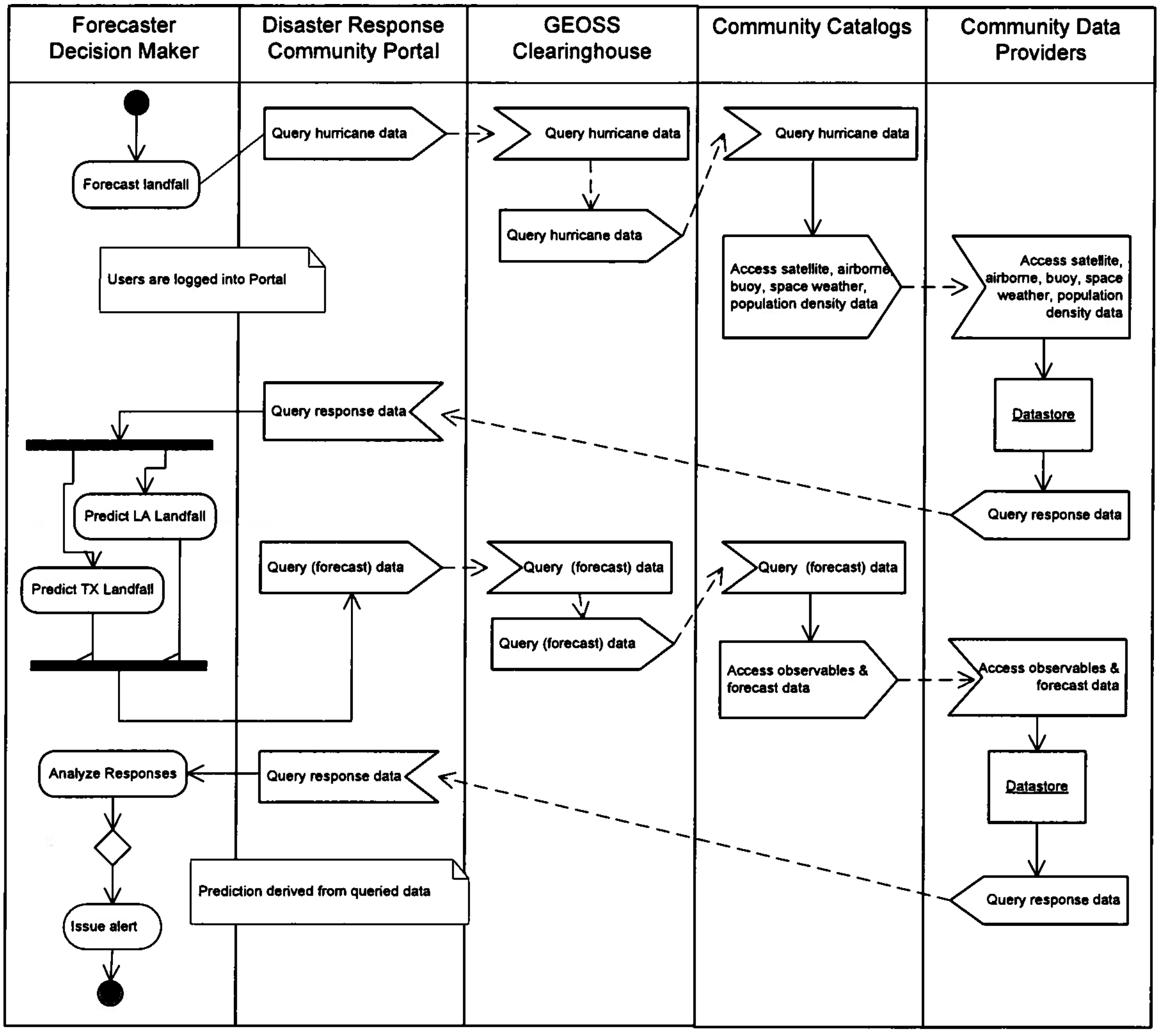

Figure 3-6: Storm Prediction Activity Diagram

3.1.3 Participation in Pilot Disaster Response SBA Activities

Northrop Grumman proposes to actively participate in the Pilot Disaster Response SBA activities to develop scenarios and to facilitate component integration for USGEO to include NOAA data and service providers and demonstrations. Northrop Grumman proposes to:

- Participate in the Pilot Kickoff,
- Develop Interoperability Agreements with other Disaster Response Pilot participants,
- Participate with other disaster response scenario developers, especially those involved with GEO tasks DI-06-09 "Use of Satellites for Risk management," DI-07-01 "Risk management for floods" and the Caribbean Flood Management Pilot program. As a result of our coordination with these groups, our disaster scenario follows the Disaster Cycle activities and uses the corresponding commonly developed user needs of the Carribean scenario participants,
- Participate in the development of the RM-ODP viewpoints,
- Participate in the generation of Disaster Response user scenarios,
- Leverage our arrangements with data providers to broaden the reach of information necessary for the benefit of the Disaster Response SBA,

- Register services and components in the GEOSS Registry that support the disaster response scenario,
- Support the reporting of status of the Pilot Disaster Response SBA activities,
- Coordinate with data and service providers to ensure data access in support of the scenario and plans to become persistent exemplars,
- Participate in professional conferences to discuss our GEOSS activities, and
- Participate in the Final Results of AIP Phase 2.

3.2 Component and Service Contributions

Northrop Grumman proposes to register services and components as part of GEOSS Common Infrastructure. These may include:

- Data access services using OGC WMS, WCS, SOS, WFS, and others
- Data processing services using OGC WPS and SOAP/WSDL,
- Data comparison services using OGC WPS and SOAP/WSDL, and
- Clients executing service requests to visualize and manipulate results.

The services and components will be implemented into the disaster response scenarios and are intended to be applicable to future uses of the services within GEOSS applications.

3.3 Architecture and Interoperability Arrangement Development

Northrop Grumman also proposes to provide a Disasters SBA Community Portal that will access the information and services necessary for the implementation of the Disaster Response Scenario.

The services of our USGEO government collaborators will be made available once services and the community portal have been integrated and deployed. The services and data will persist in the GEOSS operational environment and be made available to GEOSS Web Portal and Clearinghouse users no later than the end of the Phase II Pilot.

Northrop Grumman has entered into arrangements with governmental organizations for the successful implementation of the disaster response scenario outlined in Table 3-1. Northrop Grumman has reached agreements with the following data and product providers:

- NOAA Regional Climate Centers (RCC)
- National Drought Mitigation Center (NDMC)
- NOAA Space Weather Prediction Center (SWPC)

These organizations will be working with Northrop Grumman to make accessible the data and products necessary for successful execution of the disaster response scenario. Northrop Grumman will be providing the integration and services necessary to make data provided for the scenario compliant with GEOSS open standards.

3.3.1 Performance and Availability of Components

Our OGC services for the disaster response scenario, including the Disaster Response Community Portal, will be hosted on Northrop Grumman servers in Omaha, NE. Northrop Grumman will design the Community Portal and services to support an average of 1,000 hits per hour, at a minimum, and that will have an availability of at least 99%. We expect our participating data and product providers, along with the services and components we offer for their integration, to become persistent exemplars within GEOSS and transition to operational GEOSS status.

4 Description of Responding Organization

Northrop Grumman Corporation is a trusted provider of solutions to the environmental community and particularly, agencies of the USGEO component of GEO. Northrop Grumman has a multi-decadal history of deploying and transitioning mission critical solutions through programmatic discipline and engineering rigor. Northrop Grumman's experience with space and surface based sensors, large-scale information management and storage systems; architectures, services, and interfaces; mapping, charting, and geodesy products; space weather domain knowledge, tactical products and systems; and SOA architectures are representative of the breadth and depth of experience, knowledge, and resources that Northrop Grumman is able to place at the GEO community's disposal.

Northrop Grumman is offering integrated, interdisciplinary teams in both scenarios for this year's AIP with experience in GEOSS, environmental systems, meteorology, climatology, global change, sensing systems, software development, integration, systems architecture, systems engineering, and GIS services. This broad expertise is spread across the Northrop Grumman team participating in this year's AIP and is located in St. Louis, MO; Omaha, NE; Redondo Beach, CA; and Chantilly, VA USA.

Northrop Grumman is both a global defense and technology company of 120,000 employees with a growing environmental footprint. Seven business sectors comprise Northrop Grumman, three of which are contributing to this AIP-II CFP response. The Information Technology and Space Technology sectors are contributing to the Air Quality scenario. The Mission Systems sector is contributing to the Disaster Response scenario. All Northrop Grumman participants are committed to exploring the potential of cross scenario interoperability with other groups and teams, such as shared data services between the Air Quality and Disaster Response data and product providers.

Northrop Grumman's Information Technology sector (NGIT) is a trusted IT leader and premier provider of advanced IT solutions, engineering and business services for government and commercial clients. The company's technological leadership spans such areas as homeland security solutions, secure wireless, cyber and physical assurance, IT and network infrastructure, managed services, knowledge management, modeling and simulation, and geospatial intelligence solutions. NGIT's GeoEnterprise architecture is a standards-based framework for access, processing, and application of heterogeneous sensor and data sources. Included in the GeoEnterprise Architecture is the sensor web framework, PULSENet, that connects sensors to the other data, processing and visualization services.

NGIT's Atmospheric Sciences and Engineering Department provides support to NASA, DoD, and the IC community in areas such analyzing atmospheric impacts on communication systems, remote sensing of cloud parameters and cloud forecasting, mesoscale weather modeling, climate modeling, and high performance computing and communications research and development.

Northrop Grumman Space Technology (NGST) is a prime integrator for spacecraft and sensors for defense and civilian government agencies. NGST is currently building the National Polar orbiting Operational Environmental Satellite System (NPOESS), and has previously built the NASA Earth Observing Satellites (EOS), Aura and Aqua, It builds sensors such as CERES that is carried on Aqua and EOS-TERRA. NGST built the unique, flight proven hyper-spectral imager, Hyperion. Hyperion was launched in 2001 on NASA's EO-1 and remains in operation to this date. NGST is also the manufacturer of the successful Earth Probe, TOMS, that for over a decade has captured images of the CFC induced stratospheric ozone hole. NGST has extensive capabilities in hyper-spectral and radiometer imagery as well as active laser imaging (LxDAR).

Northrop Grumman Mission Systems (NGMS) is a leading global integrator of complex, mission-critical systems. The sector's technology leadership spans command, control, communications, and computers, intelligence, surveillance and reconnaissance, and missile systems. The sector differentiates itself from others in the corporation by developing systems that enable its customers to execute their missions. From designing system architectures to developing and sustaining mission-critical systems, Mission Systems' technological solutions span an entire program life-cycle and bring a wealth of expertise from the systems engineering perspective to its customers.

Northrop Grumman is a strategic member of the OGC and has been a key sponsor and participant in OGC test beds and the evolution of OGC standards. Northrop Grumman is also active in other standards bodies and works with defense and civilian government agencies to integrate standards architectures into their operations. Northrop Grumman is participating with several Federal organizations in the GEOSS AIP with the goal of transitioning them to GEOSS operational status as persistent data and product providers. Letters of acknowledgement and support are attached.

List of Acronyms

AIP	Architecture Implementation Pilot
CAP	Common Alert Protocol
CAT	Category
CFP	Call for Participation
COP	Communities of Practice
FEMA	Federal Emergency Management Agency
GCI	GEOSS Common Infrastructure
GCI	GEOSS Common Infrastructure
GEO	Group on Earth Observations
GEOSS	Global Earth Observing Systems of Systems
GIS	Geographical Information System
NASA	National Aeronautics and Space Administration
NDMC	National Drought Mitigation Center
NGIT	Northrop Grumman Information Technology
NGMS	Northrop Grumman Mission Systems
NGST	Northrop Grumman Space Technology
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
RCC	Regional Climate Center
RDSC	Regional Decision Support Center
SAS	Sensor Alerting Service
SBA	Societal Benefit Areas
SOA	System Oriented Architecture
SOS	Sensor Observing Service
SPS	Sensor Planning Service
SWPC	Space Weather Prediction Center
UAS	Unmanned Aerial Systems
USGEO	United States Group on Earth Observations
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WNS	Web Notification Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
National Centers for Environmental Prediction
Space Weather Prediction Center
325 Broadway W/NP9
Boulder, CO 80305
Telephone: (303) 497-3311 Fax: (303) 497-4006
Mobile: (720) 384-7659 Tom.Bogdan@noaa.gov

Dr. Thomas J. Bogdan
Director

August 26, 2008

Ronald P. Lowther
Manager, Advanced Environmental Systems
Northrop Grumman Mission Systems
ISRS/SDO/EBA
3200 Samson Way, NEB1/1754L
Bellevue, NE 68123

Dear Ron,

I acknowledge that my organization supports and is identified as a data and product provider in Response to Call for Participation (CFP) on Global Earth Observing System of Systems (GEOSS) Architecture Implementation Pilot – Phase II (AIP-II), submitted by Northrop Grumman to the Open Geospatial Consortium, acting on behalf of the Group of Earth Observations (GEO) Secretariat. My organization intends to make our data and products available for the Disaster Response Scenario of the CFP, and furthermore, for persistent operational integration into GEOSS by Northrop Grumman. I understand that the extent and justification of my organization's participation as stated in this CFP response will be considered during peer review. I also authorize Northrop Grumman to use my organization's logo on all data and products delivered to GEOSS users that originate from my organization.

Sincerely,

Thomas J. Bogdan

NOAA Southern Regional Climate Center

E328A Howe-Russell Geoscience Building
Department of Geography and Anthropology
Louisiana State University • Baton Rouge, LA 70803

February 23, 2007

August 26, 2008

Ronald P. Lowther
Manager, Advanced Environmental Systems
Northrop Grumman Mission Systems
ISRS/SDO/EBA
3200 Samson Way, NEB1/1754L
Bellevue, NE 68123

Dear Ron,

I acknowledge that my organization supports and is identified as a data and product provider in **Response to Call for Participation (CFP) on Global Earth Observing System of Systems (GEOSS) Architecture Implementation Pilot – Phase II (AIP-II)**, submitted by Northrop Grumman to the Open Geospatial Consortium, acting on behalf of the Group of Earth Observations (GEO) Secretariat. My organization intends to make our data and products available for the **Disaster Response Scenario** of the CFP, and furthermore, for persistent operational integration into GEOSS by Northrop Grumman. I understand that the extent and justification of my organization's participation as stated in this CFP response will be considered during peer review. I also authorize Northrop Grumman to use my organization's logo on all data and products delivered to GEOSS users that originate from my organization.

Sincerely,

Kevin Robbins

Kevin Robbins, PhD
Director, NOAA SRCC

Phone: 225.578.5021 *Fax: 225.578.2912* *http://www.srcc.lsu.edu*

NORTHEAST
REGIONAL
CLIMATE
CENTER

1123 Bradfield Hall
Cornell University
Ithaca, NY 14853-1901

Phone (607) 255-1751
Fax (607) 255-2106

Internet mail nrcc@cornell.edu

August 26, 2008

Ronald P. Lowther
Manager, Advanced Environmental Systems
Northrop Grumman Mission Systems
ISRS/SDO/EBA
3200 Samson Way, NEB1/1754L
Bellevue, NE 68123

Dear Ron,

I acknowledge that the Northeast Regional Climate Center (NRCC) at Cornell University supports and is identified as a data and product provider in **Response to Call for Participation (CFP) on Global Earth Observing System of Systems (GEOSS) Architecture Implementation Pilot – Phase II (AIP-II),** submitted by Northrop Grumman to the Open Geospatial Consortium, acting on behalf of the Group of Earth Observations (GEO) Secretariat. The NRCC intends to make our data and products available for the **Disaster Response Scenario** of the CFP, and furthermore, for persistent operational integration into GEOSS by Northrop Grumman. We have designed our Applied Climate Information System (ACIS) to fulfill such data and decision support needs and look forward to having it used as part of these venues. I understand that the extent and justification of the NRCC's participation as stated in this CFP response will be considered during peer review. I also authorize Northrop Grumman to use my organization's logo on all data and products delivered to GEOSS users that originate from my organization.

Sincerely,

Arthur DeGaetano
Professor
Director, Northeast Regional Climate Center

University of Nebraska Lincoln

SCHOOL OF NATURAL RESOURCES
National Drought Mitigation Center

August 27, 2008

Ronald P. Lowther
Manager, Advanced Environmental Systems
Northrop Grumman Mission Systems
ISRS/SDO/EBA
3200 Samson Way, NEB1/1754L
Bellevue, NE 68123

Dear Ron,

I acknowledge that my organization, the National Drought Mitigation Center (NDMC), supports and is identified as a data and product provider in **Response to Call for Participation (CFP) on Global Earth Observing System of Systems (GEOSS) Architecture Implementation Pilot – Phase II (AIP-II),** submitted by Northrop Grumman to the Open Geospatial Consortium, acting on behalf of the Group of Earth Observations (GEO) Secretariat. The NDMC intends to make our data and products available for the **Disaster Response Scenario** of the CFP, and furthermore, for persistent operational integration into GEOSS by Northrop Grumman. I understand that the extent and justification of the NDMC's participation as stated in this CFP response will be considered during peer review. I also authorize Northrop Grumman to use the NDMC's logo on all data and products delivered to GEOSS users that originate from the NDMC.

Sincerely,

Michael J. Hayes

Michael J. Hayes, Ph.D., Director
National Drought Mitigation Center

3310 Holdrege Street / 819 Hardin Hall / P.O. Box 830988 / Lincoln, NE 68583-0988
(402) 472-4271 / FAX (402) 472-2946 / E-mail: mhayes2@unl.edu / http://drought.unl.edu