OGC®
Open Geospatial Consortium (OGC)

Request for Quotations (RFQ)
and
Call for Participation (CFP)
for
OGC Testbed 11

Annex B
OGC Testbed 11 Architecture

RFQ Issuance Date: 22 October 2014
Proposal Due Date: 21 November 2014

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1 OGC Testbed 11 Introduction

A significant part of the OGC standards development process is the Interoperability Program (IP), which conducts international interoperability initiatives such as Testbeds, Pilot Projects, Interoperability Experiments, and Interoperability Expert Services. These activities are designed to encourage rapid development, testing, validation, demonstration and adoption of open, consensus based standards and best practices. Descriptions of these various initiatives can be found here:

http://www.opengeospatial.org/ogc/programs/ip

The OGC Testbed 11 is a Testbed within the Interoperability Program. OGC Testbed 11 is a global, hands-on and collaborative prototyping activity designed for rapid agile development and delivery of components and services, as well as experience leading to documented best practices. The results of OGC Testbed 11 will be documented as Engineering Reports and submitted to OGC's Technical Committee for consideration for release as public documents. In the future, some of the Engineering Reports, upon formal adoption within the OGC Standards Program may lead to new standards, revisions to existing standards, or best practices.

An index to the policies and procedures governing OGC can be found here:

http://www.opengeospatial.org/ogc/policies

The policies and procedures that define the OGC Interoperability Program are available here:

http://www.opengeospatial.org/ogc/policies/ippp

The purpose of Annex B is to describe the detailed context and requirements for OGC Testbed 11 development, which involves multiple interdependent activity threads. The requirements and architectures presented here are based upon a collaborative effort between OGC Testbed 11 Sponsors and OGC's IP program and project management staff, collectively referred to as the IP Team. The OGC Testbed 11 architecture builds on the results from previous and ongoing OGC IP initiatives, existing OGC discussion papers and specifications, OGC Technical Committee activities, and publicly available documentation from related standards organizations including ISO, W3C, OASIS, and others.

Section 2 provides an overview of the OGC Testbed 11 development threads.

Section 3 discusses the architectural approach and technical baseline for OGC Testbed 11.

Sections 4 through 6 provide the requirements, deliverables, architectural approaches and issues for each of the OGC Testbed 11 development threads.

The OGC public website provides a Glossary of Terms at the following URL that may be useful to aid in understanding and interpretation of terms and abbreviations contained throughout this RFQ:

http://www.opengeospatial.org/ogc/glossary

2 OGC Testbed 11 Thread Summaries

Testbed-11 is organized in three threads, Cross Community Interoperability, Urban Climate Resilience, and Geospatial Enhancements for NIEM (Geo4NIEM). Though those

threads are described separately throughout this RFQ, please be aware that components provided in one thread may used in other threads as well. The same applies to Engineering Report. A report may need to cover aspects that where addressed in more than one thread if they belong to the same overarching topic.

2.1 Cross-Community Interoperability (CCI) Thread

The Cross-Community Interoperability Thread seeks to address a broad variety of topics as shown in the list below:

- Architecture (various)
- Symbology
- Compliance
- Aviation

The OGC Architecture subtask seeks to address a number of issues that cross over multiple OGC services and standards by defining a common set of implementation guidelines that can be applied across the OGC Architecture for REST and SOAP. This subtask also seeks to develop a consistent approach across the OGC suite of standards for using JSON and GeoJSON. Additional areas include continuing work to advance the use of Linked Data and Semantic Enabling of OGC Web Services, use of social media data, and to advance the use and sharing of common symbology.

The compliance subtasks seek to advance the CAT 3.0 test suite and to develop a basic conformance class for WFS1.1.0.

The Aviation subtask seeks to continue to advance the work from previous testbeds for the net-centric (System Wide) Information Management (SWIM) related components of the US NextGen and EU SESAR programs. Task includes development technology for use of Semantics Of Business Vocabulary And Rules (SBVR), advance the use of Digital NOTAMs using Validation and Enrichment services, and work on Aviation Feature Schema (AFX) as a template for application schemas to implement by adding their "operational" attributes

2.2 Urban-Climate Resilience (UCR) Thread

The Urban Climate Resilience Thread responds to the urgent need to make climate information and related data readily available for the public and government decision makers to prepare for changes in the Earth's climate. The thread includes four scenarios that all add to a flood a inundation master scenario:

- High Resolution Flood Information System: Addressing access to and control of simulation models and high-resolution data
- Displaced Population due to Coastal Indundation Scenario: Addressing integration of various data sources using different encodings and bindings, including data streaming, GeoPackage creation, and web processing
- Transactional Flood Management Scenario: Addressing transactional aspects of data handlings and geosynchronization aspects in secure environments
- GeoPackage Production and Synchronization Scenario: Addressing creation and synchronization of GeoPackages across GeoPackages and Web services

2.3 Geospatial Enhancements for NIEM (Geo4NIEM)

This thread aims to build on the success of the previous Geo4NIEM effort within OGC, to further collaboration and to advance the findings and recommendations from the previous Geo4NIEM initiative. With the development of NIEM Version 3.0, the NIEM architecture took a significant step forward in supporting the use of Intelligence Community (IC) data encoding specifications. Collaboration between the necessary communities resulted in an architecture that can sustain the rapid updates to IC specifications, while still providing core support for data tagging and security attributes. This thread in Testbed 11 aims to gain IC concurrence of the NIEM architecture through the development, implementations, test and conducting a robust demonstration making use of IC specifications in a simulated "real-world" scenario.

2.4 Types of Deliverables

The OGC Testbed 11 threads require several types of deliverables in each Thread:

- **Documents - Engineering Reports (ER), Information Models (IM), Encodings (EN), Change Requests (CR):** will be prepared in accordance with OGC published templates. Engineering Reports will be delivered by posting on the OGC Portal Pending Documents list when complete and the document has achieved a satisfactory level of consensus among interested participants, contributors and editors. Engineering Reports are the formal mechanism used to deliver results of the Interoperability Program to sponsors and to the OGC Specification Program Domain and Specification Working Groups for consideration.
- **Implementations - Services, Clients, Datasets and Tools:** will be provided by methods suitable to its type and stated requirements. For example, services and components (ex. WFS) are delivered by deployment of the service or component for use in the testbed via an accessible URL. A Client software application or component may be used during the testbed to exercise services and components to test and demonstrate interoperability; however, it is most often not delivered as a license for follow-on usage. Implementations of services, clients and data instances will be developed and deployed in the Aviation thread for integration and interoperability testing, in support of the agreed-up thread scenario(s) and technical architecture. The services, clients and tools may be invoked for cross-thread scenarios in demonstration events.

Note that certain draft deliverables may have to be completed by the Preliminary Design and Deliverables milestone to support cross-thread development. These early deliverables are designated and handled on a thread-by-thread basis.

3 OGC Testbed 11 Baseline

3.1 OGC Reference Model

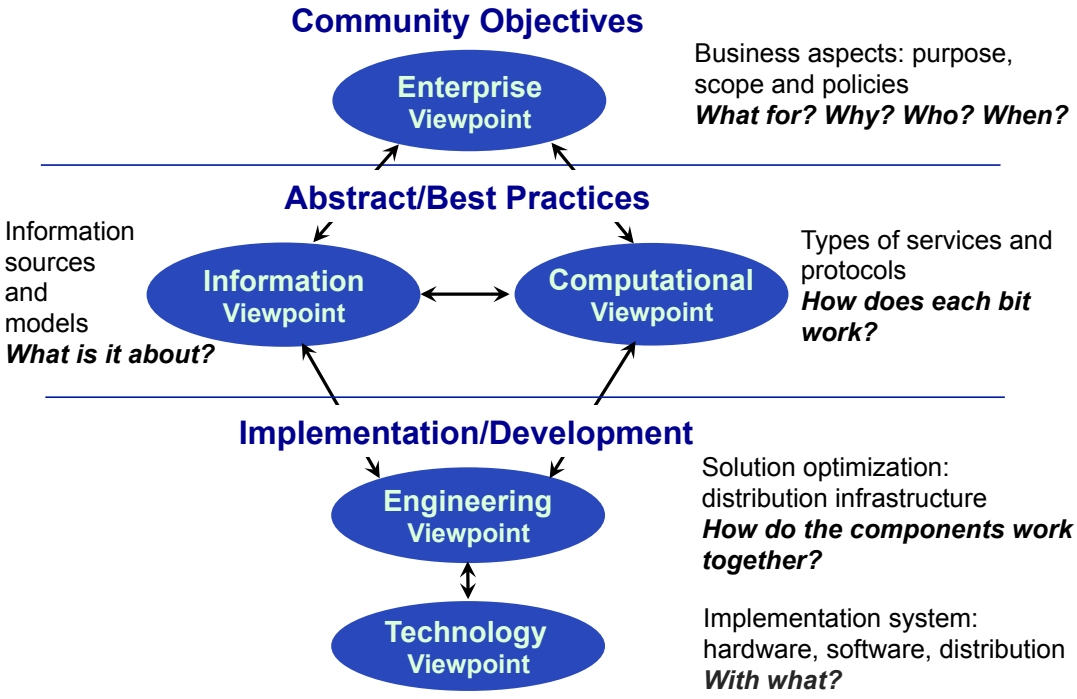
Reference: OGC Reference Model version 2.1, document OGC 08-062r7

http://www.opengeospatial.org/standards/orm

The OGC Reference Model (ORM) provides an architecture framework for the ongoing work of the OGC. Further, the ORM provides a framework for the OGC Standards Baseline. The OGC Standards Baseline consists of the member-approved Implementation/Abstract Specifications as well as for a number of candidate specifications that are currently in progress.

The ORM is a living document that is revised on a regular basis to continually and accurately reflect the ongoing work of the Consortium. We encourage respondents to this RFQ to learn and understand the concepts that are presented in the ORM.

The structure of the ORM is based on the Reference Model for Open Distributed Processing (RM-ODP), also identified as ISO 10746. This is a multi-dimensional approach well suited to describing complex information systems. This Annex of the OGC Testbed 11 RFQ will use one or more of the upper four viewpoints of RM-ODP: Enterprise, Information, Computational, and Engineering, as shown in the figure below, for discussing the context for each activity thread in OGC Testbed 11.



3.2 OGC Standards Baseline

The OGC Standards Baseline is comprised of all member-approved Implementation Standards, Abstract Standards, and Best Practices documents. These standards and related documents are freely available to the public at this website:

http://www.opengeospatial.org/standards

Each major section of the thread descriptions below identifies the relevant standards and other useful references, both normative and informative. The context of the description

will make it clear whether a standard is normative (normally expressed as “will” or “shall” be used) or informative (“may” or “should”).

3.3 Data

All participants are encouraged to provide data that can used to implement the various scenarios. A number of Testbed-11 sponsors will provide data, but it might be necessary to complement these with additional data sets. Please provide detailed information if you plan to contribute data to this testbed.

3.4 Service and Data in the Cloud

Participants are encouraged to provide data or services hosted in the cloud. There is an overarching work item to provide cloud-hosting capabilities to allow thread participants to move services and/or data to the cloud.

4 Cross-Community Interoperability (CCI) Thread

4.1 CCI Thread Scope

The CCI thread has the following requirements explained in detail in this section:

1. Advance OGC Architecture
    a. REST Interface
    b. SOAP Interface
    c. Encodings
2. Advance use of Linked Data and Semantic Enabling of OGC Web Services
3. Advance use of Linked Data for Hydrographic Data
4. Advance Catalog Services
5. Advance use of Social Media data
6. Advance use of a common symbology
7. Compliance Tests
    a. Advance WFS 1.1.0 Compliance Test
    b. Advance CAT 3.0 Compliance Test
8. Aviation
    a. Develop guidance on using Geometrical Constraints in SBVR
    b. Advance a Digital NOTAM Validation Service
    c. Advance a Digital NOTAM Enrichment Service
    d. Advance use of Aviation Feature Schema (AFX)

Background

The Cross-Community Interoperability (CCI) thread seeks to build on interoperability within communities sharing geospatial data and advance semantic mediation approaches for data discovery, access and use of heterogeneous data models and heterogeneous metadata models. This thread will explore the creation of domain ontologies and tools to create, assemble, and disseminate geographic data provided voluntarily by individuals. In addition to build integration across all OGC web services with the intent to provide a better understanding of service content and the relationships or associations that exist between OGC services, resources and content.

Requirements

4.1.1 Advance OGC Architecture

The OGC Architecture subtask seeks to address a number of issues that cross over multiple OGC services and standards by defining a common set of implementation guidelines that can be applied across the OGC Architecture. The following tasks shall utilize the work in support of the scenario driven subtask to inform recommendations and results of the Architecture studies. OGC Architecture requirements are as follows:

4.1.1.1 REST Interface

Numerous discussions and attempts have been made to identify REST interfaces and what it means to have a RESTful suite of OGC service standards. This task seeks to create a single architectural document which defines the framework for REST based OGC Services to include community best practices and use case recommendations for when a REST architecture is the appropriate choice and when other options are more suitable. The document shall include a detailed analysis of the current suite of OGC standards and policy statements to identify inconsistencies and gaps in defining REST interfaces. The REST approach shall work across the OGC suite of service standards.

Input documents for consideration include the following OGC documents but should not be limited to:

a. any previous guidance or recommendations from the RESTful Policy SWG and the REST SC

b. OGC GeoServices REST draft standards

c. any current OGC service standards that provide RESTful interfaces

d. OWS-6 Geoprocessing Workflow Architecture Engineering Report

e. OWS-6 DSS Engineering Report - SOAP/XML and REST in WMTS

f. OGC 14-012 RESTful Encoding of Sensor Planning Service for Earth Observation Satellite Tasking

g. OGC 11-080 A REST binding for WFS 2.0

h. IC/DoD REST Interface Encoding Specification for CDR Search, Version 3.0 (3 Oct 12)

i. IC-DoD REST Interface Specification for CDR Retrieve (Version 2) 3 Oct 12

j. IC/DoD REST Interface Encoding Specification for CDR Deliver, Version 1.0 (12 May 11)

k. IC-DoD REST Interface Encoding Specification for CDR Query Management, Version 1.0 (14 Dec 11)

l. IC/DoD REST Encoding Specification for CDR Brokered Search, Version 1.1 (12 May 11)

To test the architecture different implementations are required to implement the REST interface, including: WFS, WMS, WMTS, SOS, WPS and WCS.

4.1.1.2 SOAP Interface

Several but not all OGC service standards define a SOAP binding. This task is to create a single architectural document, which defines the framework for SOAP bindings across the OGC service standards. This tasking should evaluate all OGC service standards already providing for a SOAP interface and determine whether they are providing consistent implementation recommendations and whether the potential exists for interoperability issues. All SOAP bindings developed should be added via change request to any existing standard without a SOAP defined binding.

Previous testbed activities have defined the use of a Proxy method for wrapping an XML/POST binding inside of SOAP. This task shall also evaluate this option or others such methods to wrap other OGC bindings with SOAP to satisfy this requirement. It is important that the proposed solution supports security in transit measures with HTTPS Get and Post services with SOAP. A defined Proxy solution shall consider document OGC 07-158 below when providing guidance and recommendations. This task will also include the drafting of Change Requests to integrate the recommendation into the appropriate standards.

Input documents for consideration include the following OGC documents but should not be limited to:

a. OGC 12-133. OGC Web Services Facade for OGC IP Engineering Report.

b. OGC 07-158 OpenGIS Wrapping OGC HTTP-GET and -POST Services with SOAP - Discussion Paper; dated: 2008-01-24

c. OGC 06-094r1 OWS Common change request: Add SOAP encoding

d. OGC 12-133 OGC Web Services Facade for OGC IP Engineering Report

e. IC-DoD SOAP Interface Encoding Specification for CDR Search, Version 3.0 (3 Oct 12)

f. IC-DoD SOAP Interface Specification for CDR Retrieve (Version 2) 3 Oct 12

g. IC-DoD SOAP Interface Encoding Specification for CDR Deliver, Version 1.0 (12 May 11)

h. IC-DoD SOAP Encoding Specification For CDR Query Management, Version 1.0 (14 Dec 11)

i. IC/DoD SOAP Encoding Specification for CDR Brokered Search, Version 1.1 (12 May 11)

To test the architecture different implementations are required to implement the SOAP interface, including: WFS, WMS, WMTS, SOS, WPS and WCS.

4.1.1.3 Encodings

The OGC seeks a consistent approach across the OGC suite of service standards for using JSON and GeoJSON. A clear OGC position on the use of these encodings is required. This task shall document rules for implementing JSON/GeoJSON within the OGC standards, example encodings and recommendations for WMS, WFS, WCS, SWE, WPS, WMTS shall be included within the document. Recommendations shall be consistent with recommendations made for REST based services. This task shall continue the work on defining Rules for JSON and GeoJSON extensions to OGC Web Service encodings which was started in OWS-10 and reflected in the draft OWS Context GeoJSON Encoding. The document shall be written is such a way that it can be promoted as a OGC Best Practice defining appropriate use cases for JSON/GeoJSON to identify the advantages and disadvantages of JSON. Recommendations shall consider such issues as complex geometry requirements and complex feature and attribute schemas when identifying appropriate use cases. Recommendations shall be prototyped as a JSON encoding for one of the OWS 11 WFS 2.0 implementations.

Input documents for consideration include the following OGC documents but should not be limited to:

a. OGC 14-009r1, OGC Testbed-10 Rules for JSON and GeoJSON Adoption: Focus on OWS-Context

b. any REST based document identified above which defines or makes recommendation for JSON/GeoJSON encodings

c. OGC 12-121, [OWS Common] Define XML and JSON schema for a web linking structure based on RFC 5988

4.1.2 Advance use of Linked Data and Semantic Enabling of OGC Web Services

By encouraging the inclusion of semantic content in web pages, the Semantic Web aims at converting the current web, dominated by unstructured and semi-structured documents into a "web of data". A similar consistent approach can be developed for OGC web services to enable the publishing and use of unstructured and semi-structured data. This task shall exercise components and develop documentation to define an architecture that provides a semantically enabled set of OGC web services to support discovery, access, and retrieval of data. The requirements are as follows:

- Use of Controlled Vocabularies. Controlled vocabularies are a set of terms used by a specific community. They can be flat, (e.g. glossaries, code lists), multi-level (e.g. taxonomies) or relational (e.g. thesaurus, ontologies). This task shall document the use of Web Service Keywords and Ontologies.

- Perform semantic mediation between data sources and information expected by the end user. Semantic Mediation is a process to interrelate data from, heterogeneous sources (e.g. different community models). Semantic Mediation approach shall be advanced as follows:

  - Use of Catalogues and their role in semantically enabling the OGC architecture to enable data discovery, access of spatial data and semantic relationships, and linking to related data.

  - Use semantic analysis to inferred geo-location.

- Develop and use of machine learning and semantic modeling algorithms and analysis.

Input documents for consideration include the following but should not be limited to:

a. IC-DoD Keyword Query Language Specification Version 2 (3 Oct 12)

b. JSON-based Serialization for Linked Data (JSON-LD) W3C Recommendation 16 January 2014

c. Web Ontology Language (OWL) Publication date: 2012-12-11

d. Resource_Description_Framework (RDF) Publication date: 2014-02-25

e. OGC 11-052r4 GeoSPARQL - A Geographic Query Language for RDF Data

f. SPARQL query language for RDF (SPARQL) Update, 26 March 2013

g. OGC 10-070r2 OpenGIS Georeferenced Table Joining Service Implementation Standard

Linked Data empowers people that publish and use information on the Web. It is a way to create a network of standards-based, machine-readable data across Web sites. It allows an application to start at one piece of Linked Data, and follow embedded links to other pieces of Linked Data that are hosted on different sites across the Web. Linked Data within the OGC context shall be advanced as follows:

- Link data and resources of data with common or similar content, including map data (from WMS), feature data (from WFS), imagery data (from WCS) and social media (e.g. OpenStreetMap, Twitter, tumblr, flickr, Snapchat, Facebook, Instagram, YouTube, Vimeo, Panoramio, Pinterest, Picasa, storyful).
- Document and exercise the process to define relationships between data points
- Evaluate and recommend a standardized data input, output, taxonomy, and data model for linking social media content. It can include open and proprietary solutions.
- Link Data Provenance to retain historical connection to the original source of the data.
- Analyze the use of Table Joining Service and its capabilities to link web based information to features.
- Continue the work outlined in OGC 14-049 Testbed 10 Cross Community Interoperability (CCI) Ontology Engineering Report
- Explore JSON and GeoJSON encodings to facilitate data linking
- Take into account OGC 12-121, [OWS Common] which defines XML and JSON schema for a web linking structure based on RFC 5988

4.1.3 Advance use of Linked Data for Hydrographic Data

Semantic Mediation can successfully be applied in Gazetteers and Hydrography data, as done in OWS-10. In the OWS-10 semantic mediation was exercised to link results between hydrological information models, as well as linking gazetteer data with other Gazetteers and with Voluntary Geographic Information (e.g. Flickr, Twitter and OSM). This task seeks to advance the understanding of how to better build relations with hydro features and

non-hydro features (e.g., stream gage measurement /location vs bridge or other built features upstream or downstream). These can help with:

- Determining the societal impact of quality and quantity of water resources (e.g., pollutants, rain events, flooding, etc.)
- Getting related societal feature about hydro features. For example, linking hydro features to Gazetteers and other linked Data.
- Understanding the context about when there can be a potential relation between hydro and non hydro features.
- linking millions of sources (WQ and stream gages) into watersheds and stream networks (available via Linked Data and Gazetteers).
- Calculating impacts of rising Ocean levels using Elevation data and other hydro data.
- Integration of topo and stream networks with watersheds.

The proposed solution shall:

- Get related features given a set of stream reaches (determined by some prior mechanism)
- For non-hydro features (bridges, towns, other GNIS features) determine the relation with hydro (NHD-Events which are points, lines, or polygons) features. This association can be created through proximity.
- Publish the National Map, National Hydrography Dataset (NHD) via Linked Data.
- Provide recommendations on scaling using Linked Data technologies with geospatial data.

References:

- OGC 14-048. OGCTestbed 10 Cross Community Interoperability (CCI) Hydro Model Interoperability Engineering Report
- OGC 14-029r2. OGC® Testbed 10 Virtual Global Gazetteer Engineering Report. OGC Testbed 10 Virtual Global Gazetteer Engineering Report
- OGC 14-049. OGC Testbed 10 Cross Community Interoperability (CCI) Ontology Engineering Report.
- RDF Conversion code for TNM: https://github.com/dmm/SemanticNationalMap

4.1.4 Advance use of Catalog Services

The cataloging capability shall be able to support discovery of data content in a crisis event. It shall allow register multiple types of data content, multiple types of services, multiple models, common operational pictures and potential social media sources.

The cataloging solution shall consider alignment with the *IC-DoD REST Interface Encoding Specification for CDR Search (V3.0-20101003)*. This specification, defined by the Intelligence Community/Department of Defense (IC/DoD) provides a common service interface and model to enable clients though the process of Content Discovery and Retrieval (CDR).

The cataloging solution shall consider the functionality available at the DoD Enterprise Search (ES). ES is the DoD tool for content discovery and it provides the following features:

- Presents a single, simple user interface for searching and the tools needed to expose your data.
- Indexes content efficiently, ensuring it is discoverable by both anticipated and unanticipated users.
- Provides the data owner and authoritative data source control over who can access your data.
- Supports the DoD goals for improved information sharing and increased awareness of information.
- Content Discovery Deployable Architecture (CDDA) – CDDA is a lightweight version of the Enterprise Search suite of services with minimal capability loss. The purpose is to provide Disconnected, Intermittent & Low Bandwidth (DIL) environments a search service with no licenses and minimal hardware costs.
- Mobile Enterprise Search - Enterprise Search is accessible via any mobile device for users on the go. A certificate is required for access.
- Enterprise Search and Catalog Widgets - End users can now have search at their fingertips by adding the Enterprise Search and Catalog Widgets to their web pages. Look for these widgets powered by Enterprise Search in the Enterprise Storefront.
- Enterprise Search will be able to perform a Cross Domain content search and retrieval from SIPR to NIPR in FY15 Q2.

The catalog shall support the NSG Metadata Framework and the associated NSG Metadata Implementation Specification.

An evaluation shall be performed based on CAT 3.0 with Open Search and CSW 2.0.2 and the CSW ebRIM Profile 1.0. in determining the best solution for discovery of information and services in support of a crisis notification scenario. Recommendations shall be made identifying the appropriate Catalogue implementation depending on the search and discovery of structured and unstructured data and services both cloud and non-cloud based.

4.1.5 Advance use of Social Media data

Social media sources are a valuable supplement to providing up to date information. However social media data can be both overwhelming in volume and questionable in its accuracy and legitimacy. This task shall consider how best to make use of such sources of information to include OpenStreetMap, Twitter, tumblr, flickr, Snapchat, Facebook, Instagram, YouTube, Vimeo, Panoramio, Pinterest, Picasa and storyful. This task shall consider the following requirements when determining the usefulness of social media based information:

1. The ability to search for social media sources with the following capability requirements:
    - The ability to develop and update search parameters, given changes in trends and ongoing on line activity

- The ability to develop and set standard search parameters based on scenario, jurisdiction size, agency type, etc.
- The ability to search for volume change given specific profiles or groups of profiles (e.g. within an area of interest), versus identification of change in volume in general
- The ability to identify emerging and related search terms
- The ability to search for information specifically based on an area of interest or proximity to area of interest
- The ability to quickly define search parameters or areas of interest, given mission objectives and ongoing trend analysis
- The ability to search imagery through metadata and image recognition

2. The ability to identify a general change in activity (or volume) in a specified community or with specified individuals (versus the general population of social media posts); versus the ability to just detect a change in general.
3. The ability to identify and define "normal" on line activity for a given area, and to define an area of interest
4. The ability to quickly detect deviations from normal activity that may signify the occurrence of an event
5. The ability to define, update, and utilize thresholds of normal activity in order to detect deviations
6. The ability to assign geo-location to data whose discovery is otherwise hindered by the inability to search for information by geographic area of interest
7. The ability to assign meaning to information based on proximity to an area of interest to identify population or event movement
8. The ability to assign inferred geo-location through semantic analysis
9. The ability to assign geo-location based on image recognition
10. The ability to change what you are looking for once you know something, if your original assumptions about what you need to look for changes with emerging threats, changing issues, etc. - like an event that might start as one area of civil unrest which appears to be unorganized but turns into multiple areas with a more organized look.
11. The ability to cross-walk social media - they all produce data in different formats and different taxonomies.
12. The ability to parse information from social media data to satisfy multiple search parameters and mission objectives
13. The ability to assign meaning to data, given related content, context, search parameters, and mission objectives

14. The ability to identify and integrate or dismiss social media data given specific essential elements of information

15. The ability to route social media information through incident command, to appropriate groups (a need for standardization of categories based on pre-existing data standards such as EDXL, NIEM, HXL, ESF, etc.)

16. The need to define minimum information requirements for metadata of social media data

17. A need for the development and use of machine learning and semantic modeling algorithms and analysis

18. The ability to visually display both the original data points and the relationship between data points. For example, a red polygon might be used for an area that would be more greatly affected should the power go out, and highlighted once it does; or, a red road that depicts more than 50% of the available gas stations reporting outages, but the ability to "zoom" in to see the specific issues.

19. The ability to assign meaning to and visualize lack of information, changes in trends, and time decay since original time of publication

20. The different "abilities" should be implemented as one or several Web Processing Service (WPS 2.0)

It should be investigated the best way to publish social media so that it can be easily integrated with other geospatial data. A process service should get social media and filter data. The process service in conjunction with a WFS/WMS can provide data that its most legitimate and of most importance to an emergency responder. GML Streaming capabilities shall also be investigate to stream images (e.g. GMLJP2) and vector data (e.g. points representing social media latest streams).

4.1.6 Advance use of a common symbology

Various Symbology Best Practices are available for Law Enforcement and Public Safety (LEAPS) used in the context of Emergency Management.

- US FGDC ANSI 415-2006 INCITS Homeland Security Map Symbol Standard
- Canadian Emergency Management Symbology (EMS) - currently not available
- United Nations Office of Coordination on Humanitarian Affairs (UN-OCHA), which has created a set of 500 freely available humanitarian icons to help relief workers present emergency and crisis-related information quickly and simply
- Portuguese Disaster Response Map Symbols (DRMS) project, an effort to create a standard set of symbols that may aid disaster managers and responders to create efficient maps
- Australasian All-Hazards Symbology, developed by the Intergovernmental Committee on Surveying and Mapping (ICSM) and the Victoria-based company Spatial Vision
- The European INDIGO project Emergency 2D/3D Symbology Reference;

- World Meteorological Organization (WMO) Intergovernmental Oceanographic Commission efforts on map symbol standardization

None of these best practices have been widely adopted, since in house-symbols are mostly preferred. In the case of a multi-institutional or internationalization the lack of a common set of symbology can be problematic. This task will advance a common set of symbology that can be used to share common operational pictures in an international environment. The requirements of this task are as follows:

Research of symbology structures currently in use and recommend a structure for LEAPS. The proposed symbology set should be encoded in an ontology. For each symbol, a set of properties (e.g. type, name, label) and values should be included, following the Symbology ontology in OWS-10 (OGC 14-049). The proposed solution shall be tested on at least two regions, where each region uses a different conceptual models and symbology. The work should be based on work done by the UAE Ministry of Interior Abu Dhabi Police GIS Center for Security (UAE – ADP GIS CS) and the Geospatial ontology developed in OWS-10.

- Unified Geo-Data Reference Model for Law Enforcement and Public Safety (LEAPS) Services

- OGC 14-049- OGC Testbed 10 Cross Community Interoperability (CCI) Ontology Engineering Report:

This task also required to define a governance process for managing symbol sets and structures, including: Identification of the scope, identification of the nature of changes (new symbol, change of name, etc.), and review process for adjudication and update.

4.1.7 Compliance Tests

The goal of the OGC Compliance Program is to increase systems interoperability while reducing technology risks. It accomplishes this by providing a process whereby compliance for OGC standards can be tested. This program provides a mechanism by which users and buyers of software that implements OGC standards can be certain that the software follows the mandatory rules of implementation as specified in the standard. Vendors gain confidence that they are providing a product compliant with OGC standards, which will be easier to integrate and easier to market. Buyers gain confidence that a compliant product will work with another compliant product based on the same OGC standard, regardless of which company developed the product.

As part of the Compliance program, OGC provides a free "self-service" web testing facility that can be used by any developer as often as they like to test their implementations of OGC standards. This facility is also used to capture evidence that implementations are properly implementing OGC standards. The OGC testing facility is based on Executable Test Scripts (ETS), which is software code that implements the Abstract Test Suites (ATS). The ATS usually appears as Annex of OGC Implementation Specifications.

In 2013-14 the USGS Interoperability Assessment was advanced as one of the OGC Interoperability Program activities. As part of this activity USGS web services were partially tested, because of the need to load test data on the servers. Various changes were performed in the ETS test to disable this requirement that will allow to test any WFS 1.1.0 server currently in production, without the need to have test data. Also CAT 3.0 Executable test suite was developed for the basic conformance class and published in GitHub. This is a baseline that requires to be advanced further.

The tasks are as follows:

4.1.7.1 Advance WFS 1.1.0 Compliance Test

Develop a basic conformance class for WFS 1.1.0 to allow testing without test data, using both HTTP GET and POST, based on the work performed in the USGS IA: Issue #1 at WFS 1.1.0 Issue Tracker

4.1.7.2 Advance CAT 3.0 Compliance Test

Advance CAT 3.0 test suite to complete the basic and open search conformance classes. Repository: https://github.com/opengeospatial/ets-cat30

4.1.8 Aviation

The Federal Aviation Administration (FAA) and EUROCONTROL have developed the Aeronautical Information Exchange Model (AIXM) as a global standard for the representation and exchange of aeronautical information. AIXM was developed using the OGC Geography Markup Language (GML) tailored to the specific requirements for the representation of aeronautical objects, including the temporality feature that allows for time dependent changes affecting AIXM features. The overall objectives of the FAA and EUROCONTROL are to use AIXM as a basis for modernizing their aeronautical information procedures and transitioning to a net-centric, global aeronautical management capability. The FAA and EUROCONTROL plan to use AIXM in the net-centric (System Wide) Information Management (SWIM) related components of the US NextGen and EU SESAR programs.

The Weather Information Exchange Model (WXXM) is the proposed standard for the exchange of aeronautical weather information in the context of a net-centric and global interoperable Air Transport System. It is currently under development by FAA and EUROCONTROL in support of the NextGen and SESAR programs. WXXM uses the OGC Geography Markup Language (GML) tailored to the specific requirements for aeronautical meteorology and is based on the OGC Observation & Measurement Model. Within the context of global harmonization, the WXXM is harmonized and coordinated with the World Meteorological Organization (WMO), the organization traditionally responsible for standards in meteorology. The OGC's TC Meteorology Domain Working Group has set up the appropriate mechanisms and interfaces between OGC and WMO to support this global harmonization and coordination effort.

Testbed 11 aims to increase industry adoption of these formats and to support the operational use and validation of these emerging standards. In particular, there is interest in enhancing the OGC/ISO standards (WFS, Publication/Subscribe mechanisms) so that they meet SESAR SWIM requirements. The testbed will also serve as a SWIM verification platform that will help to further challenge the SWIM requirements. The results of OWS-11 testbed will be delivered to several SESAR WP8/13/14 projects, as contributions to the definition and implementation of SWIM-enabled services and systems.

References:

- Digital NOTAM Event Specification V2.0. https://drive.google.com/folderview?id=0BxlGN-YBj-q0dnFpMzBTUFBoM3c&usp=sharing
- ICAO Annex 3, 4 and 15 to the Convention on International Civil Aviation, Aeronautical Charts, Edition 11, July 2009
- OWS-8 Engineering Report - Guidelines for International Civil Aviation Organization (ICAO) portrayal using SLD/SE

- OGC Testbed 10 Aviation Human Factor Based Portrayal of Digital NOTAMs ER. OGC 14-039. 2014-07-16 https://portal.opengeospatial.org/files/?artifact_id=58929

The tasks related to Aviation are as follows:

4.1.8.1 Develop guidance on using Geometrical Constraints in SBVR

Semantics Of Business Vocabulary And Rules (SBVR) defines the vocabulary and rules for documenting business vocabularies, business facts, and business rules. It defines structural and operative rules. AIXM 5, following SBVR, has identified AIXM Structural rules and AIXM Operative rules. Some of the structural rules can be captured in the AIXM schemas. The ones that cannot be capture in a schema can be formalized in to schematron or other similar rules-engine language.

SBVR allows to provide the rules in a friendly way. For example:

- Each [...].lowerLevel that has an uom equal to 'FL' should have 2 or 3 digits
- Each AirportHeliport.ARP must have horizontalAccuracy and AirportHeliport.ARP.horizontalAccuracy should be at most 1sec

This task will advance using SBVR (as published in the ATM Profile and built on top of AIXM business rules) for writing geometrical constraints rules. The rules shall be processed automatically and convert into schematron, or any other rules-engine language. The schematron will then be used for validation as a web service an incorporated into workflows.

The task requires to:

- Define vocabulary/profile with "geospatial“ terms for SBVR. For example: object1 (spatially) intersects object2
- Determine to which extent the implementation of SBVR business rules can be automated. Target implementations: schematron, maybe also OCL.

References:

- (OMG) Semantics of Business Vocabulary and Business Rules. http://www.omg.org/spec/SBVR/
- Schematron - ISO/IEC 19757-3:2006 Information technology -- Document Schema Definition Language (DSDL) -- Part 3: Rule-based validation -- Schematron. http://www.schematron.com

4.1.8.2 Advance a Digital NOTAM Validation Service

Digital NOTAM data has the potential to be used entirely digitally, from the originator system to an end user application, without ever being checked by the eyes of a human operator. Such a completely automatic process is not going to work without a significant amount of automatic data validation. The XML Schema ensures the syntactic validation and a limited amount of checks against constraints such as data ranges. Further checks require the definition of specific business rules. These are being defined using SBVR, in an Annex of the Digital NOTAM Event Specification. For practical verification of the data against the rules, Schematron code is provided in support to the business rules definition.

This task will develop the following:

- A Digital NOTAM validation service that uses Event Specification 2.0 based on some of the corrections suggested in OWS-8.
- Investigate the use of WPS for checking each Digital NOTAM according to the rules specific for that scenario and provide the 'quality checked' Digital NOTAM for further use in the test bed.
- Analyze how Digital NOTAM encoding that have failed validation can be marked e.g. using metadata.

4.1.8.3 Advance a Digital NOTAM Enrichment Service

A Digital NOTAM is encoded as a combination of an Event feature and one or more TimeSlices for the AIXM feature (AirportHeliport, Runway, Airspace, Navaid, etc.) that is concerned by the Event. Each Digital NOTAM contains the minimal information necessary for describing what has changed. For example, as the location of a Navaid does not change when that Navaid is "out of service", the TEMPDELTA Navaid TimeSlice encoded for the Event does not contain it. In order to represent graphically the affected Navaid on a map, the location and other relevant information (type, designator, operational frequency, etc.) has to be recuperated from a source of Baseline data. Further more, there exist many aeronautical features that do not have their own geometry (such as Service, Fuel, etc.). For graphical representation, the location of a related 'owner' (such as the AirportHeliport) is used.

This task will develop guidelines for a Digital NOTAM 'enrichment' service - assuming that the Digital NOTAM contains just the minimal information (the Event and the Feature 'Delta'), the service would select from a reference database the baseline data necessary for graphical visualization or for other applications. Include in this study Digital NOTAM that refer to features that do not have their own geometry and which for graphical display inherit the geometry of a related feature.

4.1.8.4 Advance use of Aviation Feature Schema (AFX)

The Aviation Feature Schema (AFX) is designed to be generic and easily reusable. It aims to ease the delivery of data over services, including Web Feature Services. As such, its main purpose is for portrayal and it is not intended to replace the standard exchange models, for example WXXM and AIXM. AFX is a template for application schemas to implement by adding their "operational" attributes. For example, the Aerodrome Mapping format can be implemented by extending the AFX XML Schema. AFX comes with a predefined set of classes and properties e.g. for geometry and temporality. There is no need for a specific application schema to redefine these. This has the advantage of making the AFX interoperable. The use of the "Aviation Feature Schema" allows application schemas to share the same structure, allowing rapid development of schemas.

This task shall make use of AFX in the testbed in order to report on the quality and provide recommendations for improvement.

4.2 CCI Deliverables

Table 1 – CCI Thread Deliverables Summary

1.	OGC Testbed 11 REST Interface ER
2.	REST Change Requests
3.	OGC Testbed 11 SOAP Interface ER

4. SOAP Change Requests
5. OGC Testbed 11 Implementing JSON/GeoJSON in an OGC Standard ER
6. JSON/GeoJSON Change Requests
7. OGC Testbed 11 Implementing Linked Data and Semantically Enabling OGC Services ER
8. OGC Testbed 11 Use of Semantic Linked Data with RDF for National Map NHD and Gazetteer Data ER
9. WFS-G with Semantic Mediation (hydro and non-hydro features)
10. WPS to Generate RDF from National Map NHD Data
11. Generate RDF for Non-hydro Features from Gazetteer Data
12. OGC Testbed 11 Catalogue Service Analysis and Recommendation ER
13. Catalog Service Supporting the Scenario
14. OGC Testbed 11 Incorporating Social Media in Emergency Response ER
15. WPS 2.0 for Social Media
16. GeoSPARQL
17. SOS 2.0 for Social Media
18. WFS 2.0 for Linked Data
19. Ontology Server SPARQL for Symbology and Aviation
20. SLD/SE Producer for Symbology and Aviation
21. WFS 2.0 for Region One
22. WFS 2.0 for Region Two
23. FPS for Symbology and Aviation
24. Client Supporting Linked Data Semantics and Social Media
25. CAT 3.0 Compliance Test
26. WFS 1.1.0 Compliance Test
27. OGC Testbed 11 Aviation - Guidance Using SBVR for Geometrical Constraints ER
28. Tool to Automate SBVR to Schematron
29. WPS Validator for Aviation

30. OGC Testbed 11 Aviation - Digital NOTAM Validation and Enrichment Service ER
31. OGC Testbed 11 Aviation - Feature Schema Recommendations ER
32. Client for Aviation
33. WFS AIXM including Digital NOTAM
34. WFS for Aviation Feature Schemas
35. OGC Testbed 11 Symbology ER

4.2.1 OGC Testbed 11 REST Interface ER

Report that captures the architecture that provides the framework for REST based OGC services. It shall include: the proposed architecture and modifications to OGC Standards; analysis of the suite of OGC standards and policy statements to identify inconsistencies and gaps in defining REST interfaces; community best practices; and, use case recommendations for when a REST architecture is the appropriate choice and when other options are more suitable.

4.2.2 REST Change Requests

Change Request to OGC standards to accommodate the REST architecture solution.

4.2.3 OGC Testbed 11 SOAP Interface ER

Report that captures the architecture that provides the framework for SOAP bindings across OGC services. It shall include: the architecture framework and proposed modification to OGC standards; evaluation of OGC standards already providing a SOAP interface; and, evaluation of wrapping and proxy solutions.

4.2.4 SOAP Change Requests

Change Request to OGC standards to accommodate the SOAP architecture solution.

4.2.5 OGC Testbed 11 Implementing JSON/GeoJSON in an OGC Standard ER

Report that captures the rules for implementing JSON/GeoJSON within OGC standards. It shall include recommendations and examples for WMS,WCS,SWE, WPS and WMTS. Recommendations shall be consistent with recommendations made for REST based services. The document shall be written is such a way that it can be promoted as a OGC Best Practice define appropriate use cases for JSON/GeoJSON to identify the advantages and disadvantages of JSON. Recommendations shall consider such issues as complex geometry requirements and complex feature and attribute schemas when identifying appropriate use cases.

4.2.6 JSON/GeoJSON Change Requests

Change Request to OGC standards to accommodate the JSON/GeoJSON recommendations.

4.2.7 OGC Testbed 11 Implementing Linked Data and Semantically Enabling OGC Services ER

The report shall capture the work performed related to section 4.2.1 Semantic Enabled OGC Web Services. The report shall detail background, requirements, architecture and

summary of the components, lessons learned (at a general level and per component), recommendations to OGC services and encodings, and future work. It shall include proposed improvements to GeoSPARQL.

4.2.8 OGC Testbed 11 Use of Semantic Linked Data with RDF for National Map NHD and Gazetteer Data ER

This report shall capture the architecture that provides the framework for using Linked Data technologies to publish National Map NHD and Gazetteer Data.

4.2.9 WFS-G with Semantic Mediation (hydro and non-hydro features)

Enhanced WFS-G Service that publishes hydro and non-hydro features. The WFS-G shall provide data from the GNIS or Geographic Names Information System, managed by USGS, which contains information about domestic and Antarctic names. It should also contain other features

4.2.10 WPS to Generate RDF from National Map NHD Data

4.2.11 Generate RDF for Non-hydro Features from Gazetteer Data

4.2.12 OGC Testbed 11 Catalogue Service Analysis and Recommendation ER

The report shall capture the work performed related to section 4.2.1. “Cataloguing”. The report shall detail background, requirements, architecture and summary of the components, lessons learned (at a general level and per component), recommendations to OGC services and encodings, and future work. It shall also detailed the recommendations to support the scenario, semantic interoperability, inference and linking.

4.2.13 Catalog Service Supporting the Scenario

A catalog that is able to provide a CAT 2.0 ebRIM and a CAT 3.0 open search to help in the evaluation. The Catalog service solution shall fulfill the requirements detailed in section 4.2.2:

- Support semantic analysis to inferred geolocation
- Support Semantic Modeling Algorithms and Analysis
- Align with IC-DoD REST
- Implement DoD Enterprise Search (ES)
- Support NSG Metadata
- Support the Semantic Mediation work
- Support the Linked Data work

4.2.14 OGC Testbed 11 Incorporating Social Media in Emergency Response ER

The report shall capture the work performed related to section 4.2.2.2 "Social Media". The report shall detail background, requirements, architecture and summary of the components, lessons learned (at a general level and per component), recommendations to OGC services and encodings, and future work.

4.2.15 WPS 2.0 for Social Media

The WPS shall help fulfill the requirements detailed in section title "Advance use of Social Media data". This includes providing processing capabilities for analysis, inference, crosswalks and integration. Given a location or feature, the WPS shall filter social media data and get the most relevant trustworthy related data. It is encouraged that this service be provided in a Cloud infrastructure.

4.2.16 GeoSPARQL

The GeoSPARQL component will:

- allow query and discovery of controlled vocabularies
- help inference for social media data
- publish social media data as ontologies
- link and publish relations of resources
- Rules to map and link Hydro and non hydro features
- Convert needed data to RDF (e.g. The National Map to RDF)

This component will support the sections:

- *Advance Semantic Enabling of OGC Web Services*,
- *Advance use of Linked Data within OGC Services*
- *Advance Catalog Services*.
- *Advance use of Social Media data*
- *Advance use of Linked Data for Hydrographic Data*

4.2.17 SOS 2.0 for Social Media

The SOS shall help fulfill the requirements detailed in section title "Advance use of Social Media data". These includes providing social media data as observations, similar to what was developed in OWS-10.

4.2.18 WFS 2.0 for Linked Data

The solution shall help fulfill the requirements detailed in sections:

4.2.19 Ontology Server SPARQL for Symbology and Aviation

The Server manages and publishes symbol sets and mappings across feature types and or symbols. This component will be used to fulfill the requirements detailed in the *Advance use of a common symbology* and in *Advance a Digital NOTAM Validation Service* sections. Both tasks require and inference service to get an appropriate symbol for a feature type.

4.2.20 SLD/SE Producer for Symbology and Aviation

An SLD/SE Producer is required to provide a client an SLD that can be used with an FPS to get an image from data coming from a WFS. The SLD is created on the fly with the help of an ontology server. The ontology server helps inference appropriate symbology for a specific feature type. This component will be used to fulfill the requirements detailed in

the *Advance use of a common symbology* and in *Advance a Digital NOTAM Validation Service* sections.

4.2.21 WFS 2.0 for Region One

A WFS 2.0 service that publishes data from one region (e.g., Europe, Middle East or North America) is required to test the symbology set and mediation specified on the symbology requirements section (*Advance use of a common symbology*)

4.2.22 WFS 2.0 for Region Two

A second WFS 2.0 service that publishes data from another region is required to test the symbology set and mediation specified on the symbology requirements section (*Advance use of a common symbology*).

4.2.23 FPS for Symbology and Aviation

This component will be used to fulfill the requirements detailed in the *Advance use of a common symbology* and in *Advance a Digital NOTAM Validation Service* sections. It will facilitate a client to get portrayed data based on a set of symbols, which can be inferred.

4.2.24 Client Supporting Linked Data Semantics and Social Media

Integrated client. This Thread is interested in a client that is capable to help fulfill the requirements detailed in section 4.2.

- Interact with a Catalog (CSW 2.0 EbRIM and CAT 3.0 Open Search)
- Interact with a WFS 2.0, including REST and SOAP
- Provide a user interface to enable a user to view and interact with GML streaming data from a WFS 2.0
- Consume JSON/GeoJSON
- Interact with a GEOSPARQL and SPARQL endpoints
- Consume other services (WMS, WMTS, WCS, SOS, WPS) via REST interface
- Interact with an FPS to consume maps given a style sheet an a WFS endpoint
- Provide a user interface for social media data

4.2.25 CAT 3.0 Compliance Test

Advance CAT 3.0 test suite to complete the basic and open search conformance classes. https://github.com/opengeospatial/ets-cat30

A comprehensive test should be made available in beta before the end of the testbed. If existing reference implementations are available any issues with the reference implementation not passing the test, should be properly documented in the GitHub issue tracker.

4.2.26 WFS 1.1.0 Compliance Test

Develop a basic conformance class for WFS 1.1.0 to allow testing without test data, using both HTTP GET and POST, based on the work performed in the USGS IA: https://github.com/opengeospatial/ets-wfs11/issues/1

4.2.27 OGC Testbed 11 Aviation - Guidance Using SBVR for Geometrical Constraints ER

The report shall capture the guidance on using SBVR (as published in the ATM Profile) for writing geometrical constraints.

4.2.28 Tool to Automate SBVR to Schematron

This tool will be used to convert SBVR rules to schematron, so they can be loaded at a validation service for AIXM and Digital NOTAM data.

4.2.29 WPS Validator for Aviation

The WPS Validator is a Digital NOTAM validation service that uses Event Specification 2.0 based on some of the corrections suggested in OWS-8.

4.2.30 OGC Testbed 11 Aviation - Digital NOTAM Validation and Enrichment Service ER

The report shall capture the results of the following:

- The implementation of A Digital NOTAM validation service that uses Event Specification 2.0 based on some of the corrections suggested in OWS-8.
- Investigation of the use of WPS for checking each Digital NOTAM according to the rules specific for that scenario and provide the 'quality checked' Digital NOTAM for further use in the test bed.
- Recommendations of how Digital NOTAM encoding that have failed validation can be marked e.g. using metadata and used back by a client.
- Architecture and implementation of services that help visualize Digital NOTAM data.
- Recommendations of visualizing Digital NOTAM that refer to features that do not have their own geometry and which for graphical display inherit the geometry of a related feature.
- Architecture and implementation of services that help visualize Digital NOTAM data.
- Recommendations of visualizing Digital NOTAM that refer to features that do not have their own geometry and which for graphical display inherit the geometry of a related feature.

4.2.31 OGC Testbed 11 Aviation - Feature Schema Recommendations ER

The report shall capture the results of the using the Aviation Feature Schema(AFX). Issue at the server or client side as well as recommendations on the schema.

4.2.32 Client for Aviation

The Client for Aviation shall be able to interact with:

- WFS (AIXM and Digital NOTAM)
- WFS (AFX)
- WPS Validator and be able to report on validation results

- FPS

4.2.33 WFS AIXM including Digital NOTAM

A WFS Service that can publish AIXM 5.1.1 with Digital NOTAM data.

4.2.34 WFS for Aviation Feature Schemas

A WFS Service that can publish AFX data.

4.2.35 OGC Testbed 11 Symbology ER

Engineering report on advancing data and service discovery to demonstrate through OGC new and/or existing services the benefit of semantic mediation approaches in support of Linked Data Concepts.

4.3 CCI Enterprise Viewpoint

Testbed 11 will concentrate on two scenarios:

21. Support Predictive Analysis to help define plans to mitigate Climate Change events. This scenario will focus on "Displaced population due to coastal inundation". For example, determining if a population is impacted due to some level of sea level rise. For example, loss of land, food supplies, etc. Are there populations in unstable political environments, can their government handle it if the people start to riot, are these people then a danger to the rest of the world because they have overthrown a government with nuclear capacity, etc. The Urban Climate Resilience Thread (Section 5) provides more details about this scenario. This thread will support the discovery and semantic mediation of this scenario.

22. Support for Emergency Responders in the case of inundation, using Hydro and no Hydro data, as well as social media. Emergency response teams require OGC based services to support crisis notification, discovery of data content, use of on-line on-demand processing services, rapid access to data, access to on the ground social media sources of information, sharing of common operational pictures, access to historical information of data sources, and routing definition for the emergency response teams. To fulfill emergency responders it requires data to be inferred and mediated and fast processing of social media information.

Ingesting data via different interfaces and encodings

Some users require accessing the data via REST and via SOAP. Also some users required getting the data in JSON or GeoJSON.

Linked Data, Semantics and Social Media

- A user seeks to get the latest data about a region (PoI) or event. The data can come from different sources:
  - OGC services
  - social media sources (e.g. OpenStreetMap, Twitter, tumblr, flickr, Snapchat, Facebook, Instagram, YouTube, Vimeo, Panoramio, Pinterest, Picasa, storyful).
  - Gazetteers

- NHD
- or other services.

Hydrography, observations, models and other features

A user wants to know how the data is related to each other. For example a feature in NHD with a point in a gazetteer, model data from the region of interest, and an event reported in Twitter.

Symbology

A user wants to view different types of data with one symbology set. The data might use different feature types and might have traditionally being assigned a different symbology set.

Aviation

- An organization defining business rules uses SBVR, the rules get capture automatically in schematron and are loaded to a validation service where the data is validated.
- A pilot gets notification on events that are related to the business rules. For example an airport runway closing due to an event like flooding.
- A pilot visualizes data using common symbology, even if the data come from different sources.
- A pilot can access data that is coded in common schemas like Aviation Feature Schema (AFX).

4.4 CCI Information Viewpoint

The Information Viewpoint considers the information models and encodings that will make up the content of the services and exchanges to be extended or developed to support this component. Listed here are various information modeling and encoding standards that have direct relevance to the requirements of the thread.

Architecture

- OGC 14-009r1, OGC Testbed-10 Rules for JSON and GeoJSON Adoption: Focus on OWS-Context
- any REST based document identified above which defines or makes recommendation for JSON/GeoJSON encodings
- OGC 12-121, [OWS Common] Define XML and JSON schema for a web linking structure based on RFC 5988

Linked Data, Semantics and Social Media (including Hydro)

- JSON-based Serialization for Linked Data (JSON-LD) W3C Recommendation 16 January 2014
- Web Ontology Language (OWL) Publication date: 2012-12-11
- Resource_Description_Framework (RDF) Publication date: 2014-02-25

- Geography Markup Language (GML). USe the represent the models in the thread. Aviation, Gazetteer and social media data
- OWS Context
- National Hydrography Dataset (NHD) Model

Symbology

- Web Ontology Language (OWL) Publication date: 2012-12-11
- Resource_Description_Framework (RDF) Publication date: 2014-02-25
- Unified Geo-Data Reference Model for Law Enforcement and Public Safety (LEAPS) Services

Aviation

- AIXM. The Aeronautical Information Exchange Model (AIXM) is designed to enable the management and distribution of Aeronautical Information Services (AIS) data in digital format. - Provides the model to encode aviation data.
- Digital NOTAM.
- (OMG) Semantics of Business Vocabulary and Business Rules. SBVR.
- Schematron - ISO/IEC 19757-3:2006 Information technology -- Document Schema Definition Language (DSDL). Use to capture Aviation business rules.

4.5 CCI Computational Viewpoint

The computational viewpoint is concerned with the functional decomposition of the system into a set of services that interact at interfaces. Listed here are various service interface standards that have direct relevance to the requirements of the thread.

Services to support the Climate Modeling Scenario

Data should be published following these services:

- DGWIG Web Coverage Service (WCS) 2.0 Profile
- NSG/DGWIG Web Feature Service (WFS) 2.0 Profile
- DGWIG Web Mapping Service (WMS) 1.3 Profile
- NSG Web Map Tile Service (WMTS) 1.0 Profile
- Web Processing Service (WPS) 2.0

Architecture: REST

- OWS-6 DSS Engineering Report - SOAP/XML and REST in WMTS
- OGC 14-012 RESTful Encoding of Sensor Planning Service for Earth Observation Satellite Tasking
- OGC 11-080 A REST binding for WFS 2.0
- IC/DoD REST Interface Encoding Specification for CDR Search, Version 3.0 (3 Oct 12)

- IC-DoD REST Interface Specification for CDR Retrieve (Version 2) 3 Oct 12
- IC/DoD REST Interface Encoding Specification for CDR Deliver, Version 1.0 (12 May 11)
- IC-DoD REST Interface Encoding Specification for CDR Query Management, Version 1.0 (14 Dec 11)
- IC/DoD REST Encoding Specification for CDR Brokered Search, Version 1.1 (12 May 11)

Architecture: SOAP

- IC-DoD SOAP Interface Encoding Specification for CDR Search, Version 3.0 (3 Oct 12)
- IC-DoD SOAP Interface Specification for CDR Retrieve (Version 2) 3 Oct 12
- IC-DoD SOAP Interface Encoding Specification for CDR Deliver, Version 1.0 (12 May 11)
- IC-DoD SOAP Encoding Specification For CDR Query Management, Version 1.0 (14 Dec 11)
- IC/DoD SOAP Encoding Specification for CDR Brokered Search, Version 1.1 (12 May 11)

Linked Data, Semantics and Social Media

- IC-DoD Keyword Query Language Specification Version 2 (3 Oct 12)
- OGC 11-052r4 GeoSPARQL - A Geographic Query Language for RDF Data
- SPARQL query language for RDF (SPARQL) Update, 26 March 2013
- OGC 10-070r2 OpenGIS Geo referenced Table Joining Service Implementation Standard
- IC-DoD REST Interface Encoding Specification for CDR Search V3.0-20101003
- JPEG 2000 Interactive Protocol Part 9 - JPIP.

Symbology

- Unified Geo-Data Reference Model for Law Enforcement and Public Safety (LEAPS) Services
- GML

Aviation

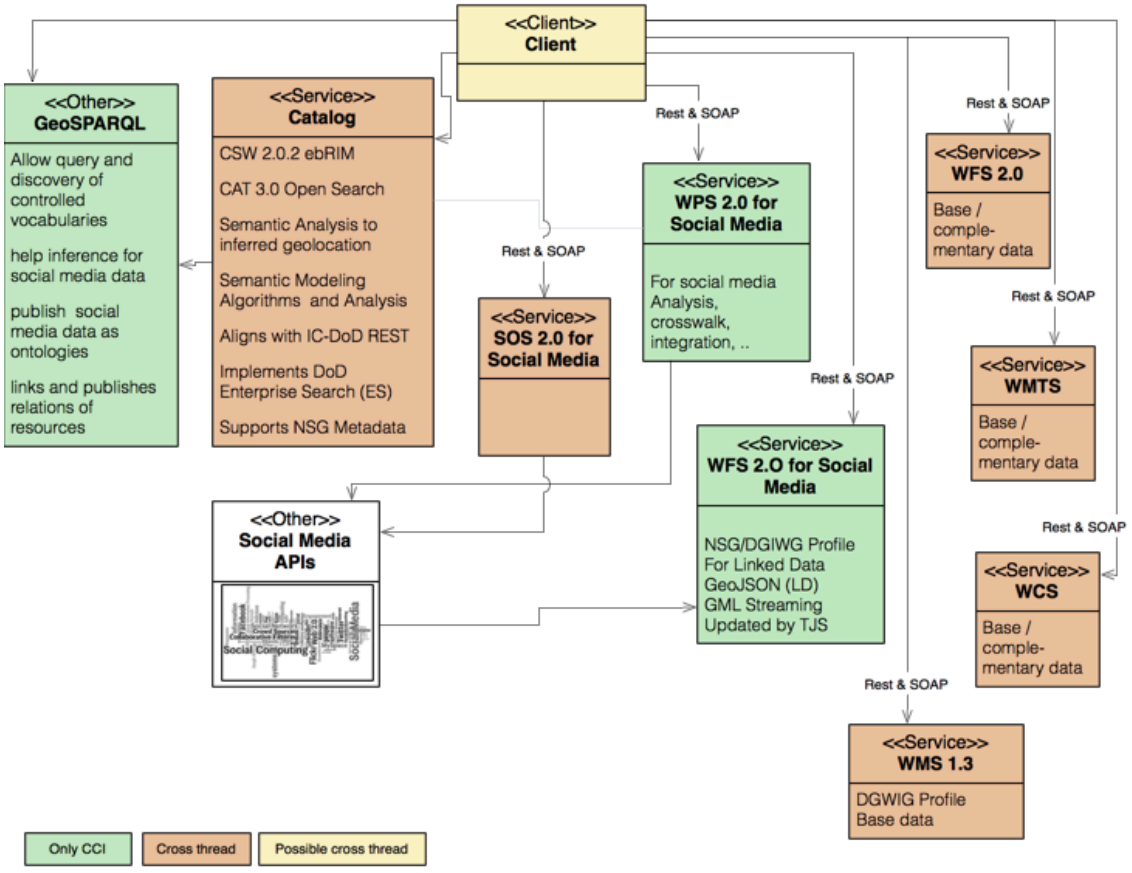
- WFS - to publish Aviation data
- SPARQL - to mediate symbology for features
- WMS - to validate Digital NOTAM

4.6 CCI Engineering Viewpoint

The following viewpoints have been divided in the following themes:

- Semantics and Architecture
- Hydro Features
- Symbology
- Aviation

4.6.1 CCI Engineering Viewpoint for Semantics and Architecture

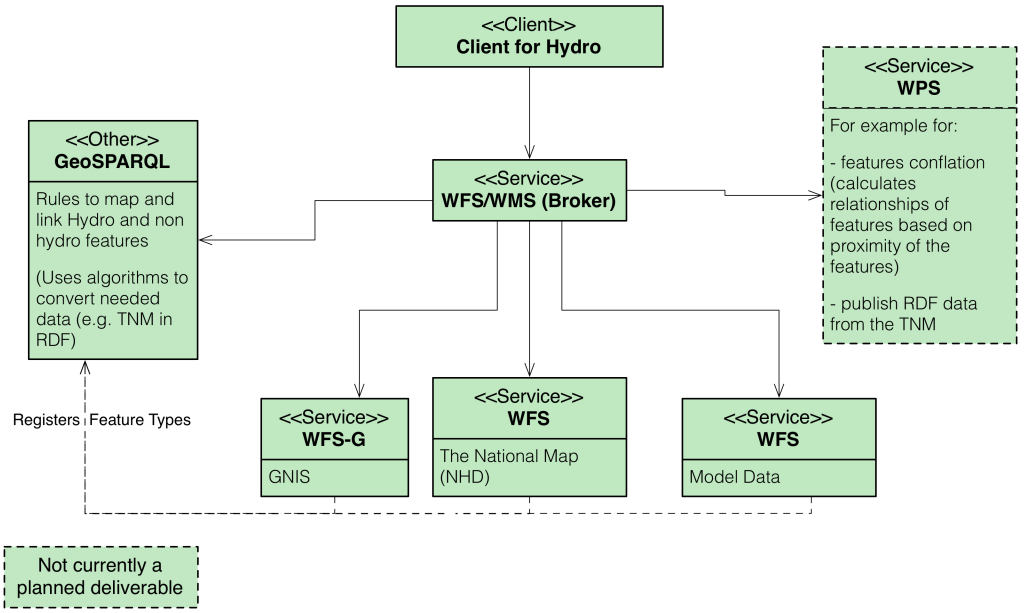


Semantics, Linking and Architecture

The diagram shows the components required for the requirements: *Advance OGC Architecture*, *Advance use of Linked Data and Semantic Enabling of OGC Web Services*, *Advance Catalog Services*, and *Advance use of Social Media data*.

A client is able to consume data from different sources. Discover data form a catalog, including inferring data, possibly be using a GeoSPARQL server. The client is able to ingest social media data, data from other Testbed threats, and context data (e.g base maps). Services should follow the DGWIG profiles. Social Media data ban be wrapped via OGC services or made available via other mechanism to the client (e.g. GeoSPARQL server)

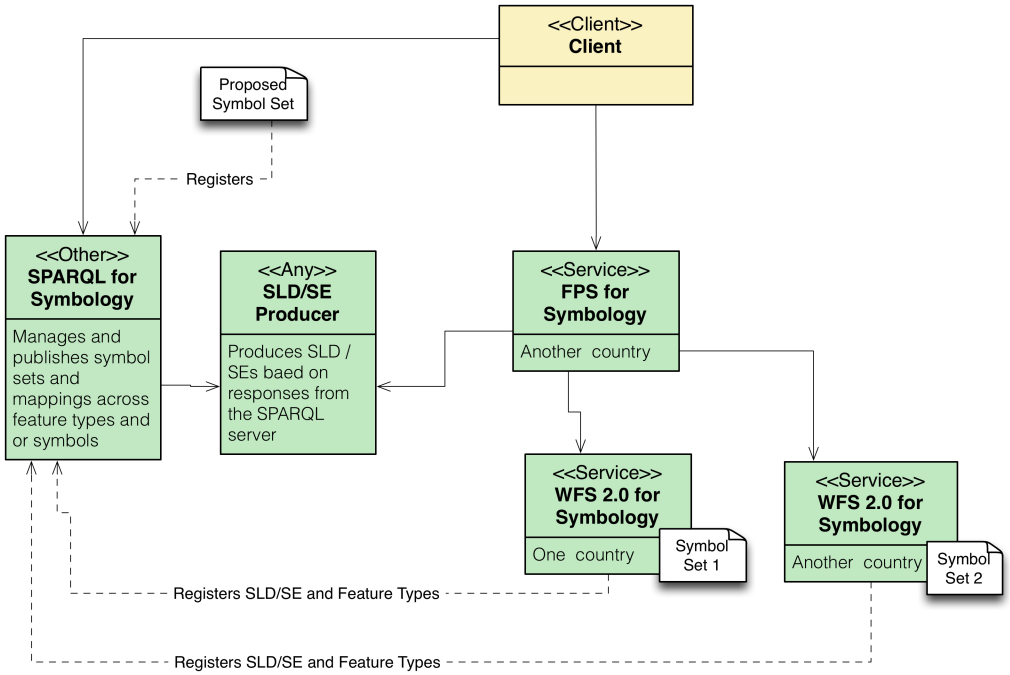
4.6.2 CCI Engineering Viewpoint for Hydro



Advancing Semantics with Hydro Features

The figure shows a proposed architecture for the *Advance use of Linked Data for Hydrographic Data* requirement. A client interacts with a WFS/WMS that acts as a broker. The broker cascade requests to other OGC services and use a GeoSPARQL server to help mediate across features. Participants can propose their own architecture and recommend components not shown in the diagram. For example a WPS that helps conflating features or publishes RDF data from the National Map.

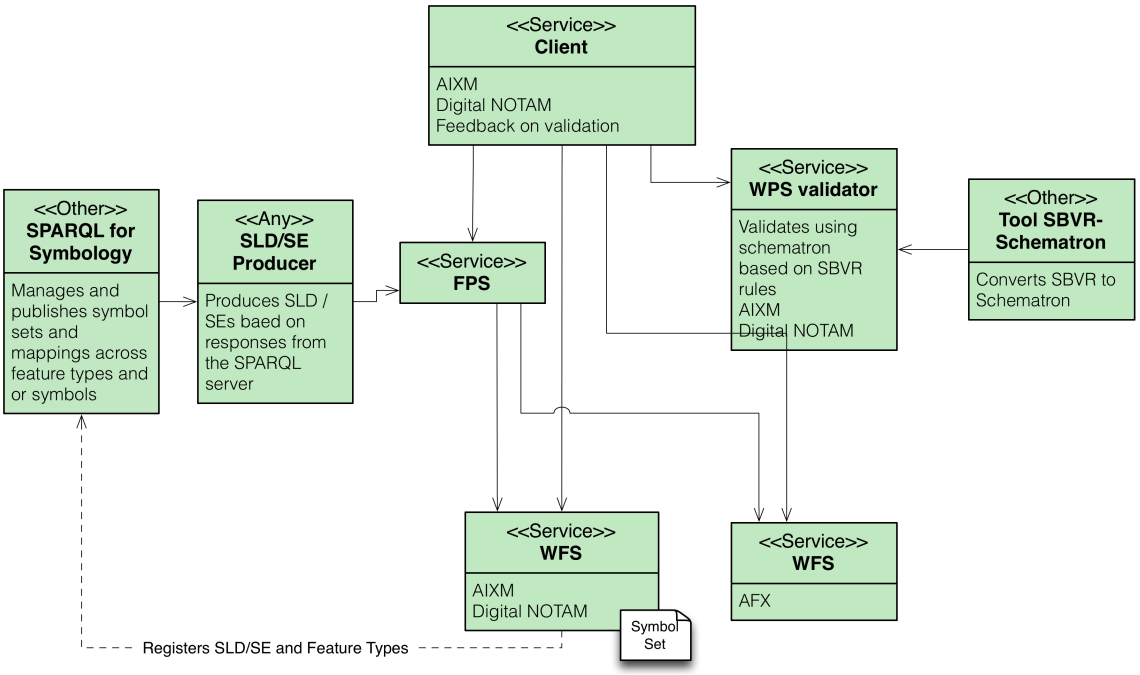
4.6.3 CCI Engineering Viewpoint for Symbology



Semantics, Linking and Symbology

The diagram summarizes the components involve in advancing the symbology work detailed in the requirement: *Advance use of a common symbology*. A client interacts with an FPS to portray data from different sources using one common set of symbols. An SLD/ED producer is necessary to provide the client or FPS the symbology encoding. The SPARQL server provide the inference across features to get the best symbol for a particular feature type.

4.6.4 CCI Engineering Viewpoint for Aviation



Aviation

The diagram above summarizes the components involved in the Aviation requirements. A WPS Validator provides Digital NOTAM Validation, using schematron provided by the *TOOL SBVR-Schematron*. The tool converts SBVR geometrical constraints rules to schematron files.

The WFS that provides AIXM and Digital NOTAM data will help prototype the Digital NOTAM Enrichment Service. The client will get from the FPS the best graphical visualization for the WFS data, with the help of an ontology server that can help provide the necessary inference across features (e.g. get graphical representation of a feature that inherits the geometry of a feature, for which Symbology rules exist.)

5 Urban Climate Resilience (UCR) Thread

The *Defense Quadrennial Review* reported recently that climate changes will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence. It is commonly accepted fact that climate change will have unavoidable impacts on urban systems and populations. Climate adaptation will be essential, and planning for adaptation can be simplified through operationalizing concepts of climate resilience and

vulnerability.[1] Space agencies such as NASA, ESA, or JAXA together with ground based national surveying, mapping, or environmental protection agencies and institutes collect enormous amounts of data that can be used to meet the requirements caused by a changing climate. The challenge is to create easy-to-use tools for regional planners, farmers, hospitals, scientist, disaster response teams, political analysts, or businesses that allow for a better understanding of a changing climate and related consequences, mitigation and adaptation strategies, and general planning processes.

5.1 UCR Thread Scope

The Urban Climate Resilience Thread responds to the urgent need to make climate information and related data readily available for the public and government decision makers to prepare for changes in the Earth's climate.

The technology developed in the thread will be demonstrated using a master scenario with multiple use cases as described in the next sections. Technology developments to support the Climate Resilience Thread include:

Open Climate and Hydrologic Cycle Data. Provide access to open climate data, stream gauges data, precipitation data etc. using OGC Web Services including enhancements to existing OWS standards and consideration of revisions.

Climate Decision and Common Operational Picture Tools. Deploy applications and toolkits that access open climate data, triggering production of additional data using (simulation) models, and support decision-making relevant to the Climate Resilience Scenario.

Climate, Inundation, Flood, and Human Geography Processes Models. Provide access to two types of models: 1) Access to pre-computed outputs from computationally expensive model runs; 2) Provide access to prediction algorithms and integrated environmental, human geography, and political/social models for decision makers to conduct "what-if" studies in their geographic region of interest.

Data Synchronization and Transactional Data Handling: Ensure properly synchronized data sets across different types of data stores and applications. Data shall be created and updated in secure ways across organizations and players, both in house and in the field.

Image Handling and Streaming: As decision makers depend on reliable information, ways shall be explored to combine imagery data with complementing information directly embedded into the image files. Imagery shall be accessible through optimized interfaces with data streaming enabled.

The following diagram illustrates the different use cases addressed in the Urban Climate Resilience scenario.

[1] Tyler, S., & Moench, M. (2012). A framework for urban climate resilience. Climate and Development, 4(4), 311–326

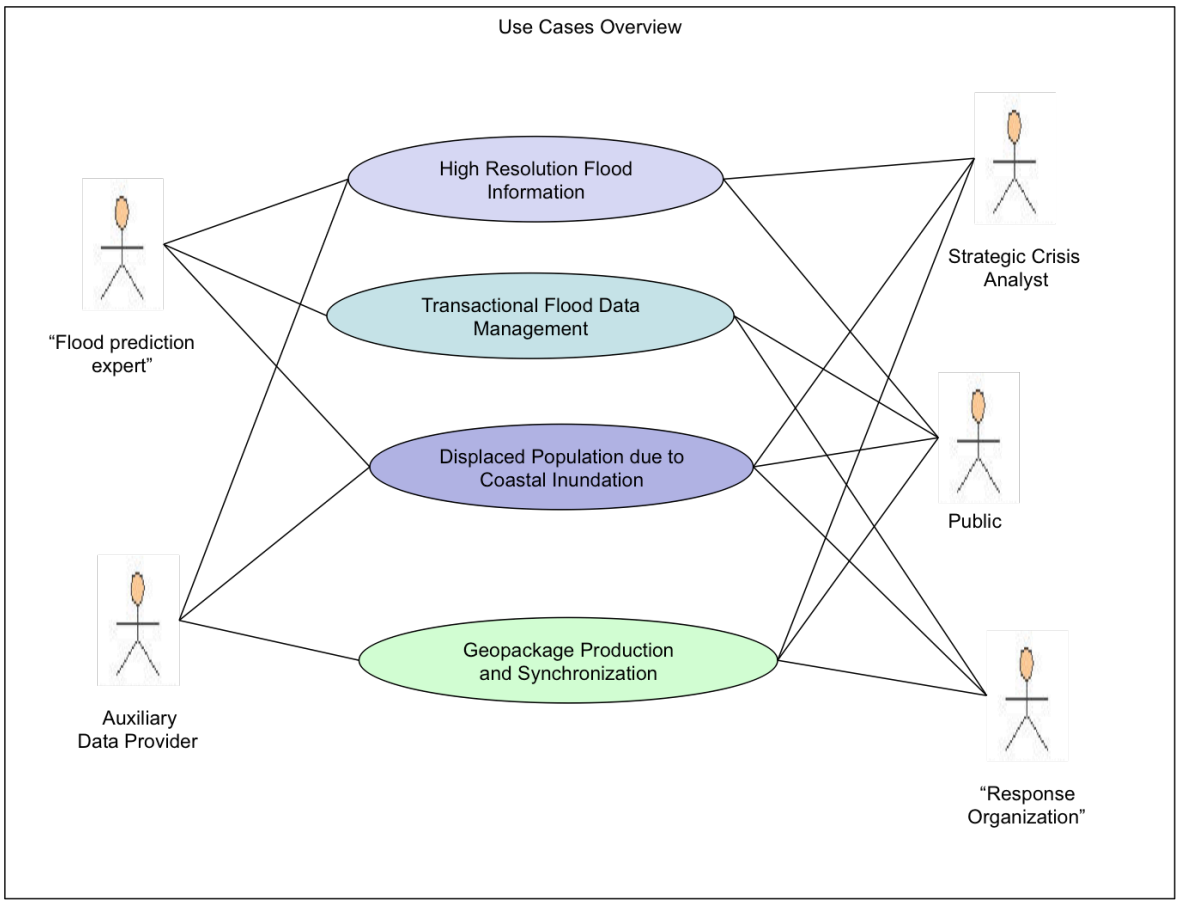


Figure 1: Use cases Urban Climate Resilience Scenario

Four use cases are foreseen, which again consist of a number of sub-use cases. These are defined in the following sections.

5.2 UCR Thread Requirements

The UCR requirements have been categorized into four high-level scenarios. All four are related to the flood and inundation information system scenario. Individual components, such as client applications or Web service instances may be used across multiple use cases. To host components and data in the cloud is an overarching requirement for all four use cases.

5.2.1 High Resolution Flood Information Scenario

One of the current major gaps in the provision of geospatial data for natural disaster response services and the scientific community is the lack of a coherent and consistent set of services providing access to observed or simulated flood event inundation and magnitude data at scales from continental to global. Regional to local "opportunistic" satellite data of flooding are useful but have many obvious limitations (cloud cover, inadequate spatial resolution for the local nature of flood risk, data latency and accessibility restrictions for some image types and sensors). In order to accurately reproduce flood characteristics such as flood inundation and water depth both in the river channels and floodplains, hydrodynamic models are required. Most of these models operate at very high resolutions and are computationally expensive, making their application over large areas very difficult.

This scenario will elaborate on the integration of high-resolution models façaded by OGC Web services into spatial data infrastructures. Models shall be automated and made partly controllable to clients using Web service interfaces, together with all required data.

The following figure illustrates the scenario.

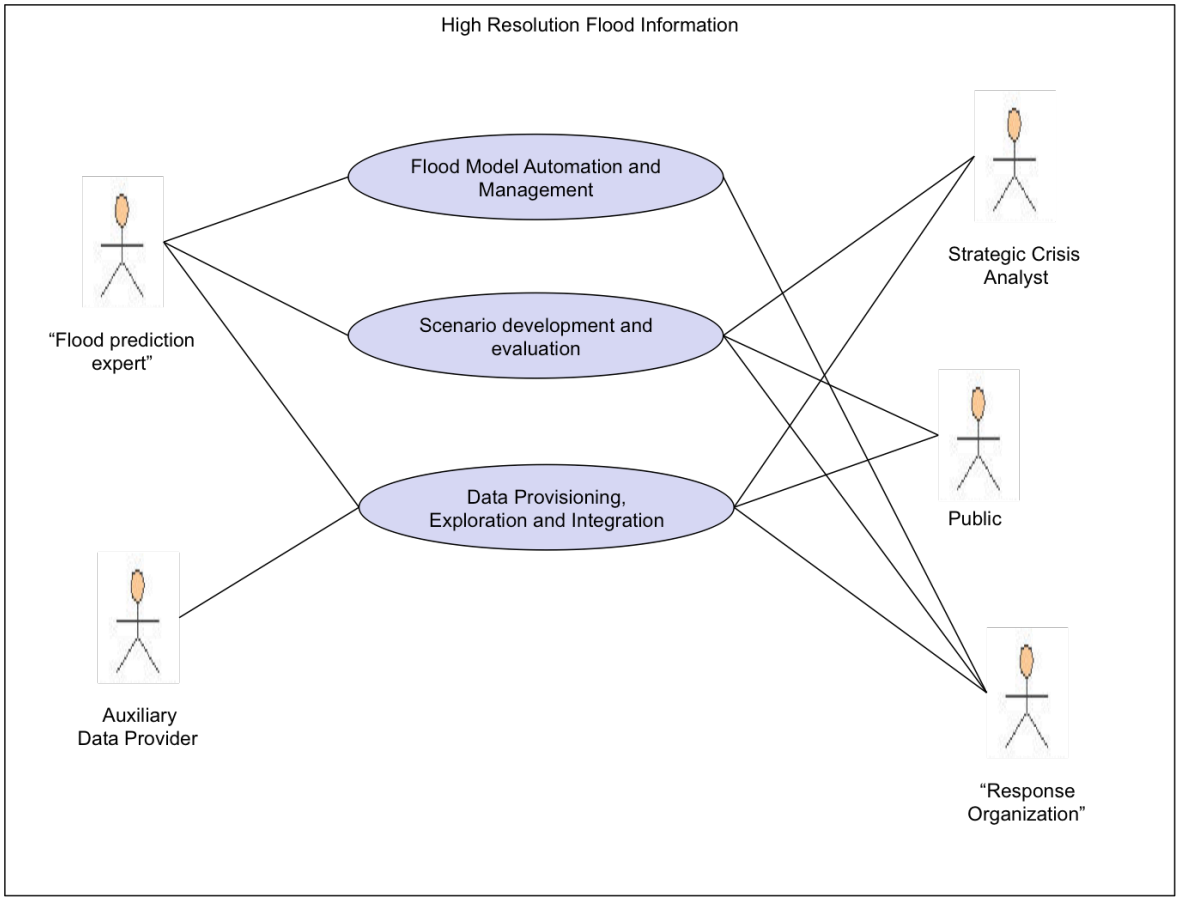


Figure 2: Top level use cases within the High Resolution Flood Scenario

The goal is to enable clients to parameterize models within distributed computing environments, e.g. by defining the area of interest, the temporal settings of the simulation run, and further parameters. Scenario based analysis shall be supported to answer questions such as: Is this road likely to be flooded within the hours under the current environmental and meteorological conditions? Models in turn shall be enabled to access required auxiliary data in time for model execution, for example by accessing data services providing stream gauge information.

5.2.1.1 Flood Information Scenario Client

The flood information scenario client shall support interactions with WPS that façade simulation models. In addition, it shall allow the exploration and visualization of simulation model data. That data shall be presented in a way that both the data itself and complementing simulation model quality information data can be explored. The client shall allow adding additional data sets from OGC Web service interfaces such as WMS, WCS, and WFS.

5.2.1.2 High Resolution Flood Data Server

The high-resolution flood data server shall provide access to (modeled) flood and inundation data. The server shall expose OGC Web service interfaces such as WCS and WMS. WFS and SOS are additional optional interfaces. The WCS interface shall provide simulation model data together with simulation model quality data, e.g. in the form of GMLJP2. The server shall support streaming of flood information using JPIP data streaming. Ideally, the service provides RESTful interfaces to facilitate data usage even further.

5.2.1.3 Low Resolution Flood Data Server

The server shall provide access to low resolution flood data produced by low-resolution simulation models. The server shall provide at least a WCS interface. The data shall be made available to WPS that require the data to apply downscaling algorithms using low-resolution flood data and high-resolution DEM/bathymetry data.

5.2.1.4 DEM and Bathymetry Data Server

The server shall provide access to high resolution SRTM-DEM and LiDAR-DEM data as well as high-resolution bathymetry data. The server shall provide at least a WCS interface.

5.2.1.5 Flood modeling additional data server

The server shall provide access to additional data required to operate flood simulation models, such as e.g. surge or gauge data. The server should provide different interfaces, such as WFS, SOS, or WCS. Ideally, the server supports the SOS Profile for Hydrology and returns WaterML time series data for location relevant to the flood.

5.2.1.6 High-resolution model processing server

The server shall provide control over high-resolution hydrodynamic simulation models that can calculate inundation information based on either high-resolution topography, or by downscaling low-resolution simulation data onto high-resolution DEM. Ideally, the server makes use of data provided by other OGC Web services and the Climate Data Initiative (CDI).

5.2.2 Displaced Population due to Coastal Inundation

The IPCC report states that coasts are experiencing the adverse consequences of hazards related to climate and sea level (very high confidence). Coasts are highly vulnerable to extreme events, such as storms, which impose substantial costs on coastal societies. Through the 20th century, global rise of sea level contributed to increased coastal inundation, erosion and ecosystem losses, but with considerable local and regional variation due to other factors. Late 20th century effects of rising temperature include loss of sea ice, thawing of permafrost and associated coastal retreat.

This exercise is designed to evaluate the capabilities of OGC standards and/or draft standards to satisfy a real world set of requirements. The climate change scenario "Displaced population due to coastal inundation" allows addressing a huge number of important items relevant to situation analysis, information exchange, and information processing in distributed environments; with large amounts of open source data and models being available. The scenario addresses aspects such as determining the ability of OGC based services to support crisis notification, discovery of data content, predictive analysis using well defined analysis models, on-line on-demand processing services, rapid

access to data, access to on the ground social media sources of information, creation of sharing of common operational pictures, and routing for emergency response teams.

The following figure illustrates the scenario.

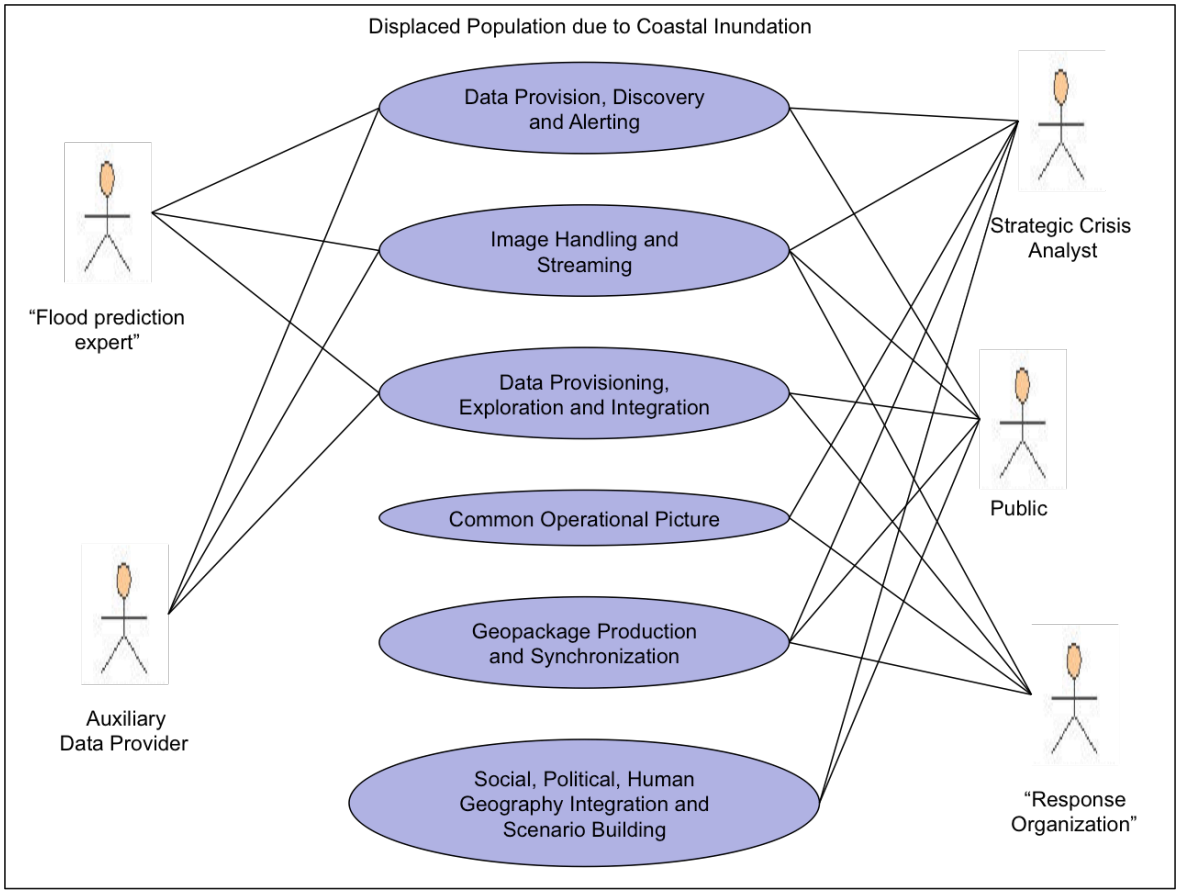


Figure 3: Coastal inundation scenario overview, green: data services, yellow: clients, red: processing services, blue: other services

This scenario requires the ability to provide a Common Operational Picture in response to a civil unrest situation. A Common Operational Picture client application allows exploring, analyzing, processing, and visualizing the situations in the scenario. This includes handling of imagery and streaming information provided various Web services. A catalog service provides information on available resources and an alerting capability can be used to provide alert notifications interested clients can subscribe to. The data is provided by a number of OGC Web services, such as WMS, WMTS, WCS, and WFS. Additional data can be produced by WPS and WCPS. A Table Joining Service (TJS) allows adding further social and political data to the scenario. Geopackage builders provide data in the form of geopackges that contain evacuation routes and terrain information. All requirements are further described in the following sub-sections.

5.2.2.1 Common Operational Picture Client

The client software supporting the scenario shall implement the ability to make use of and visualize the content encoded in an OWS Context JSON document. Optionally in support of this effort the OWS Context Atom encoding shall be used for comparison of content and capability. The OWS Context document shall support linkage between different data content to include feature data from WFS implementing the Stored Query

option, WMTS and WCS for image and terrain data, as well as social media sources. Additionally, this task shall utilize OWS Context in support of OGC GeoPackage.

The client application shall provide support to visualize social media content, visualize associations between multiple data sources, and to visualize predictive analysis results. The client shall support access to several OGC Web service interfaces including WPS and WCPS and support JPIP and GML streaming.

5.2.2.2 Catalog

The catalog is described in the CCI thread section of this RFQ.

5.2.2.3 Alerting

The alert/notification service in support of this scenario shall consider the OGC draft Pub/Sub standard ability to satisfy currently established emergency response alerting standards (EDXL, NIEM, HXL, ESF, etc.).

5.2.2.4 Data Services and Image Handling

The scenario requires rapid access to data content and processing results. This includes the ability to provide imagery data in a georeferenceable grid and support of data streaming to include vector data streaming and image streaming. Part of this task shall consider the harmonization requirements for GMLCOV, GML 3.3, GMLJP2 and SWE in order to support the georeferenceable grid. The issue is that GMLJP2 uses GML 3.2.1 and GMLCOV, the coverage application schema used by WCS, which again uses GML 3.2.1. Now there is a new proposal on the table that GMLJP2 shall make use of SensorML 2.0. SensorML 2.0 supports so-called Community Sensor Models, i.e. a process that determines the location of a particular measured array element (e.g. an image pixel) within some geospatial domain (e.g. latitude-longitude-altitude or Earth-Centered-Earth-Fixed (ECEF) XYZ). SensorML 2.0 uses GML 3.3.1, which leads to a clash of GML versions 3.2.1 vs. 3.3.1, as illustrated in the following figure.

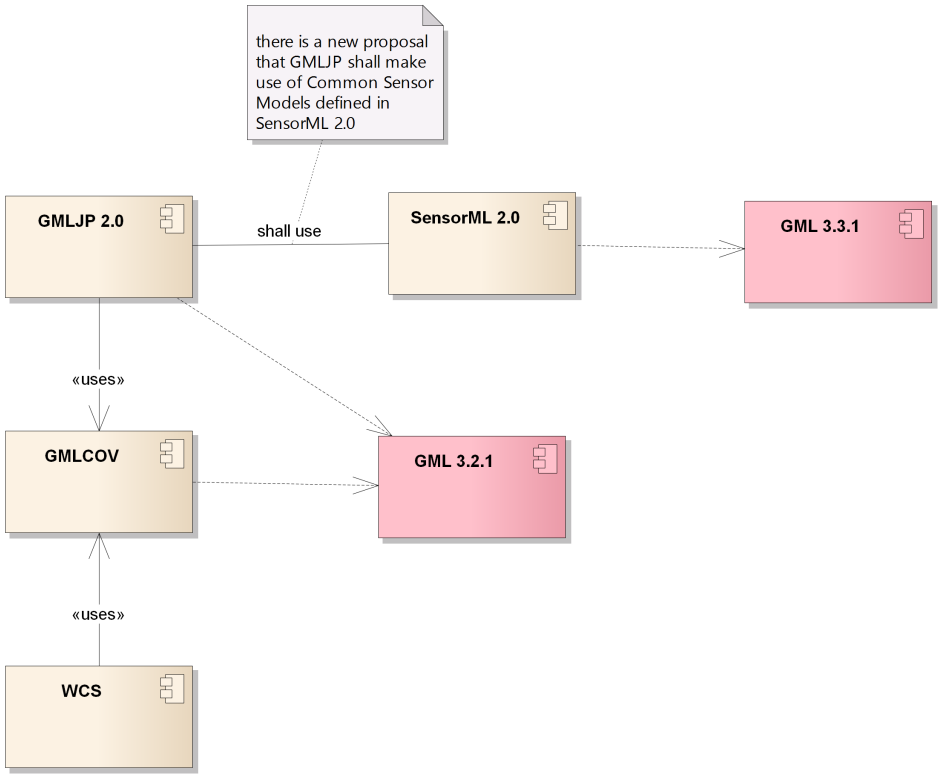


Figure 4: GMLJP 2.0 interoperability issue due to conflicting GML versions

Further on, the task shall consider GML streaming capabilities as well a JPIP streaming. Where possible streaming technology should be made consistent and interoperable in such a way that GML data content can be streamed along with the associated underlying imagery data.

Input documents for consideration include the following but should not be limited to:

a. OGC 09-034 OWS-6 Georeferenceable Imagery Engineering Report
b. Draft GMLJP2 2.0 Standard
c. OGC 10-129r1 GML 3.3
d. OGC GML Application Schema – Coverages
e. Any applicable SWE 2.0 Standard
f. OGC 12-097 OWS-9 Engineering Report - SSI - Bulk Data Transfer (GML Streaming) Engineering Report
g. OGC 12-155 OWS-9 OWS Innovations WCS for LIDAR Engineering Report
h. OGC 07-169 OWS-5 WCS JPIP Coverage Subsetting Engineering Report
i. DGIWG draft WCS 2.0 Profile (Geo)

Support for this scenario will require the standup of a number of OGC based web services including WFS, WCS, WMS, and WMTS. Also required would be implementations utilizing the DGIWG GeoTIFF Profile and the DGIWG ESM (elevation surface model) Profile. Service implementations shall be based on the DGIWG or NSG/DGIWG profiles for these services when available. These will include at least:

a. DGWIG WMS 1.3 Profile

b. NSG/DGIWG WFS 2.0 Profile. The WFS shall support *stored query* and GML streaming

c. DGIWG WCS 2.0 Profile. The WCS shall support JPIP streaming

d. NSG WMTS Profile

5.2.2.5 Processing Services

The scenario shall support the development of services and workflow recommendations to address predictive analysis through the use of multiple models. Including the ability to model potential impact and cascading effects given pre-existing relationships and ongoing trends. Additionally, the role of Table Joining Service as a means to supplement feature information with additional web based information shall be determined.

The draft OGC Web Processing Service 2.0 and the OGC Web Coverage Processing Service extension ability to incorporate multiple different models in support of this scenario shall be considered. The processing services shall incorporate climate change models to predict the effects of rising ocean levels in 25 years and again in 50 years. The models shall consider current state of ocean water levels.

Modeling shall then extend further to evaluate the effects in a what-if scenario related to which areas will be affected to the point of potential political destabilization. Where appropriate the model results shall utilize the NSG Application Schema (NAS) Human[2] Geography data models for visualizing and categorizing the results (https://nsgreg.nga.mil/index.jsp)).

The following services are required to support the scenario:

a. Web Processing Service incorporating coastal inundation models, what-if scenarios, political destabilization models and human geography data models

b. Web Coverage Processing Service incorporating coastal inundation models, what-if scenarios, political destabilization models and human geography data models. The WCPS may be used to support the provision of routing information.

c. Table Joining Service implementation supporting the extraction of supplemental web based information linked to existing feature data.

5.2.2.6 GeoPackage Production for Routes and Terrain Information

The scenario requires the ability to provide a routing capability. Within the scenario, the routes would be used by emergency responders to access the area of civil unrest. This task shall implement routing capabilities within the OGC GeoPackage. This subtask shall consider the Web Coverage Processing Service method of providing routing for aircraft

[2] Human geographic information involves the human, political, cultural, social and economic aspects of the social sciences that study human use and understanding of the Earth and the processes, which have affected that use. While the major focus of human geography is not the physical landscape of the Earth, it is not possible to discuss human geography without also understanding the physical landscape within which human activities occur. Different views apply, such as Communications and Media Use, Cultural Heritage, Demographic and Human Population Measures, Economy, Education, Ethnicity, Groups and Organizations, Health and Medical, Land Ownership, Land Use and Cover, Language, Religion, Significant Events, Transportation Use, or Water Supply and Control.

within time slices and how to apply this to on the ground routing. The determination of routes shall make use of vector data, terrain data, coverage data and timelines.

The following components are required to support the scenario:

a. OGC GeoPackage SQLite container with routes embedded
b. OGC GeoPackage SQLite container with terrain information

5.2.3 Transactional Flood Management

In the preparation, response and recovery for flood events, limited capability to transact geospatial data in a secure, robust and seamless way between agencies, citizens and responders has been a recurring and limiting factor. In an interoperability plugfest executed 2012 in Canterbury, New Zealand, it became obvious that additional engineering and workflow aspects needed to be addressed in order to produce solutions that allow the setup of crisis management systems using off the shelf products. Those aspects include verification and notification, transactional data handling, data and access security, exception handling and system hardening. In addition, the plugfest revealed vendor software capability gaps regarding adoption of open standards for Web services.

The key objective to be addressed by the requirements in this scenario is to transact data via open standards between geospatial software systems held by independent agencies and/or in-field operators. The following requirements shall be met:

a. Demonstrating standards-based transactional geodata sharing in a realistic, secure, robust, multi-player emergency management scenario;
b. Testing alternative WFS-T 'flavours' that are more popular with the developer community (e.g. using ReST to deliver GeoJSON);
c. Improving the implementation potential of WFS-T solutions
d. Emergency service personnel can consume and update geospatial data held in each other's agencies via open standards;
e. Field operators can submit transactional updates from their mobile devices
f. Transactions are robust and secure; submitters are notified of the result of their submitted updates.
g. Working technical solution is created and demonstrated that enables the exchange of geographic information among participants who use differing GIS platforms and data formats using WFS and WFS-T services;
h. Engineering and workflow aspects needed to support exchange of geographic information are addressed. These include verification and notification, data and access security, exception handling and system hardening.
i. Address Community Schema requirements of the data being exchanged to include schema publishing, schema registry, manual or automated configuration of WFS-T clients/servers based on published schemas, and automated schema validation of submissions

The following figure illustrates the top-level use cases of this scenario.

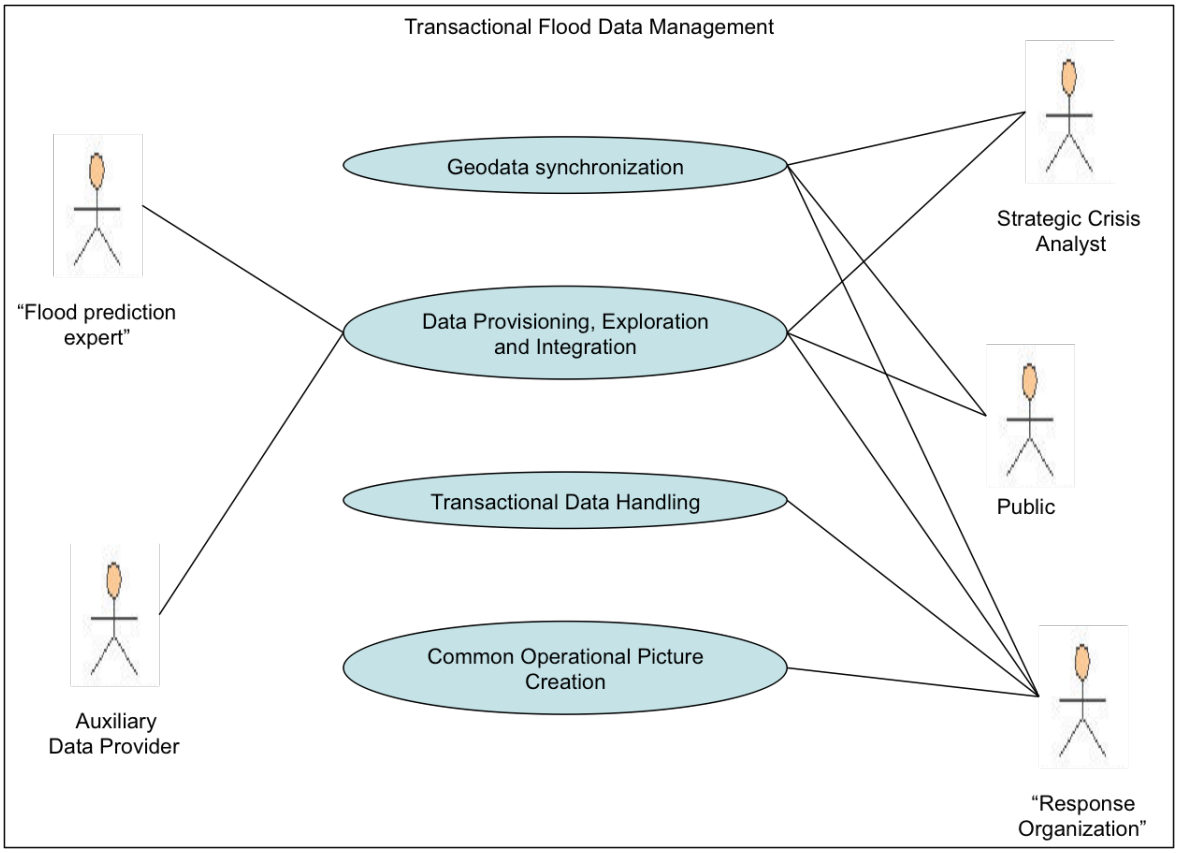


Figure 5: Top level use cases of the transactional flood management scenario

The client application allows emergency service personnel to consume and update geospatial data held in each other's agencies via open standards. The client application shall support WFS-T 2.0 servers including transactional data handling. The client shall allow analyzing, processing, and visualizing data stored on the server.

The client shall support new formats/interfaces provided by WFS-T services, such as ReST interfaces and GeoJSON data.

The transactional data handling capability and the common operational picture client may be implemented in different applications. Security is of overarching relevance for all components in this scenario.

5.2.3.1 Transactional WFS-T Client Application for Common Operational Picture

The client can interact with WFS-T 2.0 servers and Geosynchronization Services as well as WFS REST and WFS GeoJSON servers. It supports secure communication and allows field operators to submit transactional updates from their mobile devices.

5.2.3.2 Mobile WFS-T Client Application

The mobile client can interact with WFS-T 2.0 servers and allows field operators to submit transactional updates from their mobile devices. Ideally, the mobile client supports new formats/interfaces provided by WFS-T services, such as ReST interfaces and GeoJSON data. Communication between client and services shall be secure.

5.2.3.3 WFS-T Server

The WFS-T 2.0 shall provide data required by the scenario and shall support transactional features such as create, read, update and delete data. Communication between client and service shall be secure.

5.2.3.4 Geosynchronization Server

The Geosynchronization Service (GSS 2.0) allows data collectors to submit new data or make modifications to existing data without directly affecting the data in the provider's data store(s) until validation has been applied thus ensuring that the data published by the provider is of high quality.

5.2.3.5 WFS Server with REST binding and GeoJSON support

The WFS 2.0 server shall provide ReST-interfaces and shall deliver data in GeoJSON format.

5.2.3.6 Transactional data handling status quo

The current market situation shall be analyzed and documented in an engineering report. The report:

1. Identifies the differences and limitations of support and implementation of service standards (particularly WFS-T, ReST, GML, and GeoJSON) between vendors;
2. Aids to GIS vendors for implementation of support for these standards. This would include detailed advice to avoid discrepancies between implementations of these standards
3. Review of WFS-T clients available (or the lack thereof);
4. Review the capabilities of tools and standards such as GeoSynchronization Service (GSS) and others to provide additional engineering and workflow aspects needed to be addressed such as, verification and notification, data and access security, exception handling and system hardening before being robustly implementable.

5.2.3.7 Transactional data handling cookbook

The findings and recommendations illustrating the components necessary to implement a vendor agnostic architecture for a WFS-T based solution between different systems shall be captured in an Engineering Report:

1. Working technical solution is created and demonstrated that enables the exchange of geographic information project between partners;
2. "Cook Book" instructions for implementing any solution devised by GIS teams inside organizations wishing to implement this solution using the tools used in OWS-11;
3. Findings and recommendations of the steps that an organization needs to take to achieve a robust working technical implementation of the interoperability solution.

5.2.3.8 Schema implementations

One of the issues previously identified in transactional data handling scenarios is the treatment of heterogeneous community schemas. The schema implementation engineering report shall address community schema requirements of the data being exchanged. It shall include the following aspects:

1. Schema publishing
2. Schema registry
3. Manual or automated configuration of WFS-T clients/servers based on published schemas
4. Automated schema validation of submissions

5.2.4 Geopackage Production and Synchronization and Image Handling

The geoapackage production and synchronization scenario focuses on Geopackage creation and synchronization, and the integration of GML into JPEG2000 files (DGIWG GML2JP2).

The following figure illustrates the individual components of this sub-scenario.

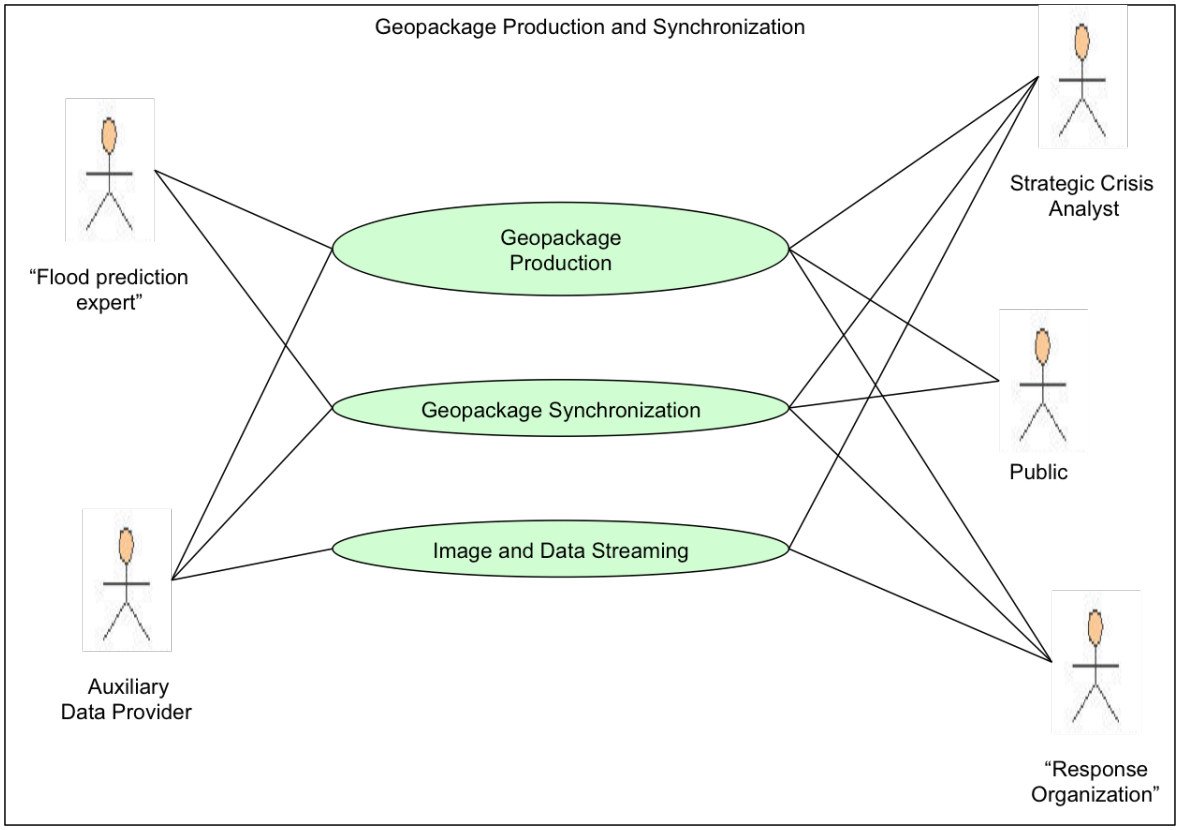


Figure 6: Top level use cases of the GeoPackage production and synchronization scenario

Clients make use of data that is stored in GeoPackages that are created using Web services. To ensure consistent data across GeoPackages, GeoPackage synchronization mechanisms shall be explored in this scenario. The data stored in the GeoPackages is served by various OGC Web service instances, such as WFS and WCS. Both service types should be used to serve GMLJP2 data, i.e. Geography Markup Language (GML) within JPEG 2000 images for adding geographic content to imagery. This shall be tested in a NATO ISR scenario ideally. The detailed requirements are described in the following sections.

5.2.4.1 Geopackage and GML2JP Client

A client application shall be developed that supports GeoPackage creation and synchronization and GML2JP handling.

5.2.4.2 Geopackage Generation and Synchronization

The work on GeoPackages shall continue work started in previous testbeds. Services shall be developed and tested that support Geopackage creation and bi-directional synchronization across GeoPackages and across complementary OGC services. All results shall be documented in an engineering report. The GeoPackage specification shall be updated as necessary.

A WPS instance shall be developed that provides geopackge creation functionality.

5.2.4.3 GMLJP2

It is required to incorporate the DGIWG GMLJP2 specification in the sub-scenario. The specification shall be tested, potential issues resolved (see 5.2.2.4 and 5.5), and testing results shall be documented. Ideally, GMLJP2 shall be tested in a NATO ISR context. Potential change requests to other OGC specifications shall be developed as necessary. GMLJP2 shall be served by WFS and/or WCS instances.

5.3 UCR Thread Deliverables

The deliverables are summarized in the Table with descriptions of the deliverables in paragraphs following the table.

Table 2 – UCR Thread Deliverables Summary

1. Flood information scenario client
2. High resolution flood data server
3. Low resolution flood model data server
4. High Resolution DEM/Bathymetry server
5. Flood modeling additional data server
6. High resolution model processing server
7. High Resolution Flood Information Scenario ER
8. Georeferenceable Grid Harmonization Engineering Report
9. Change Requests for Georeferenceable Grid
10. OGC OWS Context Change Requests (unfunded)
11. Testbed 11 Multi-dimensional GeoPackage Supporting Terrain and Routes Engineering Report
12. OGC GeoPackage Change Requests (unfunded)
13. Alert Service implementation supporting the scenario (unfunded)
14. Web Processing Service implementation supporting the scenario
15. Table Joining Service implementation supporting the extraction of supplemental web based information linked to existing feature data
16. OGC GeoPackage SQLite container with routes embedded
17. OGC GeoPackage SQLite container with terrain (unfunded)
18. Web Coverage Processing Service implementation supporting the scenario

19. Web Map Service implementation supporting the scenario(unfunded)
20. Web Feature Service with Stored Query and GML Streaming implementation supporting the scenario
21. Web Coverage Service implementation with JPIP supporting the scenario
22. Web Map Tile Service implementation supporting the scenario
23. Client software supporting the scenario
24. Summary Report of Findings for WFS-T Information Exchange Architecture ER
25. Reference Case Study of Multiple WFS-T Interoperability ER
26. Client Desktop (submitting transactions via WFS-T for Common Operational Picture
27. Client Mobile (submitting transactions via WFS-T)
28. Web Feature Service - Transactional (WFS-T 2.x) for Common Operating Picture
29. Geosynchronization Service (GSS) 2.x for Common Operating Picture data
30. WFS-T 2.x with REST Interface (and GeoJSON data delivery)
31. Schema Implementations for NZ-LINZ Applications
32. Geopackaging ER
33. DGIWG GMLJP2 Testing Results ER
34. OGC Standards Change Requests
35. OGC Web Services for GMLJP2 and GeoPackage Synchronization
36. Client to test Geopackaging WPS and GSS
37. Cloud facilities to allow participants to host services in the cloud (unfunded)
38. Simulation models (unfunded)

5.3.1 Flood information scenario client

Client application that shall support the high resolution flood information scenario and implements the requirements described in section 5.2.1.1

5.3.2 High resolution flood data server

The server shall provide access to high-resolution flood data. The server shall at least provide a WCS interface; other optional interfaces are WFS, SOS, and WMS. For detailed requirements see section 5.2.1.2.

5.3.3 Low resolution flood data server

The server shall provide access to low resolution flood data produced by low simulation models. The server shall provide at least a WCS interface. For detailed requirements see section 5.2.1.3.

5.3.4 High Resolution DEM/Bathymetry server

The server shall provide access to high resolution SRTM-DEM and LiDAR-DEM data as well as high-resolution bathymetry data. The server shall provide at least a WCS interface. For detailed requirements see section 5.2.1.4.

5.3.5 Flood modeling additional data server

The server shall provide access to additional data required to operate simulation models, such as surge or gauge data. The server should provide different interfaces, such as WFS, SOS, WCS. For detailed requirements see section 5.2.1.5.

5.3.6 High-resolution model processing server

The server shall provide control over high-resolution hydrodynamic simulation models that can calculate inundation information based on either high-resolution topography, or by downscaling low-resolution simulation data onto high-resolution DEM. For detailed requirements see section 5.2.1.6.

5.3.7 High Resolution Flood Information Scenario ER

The report shall describe the high-resolution flood information scenario that includes data services and processing services.

5.3.8 Georeferencable Grid Harmonization ER

This deliverable shall clarify the situation of and describe solutions for the harmonization of GMLCOV, GML 3.2/3.3, GMLJP2 and SWE in order to support the georeferenceable grid, as described in section 5.2.2.4.

The deliverable shall describe possible solutions to this situation. It shall highlight the advantages and disadvantages of using either GMLCOV or SensorML, or both. Experiments with the different approaches might be necessary to gather necessary experiences required to evaluate the various options.

5.3.9 Change Requests for Georeferenceable Grid

Change Requests to OGC specifications as required. Modifications or enhancements to the OGC suite of standards as needed to support the concept and implementation of Georeferenceable Grid as decribed in 5.2.2.4.

5.3.10 OGC OWS Context Change Requests (unfunded)

Change Requests to OGC specifications as required. Modifications or enhancements to the OGC suite of standards as needed to support the concept and implementation of OWS Context. Change requests may result from the experiences made in client and server developments to implement the various scenarios. Detailed requirements are described in section 5.2.2.1.

5.3.11 Multi-dimensional GeoPackage Supporting Terrain and Routes Engineering Report

Engineering report to capture results from implementing GeoPackge related requirements described in section 5.2.2.6.

5.3.12 OGC GeoPackage Change Requests (unfunded)

Change Requests to OGC specifications as required. Modifications or enhancements to the OGC suite of standards as needed to support the concept and implementation of GeoPackages containing routes and terrain information. Requirements are described in section 5.2.2.6.

5.3.13 Alert Service implementation supporting the scenario (unfunded)

Implementation of an Alert Service in support of the Displaced Population due to Coastal Inundation scenario. The implementation shall consider the OGC draft Pub/Sub standard ability to satisfy currently established emergency response alerting standards (EDXL, NIEM, HXL, ESF, etc.), see section 5.2.2.3.

5.3.14 Web Processing Service implementation supporting the scenario

Implementation of a WPS 2.0 in support of the *Displaced Population due to Coastal Inundation* scenario. The WPS shall provide access and control to multiple different models in support of this scenario. The WPS shall consider the current state of ocean water levels, incorporate climate change models to predict the effects of rising ocean levels in 25 years and again in 50 years. Modeling shall then extend further to evaluate the effects in a what if scenario related to which areas will be affected to the point of potential political destabilization. Where appropriate the model results shall utilize the NSG Application Schema (NAS) Human Geography data models for visualizing and categorizing the results. https://nsgreg.nga.mil/index.jsp. For detailed requirements descriptions, please see section 5.2.2.5.

5.3.15 Table Joining Service implementation supporting the extraction of supplemental web based information linked to existing feature data

Implementation of a Table Joining Service (TJS) in support of the *Displaced Population due to Coastal Inundation* scenario. The service shall make additional information obtained from webpages available. For further requirements descriptions, please see section 5.2.2.5.

5.3.16 OGC GeoPackage SQLite container with routes embedded

Implementation of GeoPackage SQLite container with routes embedded as described in section 5.2.2.6.

5.3.17 OGC GeoPackage SQLite container with terrain (unfunded)

Implementation of GeoPackage SQLite container with terrain data embedded as described in section 5.2.2.6.

5.3.18 Web Coverage Processing Service implementation supporting the scenario

Implementation of a Web Coverage Processing Service (WCPS) in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.5.

5.3.19 Web Map Service implementation supporting the scenario (unfunded)

Implementation of a Web Map Service (WMS) in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.4.

5.3.20 Web Feature Service with Stored Query and GML Streaming implementation supporting the scenario

Implementation of a Web Feature Service with Stored Query and GML Streaming in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.4.

5.3.21 Web Coverage Service implementation with JPIP supporting the scenario

Implementation of a Web Coverage Service with JPIP in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.4.

5.3.22 Web Map Tile Service implementation supporting the scenario

Implementation of a Web Map Tile Service in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.4.

5.3.23 Client software supporting the scenario

Implementation of a client application in support of the *Displaced Population due to Coastal Inundation* scenario. For detailed requirements descriptions, please see section 5.2.2.1.

5.3.24 Summary Report of Findings for WFS-T Information Exchange Architecture

This engineering report shall cover the aspects described in section 5.2.3.6.

5.3.25 Reference Case Study of Multiple WFS-T Interoperability ER

This engineering report shall cover the aspects described in section 5.2.3.7.

5.3.26 Client Desktop (submitting transactions via WFS-T for Common Operational Picture

The client application shall support the requirements described in section 5.2.3.1. It shall at least support the transactional data handling part.

5.3.27 Client Mobile (submitting transactions via WFS-T)

The client application shall support the requirements described in section 5.2.3.2.

5.3.28 Web Feature Service - Transactional (WFS-T 2.x) for Common Operating Picture

Implementation of a transactional Web Feature Service to support the requirements described in section 5.2.3.3.

5.3.29 Geosynchronization Service (GSS) 2.x for Common Operating Picture data

Implementation of a Geosynchronization Service to support the requirements described in section 5.2.3.4.

5.3.30 WFS-T 2.x with REST Interface and GeoJSON data delivery

Implementation of a WFS-T Service to support the requirements described in section 5.2.3.5.

5.3.31 Schema Implementations for NZ-LINZ Applications

Schema implementations as defined in section 5.2.3.8.

5.3.32 Geopackaging ER

This engineering report shall capture the results of 5.2.4.2 activities, i.e. GeoPackage creation and synchronization.

5.3.33 DGIWG GMLJP2 Testing Results ER

This engineering report shall capture the results and experiences of GMLJP2 testing campaign described in section 5.2.4.3.

5.3.34 OGC Standards Change Requests

Change Requests to OGC specifications as required. Modifications or enhancements to the OGC suite of standards as needed to support:

1. the concept and implementation of Geopackage creation and synchronization handling as described in section 5.2.4.2,
2. GMLJP2 data handling using WFS and WCS.

5.3.35 OGC Web Services for GMLJP2 and GeoPackage Synchronization

Implementations of OGC Web service interfaces such as WCS and WFS to serve GMLJP2 and WPS supporting Geopackage creation as described in section 5.2.4.2 and 5.2.4.3.

5.3.36 Client to test Geopackaging WPS and GSS

A client application that can handle both GeoPackage creation and synchronization using different OGC Web service interfaces as described in section 5.2.4.1.

5.3.37 Cloud facilities to allow participants to host services in the cloud (unfunded)

Cloud facilities shall be provided to allow participants to host their services and/or data in the cloud.

5.3.38 Simulation models (unfunded)

Simulation models to provide the High Resolution Flood Management scenario.

5.4 UCR Enterprise Viewpoint

The various scenarios in this thread address the needs coming up in dealing with a changing climate and its consequences on urban environments. Data needs be made accessible across agencies and organizations, exchanged rapidly and updated and maintained as necessary. Consistency of information across data stores and client applications is of overarching importance. The general concepts in the Urban Climate Resilience thread address data production, exchange, exploration and analysis in distributed computing environments, where the same data set is used by various clients from industry, agencies, disaster response teams, city planners, strategic analysts, or the general public. Data from very heterogeneous sources has to be pulled in order to generate common operational pictures.

Clients have the requirement to run what-if scenarios against these data sets to answer questions such as:

- Is this road likely to be flooded within the next 24 hours if rain continuous?
- Is this country likely to experience political instability if sea level rise exceeds x cm/year?
- What is the best escape route within a given inundation scenario?
- How can I synchronize data between various teams that are not permanently connected or experiencing bandwidth issues?
- How can I make high-resolution model data available to the public, to scientists, and organizations?
- How can I stream imagery data and embed GML information in an efficient way across several platforms?
- How can I incorporate many live data sources into simulation environments?
- How can I secure my data environments?

5.5 UCR Information Viewpoint

The Information Viewpoint considers the information models and encodings that will make up the content of the services and exchanges to be extended or developed to support this thread. They are categorized based on the main purpose they served. More explanation about them is available in the reference section.

Below is a listing of the specifications that are likely to be utilized within this thread. All specifications are available on the OGC portal. The latest versions are of most relevance, though previous versions might still be relevant for scenario implementation or service interplay testing.

- OGC® GML in JPEG 2000 (GMLJP2) Encoding Standard
- GML 3.2.1 and GML 3.3
- GML Filter Encoding
- SensorML 2.0
- OGC® SWE Common Data Model Encoding Standard
- O&M
- WaterML 2.0: Part 1- Timeseries v2.0.1 (OGC 10-126r4)
- WaterML 2.0 - Timeseries - NetCDF Discussion Paper (OGC 12-031r2)
- WaterML2.0 - part 2: Ratings, Gaugings and Sections Discussion Paper (OGC 13-021r3)
- OGC Sensor Observation Service 2.0 Hydrology Profile (OGC 14-004)
- Sensor Observation Service v2.0 (SOS, OGC 12-006)
- ISO 19115/19119
- Earth Observation Metadata profile of Observations & Measurements
- OGC Network Common Data Form (NetCDF) Core Encoding and extensions

- KML
- OGC OWS Context Atom Encoding Standard
- OGC OWS Context Conceptual Model
- OGC Web Service Common Implementation Specification
- OGC® GeoPackage Encoding Standard
- OGC® GML Application Schema - Coverages - GeoTIFF Coverage Encoding Profile

The following table lists engineering reports from previous testbeds that are relevant for this thread. All reports are available on the OGC portal.

Title	OGC Doc Number
OGC Testbed 10 OWS Context JSON Interoperability ER	14-009r1
OGC Testbed 10 Service Integration ER	14-013r1
OGC Testbed 10 GeoPackaging ER	14-058r1
OWS 9 Data Quality and Web Mapping Engineering Report	12-160r1
OGC® Testbed 10 Recommendations for Exchange of Terrain Data	14-006r1
OGC® Testbed-10 Service Integration Engineering Report	14-013r1
OGC Testbed 10 OWS Context in NIEM Engineering Report	14-017
OGC Testbed-10 Rules for JSON and GeoJSON Adoption: Focus on OWS-Context	14-009r1
OWS-6 Georeferenceable Imagery Engineering Report	09-034
OWS-9 Engineering Report - SSI - Bulk Data Transfer (GML Streaming) Engineering Report	12-097
OWS-9 OWS Innovations WCS for LIDAR Engineering Report	12-155
OWS-5 WCS JPIP Coverage Subsetting Engineering Report	07-169

5.6 UCR Computational Viewpoint

This viewpoint is concerned with the functional decomposition of the system into a set of objects that interact at interfaces – enabling system distribution. It captures component and interface details without regard to distribution and describes an interaction framework including application objects, service support objects and infrastructure objects.

This viewpoint describes the basic service building blocks, interfaces and interactions of high-level architectures. All service interfaces are illustrated in component diagrams; organized per scenario. The specifications for those services are available on the OGC Website. Usually, the latest version shall be used within this testbed.

5.6.1 High Resolution Flood Information Scenario

The high-resolution flood information scenario foresees the following services and functional building blocks to be relevant. Note that some interfaces are optional.

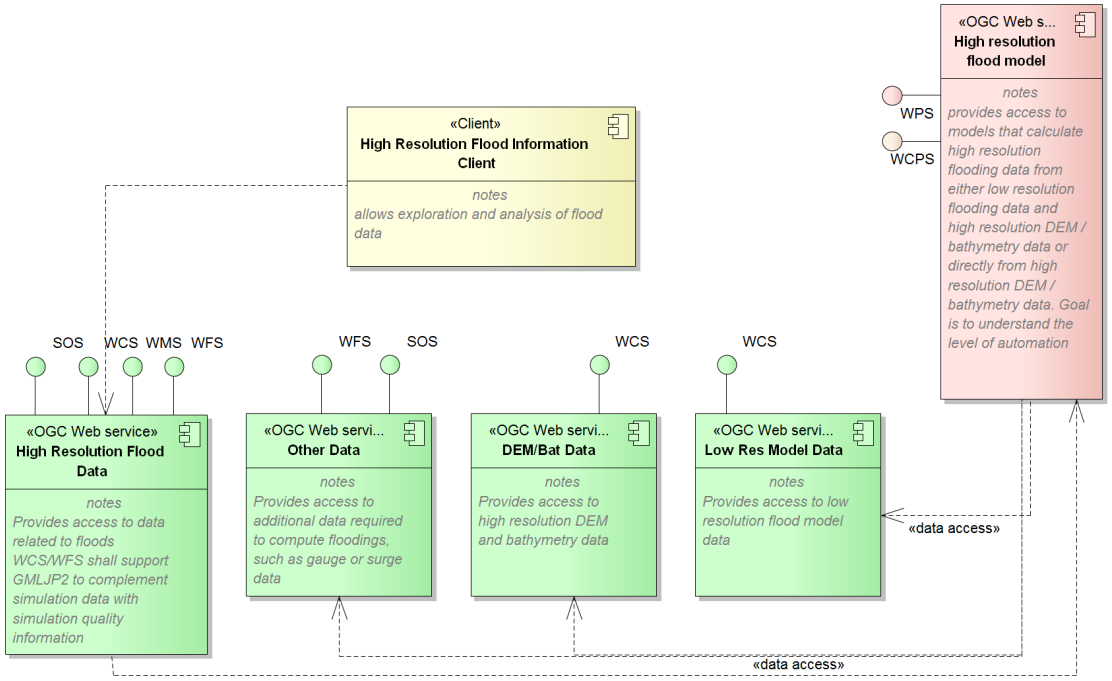


Figure 7 High resolution flood information scenario overview, red: processing services, yellow: clients, green: data services

5.6.2 Population Displacement due to Coastal Inundation Scenario

The Population Displacement due to Coastal Inundation scenario foresees the following services and functional building blocks to be relevant.

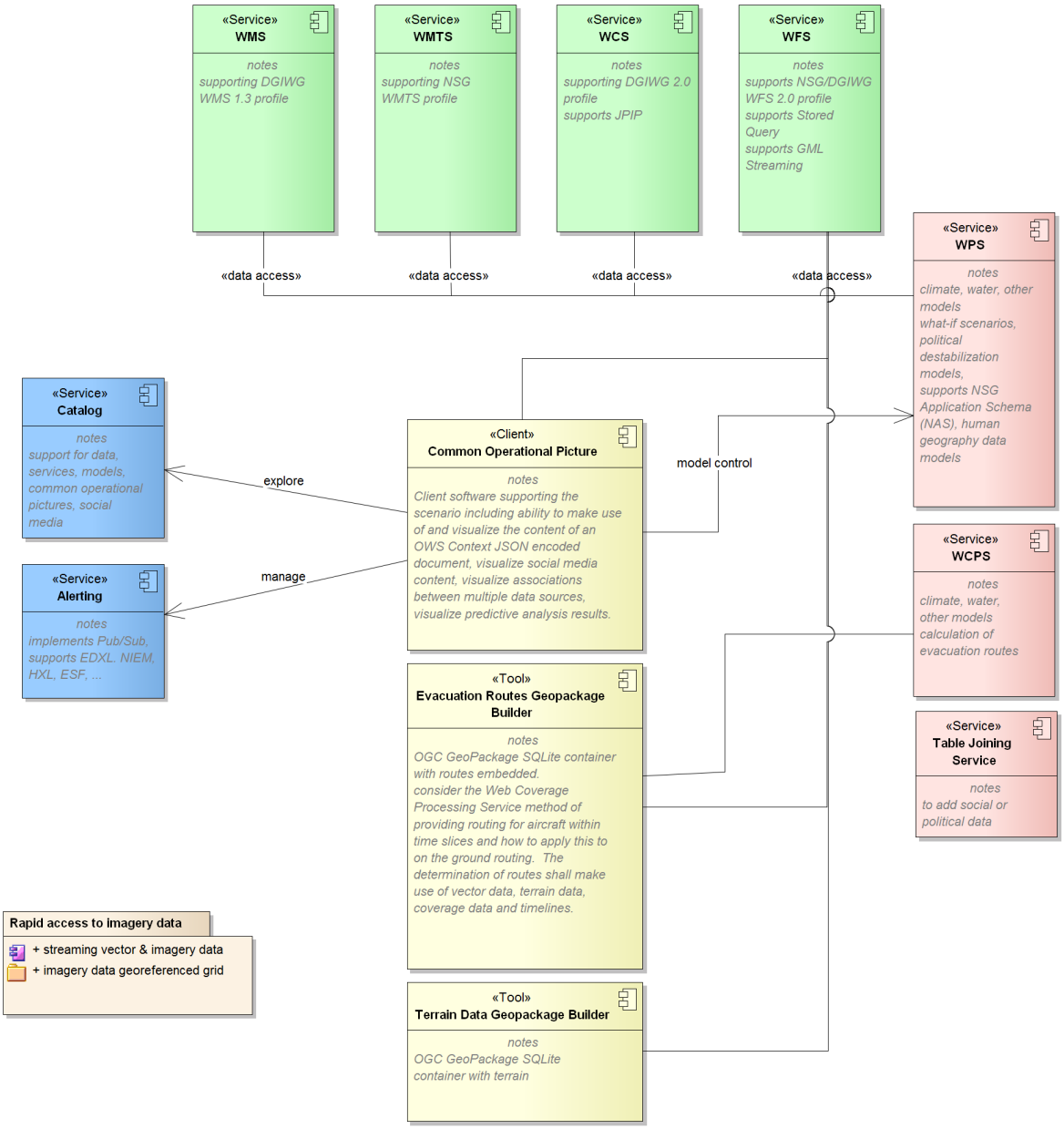


Figure 8: Displaced population due to coastal inundation scenario; red: processing services, yellow: clients, green: data services

5.6.3 Transactional Flood Management Scenario

The Transactional Flood Management scenario foresees the following services and functional building blocks to be relevant.

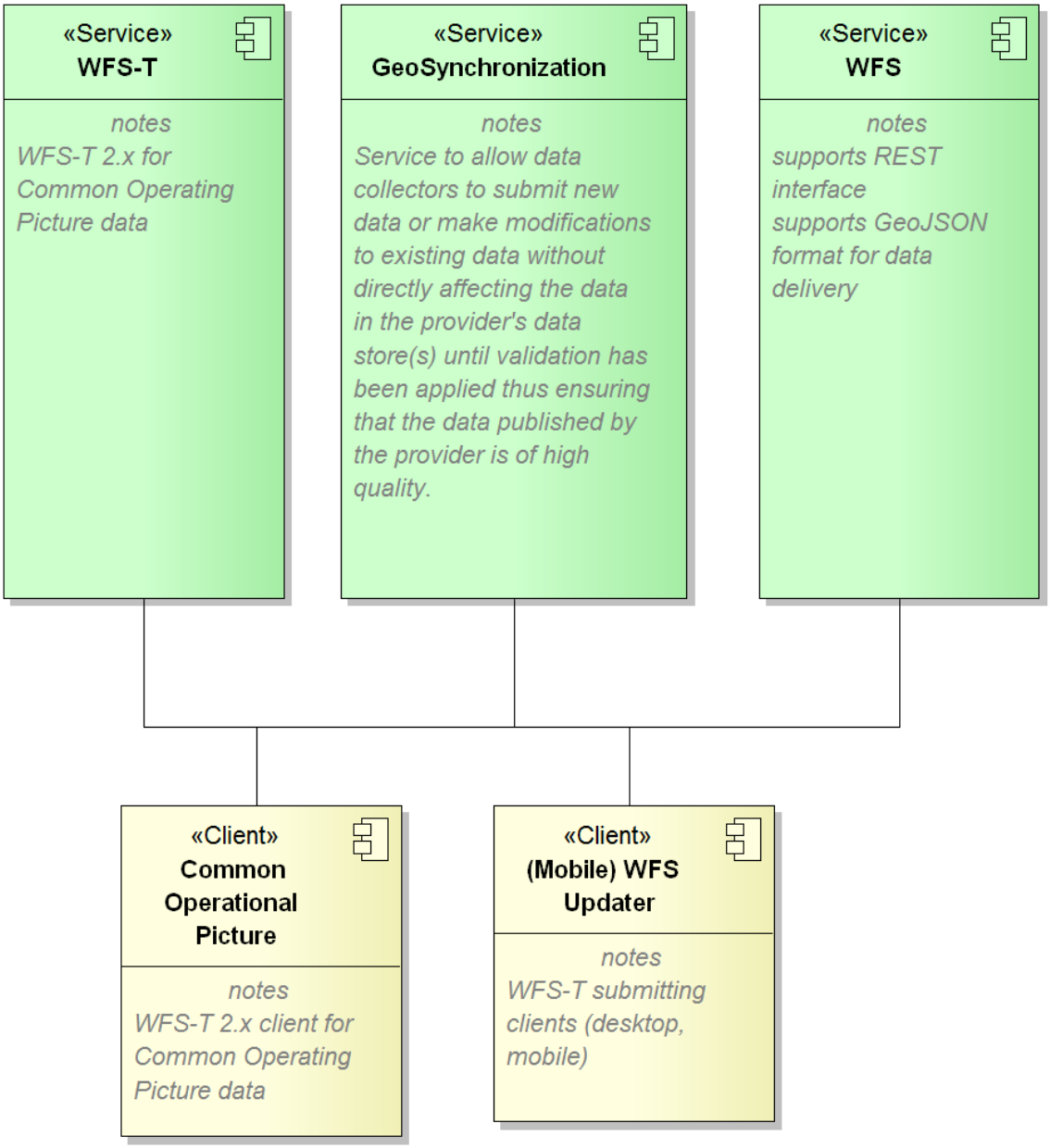


Figure 9: Transactional flood management scenario overview; green: data services, yellow: clients

5.6.4 Geopackage Production and Synchronization Scenario

The Geopackage Production and Synchronization scenario foresees the following services and functional building blocks to be relevant.

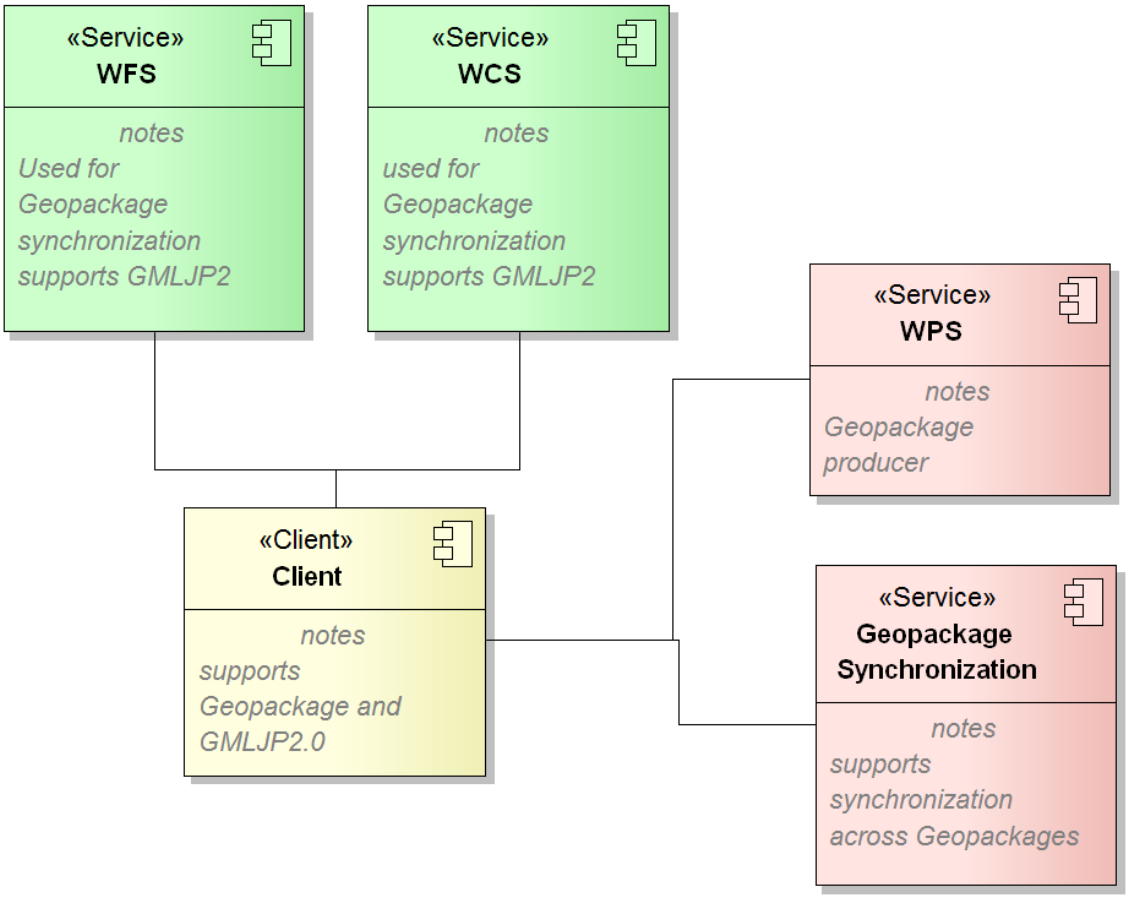


Figure 10: Overview of components, green: data services, red: processing services, yellow: client applications

5.7 UCR Engineering Viewpoint

The Engineering Viewpoint is concerned with the infrastructure required to support system distribution. It focuses on the mechanisms and functions required to: a) support distributed interaction between objects in the system and b) hides the complexities of those interactions. It exposes the distributed nature of the system, describing the infrastructure, mechanisms and functions for object distribution, distribution transparency and constraints, bindings and interactions.

This viewpoint describes the core components that are to be deployed and the infrastructure to integrate them into a single environment.

The Urban Climate Resilience engineering viewpoint will be defined in full detail during the testbed. The following diagram illustrates a first mapping of functional interfaces described in the computational viewpoint to service instances. All four scenarios have been incorporated into this master scenario.

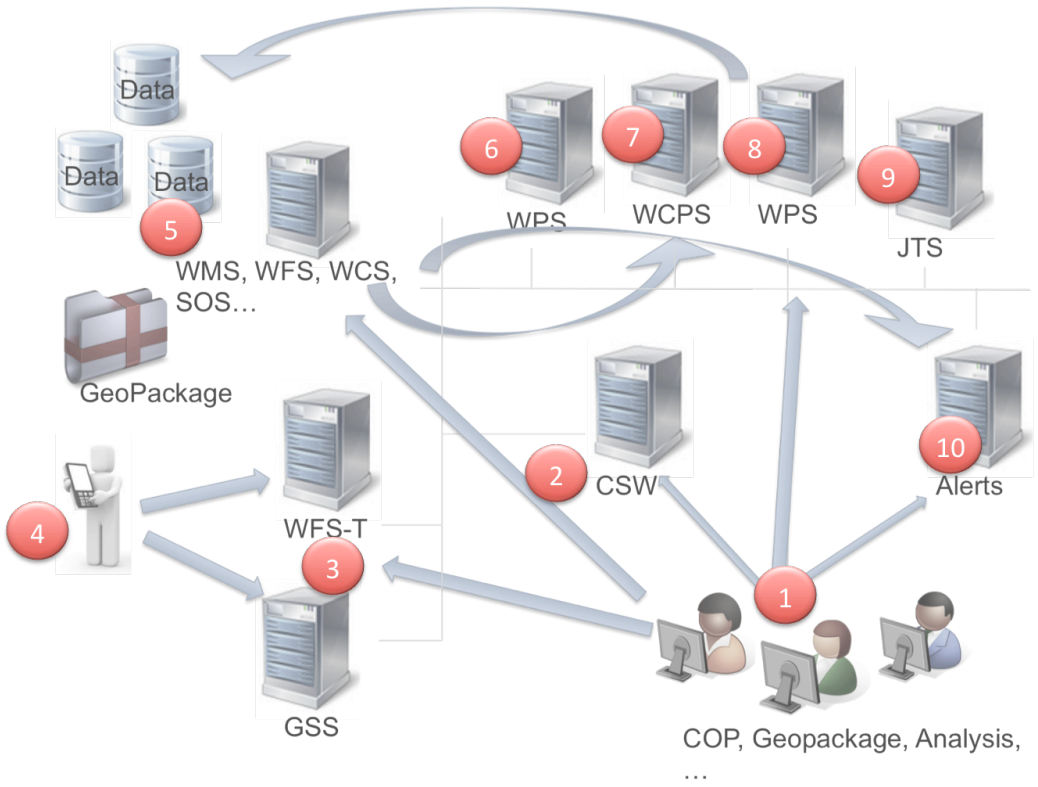


Figure 11: Master scenario, UCR thread

A number of different client applications (1) makes use of the various services offered. Using a catalog service (2), clients can discover data and services. Transactional data handling is implemented using WFS-T and GSS service instances (3). Those instances can be used by mobile clients (4) as well. Clients make further use of a variety of data services (5) and processing services (6-9) that create new data from other data or simulation models. Alerts can be sent out by alerting services (10).

6 Geospatial Enhancements for NIEM (Geo4NIEM) Thread

6.1 Geo4NIEM Thread Scope

Geospatial information technologies based on OGC open standards are a critical aspect to the foundation of the Information Sharing Environment (ISE), for homeland security, defense, law enforcement, emergency management and public safety. The ability to transport, deliver, and exchange geospatial information for geospatial assets to serve these missions is essential for prevention, preparedness, response, recovery and mitigation of all-hazards and all-threats for the nation. The Department of Homeland Security (DHS) National Information Exchange Model (NIEM) Version 3.0 provides a standard way of defining the contents for exchange that is technology-agnostic and addresses the format of data as it is exchanged between systems or organizations. With NIEM, communities can leverage a common vocabulary to support message development irrespective of technologies.

Successful interoperability of geospatial information technologies with NIEM information exchanges is critical to facilitate information exchange, service protocols, network configurations and computing environments in a service-enabled federated enterprise.

Furthermore, information exchange across agencies and various domains requires application of security measures to include authentication and access controls to ensure that information is protected and released only to authorized users in accordance with appropriate security mandates and security markings provided by the IC Data Encoding Specifications.

This thread aims to build on the success of the previous Geo4NIEM effort within OGC, to further collaboration and to advance the findings and recommendations from the previous Geo4NIEM initiative. With the development of NIEM Version 3.0, the NIEM architecture took a significant step forward in supporting the use of Intelligence Community (IC) data encoding specifications. Collaboration between the necessary communities resulted in an architecture that can sustain the rapid updates to IC specifications, while still providing core support for data tagging and security attributes. This thread in Testbed 11 aims to gain IC concurrence of the NIEM architecture through the development, implementations, test and conducting a robust demonstration making use of IC specifications in a simulated "real-world" scenario.

Topics in this thread include:

- Geo4NIEM Architecture Design and Implementation Guidance
- NIEM & IC Data Encoding Specification Support Assessment and Recommendations
- NIEM & IC Data Encoding Specification Test and Demonstration
- NIEM-GML-NIEM Round-tripping Assessment and Recommendations
- NIEM-GML-NIEM Round-tripping Test and Demonstration
- API for GML Feature Representations Test and Demonstration
- Common Security Across the OGC Suite of Standards

6.2 Geo4NIEM Thread Requirements

References:

- *Intelligence Reform and Terrorism Prevention Act of 2004* (IRTPA)
- *Guidelines and Requirements in Support of the Information Sharing Environment*, Presidential Memo, December 2005.
- Open Geospatial Consortium (OGC), Summary and Recommendations of the Geospatial Enhancement for the National Information Exchange Model (Geo4NIEM) Interoperability Program Pilot (http://www.opengeospatial.org/standards/per)
- Open Geospatial Consortium (OGC), Geography Markup Language (GML) Encoding Standard (http://www.opengeospatial.org/standards/gml)
- Intelligence Community (IC) Data Encoding Specifications (http://www.dni.gov/index.php/about/organization/chief-information-officer/ic-cio-enterprise-integration-architecture)
- NIEM Version 3.0 (http://release.niem.gov/niem/3.0)
- NIEM.gov (http://www.niem.gov)

6.2.1 Geo4NIEM Architecture Design and Implementation Guidance

The purpose of this task is to prepare and document overall architecture design and implementation guidance for NIEM to reflect enhancements and recommendations based on the results of Tasks 1 through 5 in this thread that includes the following topics:

- IC Data Encoding Specification alignment within the NIEM technical architecture validated through specific NIEM-conformant IEPDs
- Use of NIEM and GML in NIEM Information Exchange Package Documents (IEPDs) in a round-trip workflow
- Design and implementation recommendations for an API operating primarily on GML feature representations leveraging NIEM components where features may be searched, retrieved, inserted, updated and deleted

Document Deliverables:

- Testbed 11 Geo4NIEM Architecture Design and Implementation Guidance ER
- Fact Sheet for Geo4NIEM Architecture Design and Implementation Guidance

6.2.2 NIEM & IC Data Encoding Specification Assessment and Recommendations (Task 1).

This task will assess the support for geospatial and IC related use cases related to security tagging and the IC Data Encoding Specifications within NIEM to determine if its current architecture supports IC specification alignment; including but not limited to Information Security Marking Metadata (ISM), Need-to-Know Metadata (NTK), Multi Audience Tearline (MAT) (now replaced by Multi Audience Collection (MAC)) and Trusted Data Format (TDF) to enable secure information exchange and enhance user/developer understanding.

The assessment will include review of real world IEPDs, where the Extensible Markup Language (XML) schema and instance documents are populated with relevant content and includes supporting documentation to allow a comprehensive review and assessment. Additionally, the assessment should leverage existing industry work building on results of OGC Web Services, Phase 9 (OWS-9) Testbed and related prior initiatives.

Candidate IEPDs include, but are not limited to:

- Maritime Domain Awareness (MDA) Position and Tracks Version 3.2 IEPD
- DHS Request for Information (RFI) IEPD Version 2.0
- Law Enforcement Domain Suspicious Activity Reporting (SAR) IEPD

Recommendation to update these information exchanges will be provided to reflect NIEM 3.0 architecture and will include sample information security marking and need-to-know markings. The assessment should exercise services to test NIEM Version 3.0 conformant IEPDs containing the appropriate IC security markings.

Results from this task will provide a preliminary proposed architecture structure that will be tested and demonstrated in Task 2 (Section 6.2.3).

Results of this task will be documented in an Engineering Report containing the results of the analysis and assessment and support of IC Data Encoding.

Document Deliverable:

- Testbed 11 NIEM IC Data Encoding Specification Assessment and Recommendations ER

6.2.3 NIEM & IC Data Encoding Specification Test and Demonstration (Task 2)

This task will use preliminary findings and recommended architecture for IC Data Encoding Specification support identified in Task 1 (Section 6.2.2) and performs a Test and Demonstration of the recommended architecture leveraging the results of Testbed 9 and previous initiatives as appropriate.

This Test and Demonstration will invite participation from the OGC member community, extended to but not limited the Office of National Intelligence (ODNI), Department of Defense (DOD), National Geospatial Intelligence Agency (NGA), The United States Geological Survey (USGS), and the United States Environmental Protection Agency (EPA), and other OGC members as may be identified.

Results of this task will provide updates to the proposed architecture prepared in Task 1 (Section 6.2.2).

Results of this test and demonstration will be documented in an Engineering Report containing the Findings and Recommendations with reference to refinements to the originally proposed architecture prepared in Task 1 (Section 6.2.2).

Document Deliverable:

- Testbed 11 Results of Test and Demonstration of NIEM Using IC Data Encoding Specifications ER

6.2.4 NIEM-GML-NIEM Round-trip Assessment and Recommendations (Task 3)

This task will assess the NIEM and GML support for geospatial data exchange round-trip workflow process to include: creation, transfer, receipt, modification, return, and acceptance of XML content originating as NIEM IEPDs. The assessment will determine data exchange factors and conditions to include, but not limited to: data conversion, accuracy and precision, data loss, consistency, display, and performance.

Preliminary results of this task will be documented in a Report of Findings and Recommendations to reflect the geospatial data exchange life-cycle work flow process evaluation results. This task will also provide a proposed architecture and any structure modifications that will be tested and demonstrated as described in Task 4 (Section 6.2.5).

Document Deliverable:

- Testbed 11 NIEM-GML-NIEM Round Trip Assessment and Recommendations ER (Preliminary)

6.2.5 NIEM-GML-NIEM Round-trip Test and Demonstration (Task 4)

This task will use the findings and recommended architecture structure supporting NIEM-GML-NIEM round-trip assessment identified in Task 3 (Section 6.2.4) and perform a Test and Demonstration of the recommended architecture. The Test and Demonstration will invite participation from the OGC member community, extended to but not limited the National Geospatial Intelligence Agency (NGA), The United States Geological Survey (USGS), and the United States Environmental Protection Agency (EPA), and other OGC members as identified.

Results of this task will documented as a final update to the Report of Findings and Recommendations prepared in Task 3 (Section 6.2.4) to reflect refinements to the originally proposed architecture.

Document Deliverable:

- Testbed 11 NIEM-GML-NIEM Round Trip Assessment and Recommendations ER (Final)

6.2.6 Test and Demonstration of an API for Processing GML Feature Representations (Task 5)

This task will perform a Test and Demonstration using OGC web services, such as Web Map Service (WMS), Web Feature Service (WFS) or Web Feature Service with Transactions (WFS-T), to process GML feature representations leveraging NIEM components. The Test and Demonstration should include, but not be limited to feature search, retrieval, insert, update and delete. The Test and Demonstration will invite participation from the OGC member community, extended to but not limited the Department of Defense (DOD), National Geospatial Intelligence Agency (NGA), The United States Geological Survey (USGS), and the United States Environmental Protection Agency (EPA), and other OGC members as may be identified by the sponsors.

Results of this task will be documented as a Report of Findings and Recommendations and reflecting the test and demonstration architecture.

Document Deliverable:

- Testbed 11 NIEM-GML Feature Processing API using OGC Web Services ER

6.2.7 Testbed 11 Implementing Common Security Across the OGC Suite of Standards Engineering Report

The purpose of this task and engineering report is to conduct an analysis and study to reach a consistent approach across the OGC suite of service standards addressing security requirements. There is no consistent approach for any particular standards based solution to implement Authentication, Authorization, Access, Control and Auditing capabilities for the suite of OGC service standards. This report should provide an architectural view for implementing security across any implementation of OGC service standards. This architectural view should provide a clear and concise set of recommendations documented as an OGC Security Extension Common that could be added to any OGC service standard.

The analysis shall include of all OGC service standards and their GetCapabilities with the intent to identify a consistent approach to providing “service metadata” to identify the classification level of that service which is based on the highest level of classification for any data available through that service interface.

A common understanding of Authentication, Authorization, Access Control and Auditing requirements should be the starting point. The Engineering Report shall describe the different methods of Authentication and how to incorporate in the OGC architecture. Authentication generally being described as the process of determining whether someone or something is, in fact, who or what it is declared to be. Authorization is the function of specifying access rights to resources related to information security and computer security in general and to access control in particular. Access control is performed to ensure that an authenticated user accesses only what they are authorized to access and

no more. This study shall also define the mandatory minimum set of authorization attributes and values for sharing through a federation in order to support consistent and assured information sharing across an enterprise. Audit refers to an audit trail where a security-relevant chronological record or set of records provides documentary evidence of the sequence of activities that have been initiated by a user or service.

Access control shall define the attributes and values required to support Role-Based Access Control, Attribute-Based Access Control. Attribute-Based Access Control (ABAC) and Role Based Access Control (RBAC) methods shall identify methods to promote on-demand "authorization" to define an access policy to allow access to information and other resources by users and services. The set of authorization attributes should describe the design for implementation within products and servers that are capable of supporting the Encrypted Mode option of the OASIS SAML v2.0 Attribute Sharing Profile for X.509 Authentication-Based Systems, Committee Specification 01. Recommendations shall consider methods to reduce authorization vulnerabilities by strengthening the access control decision process.

This task shall evaluate the U.S. DNI standards as identified in the list below. This task shall consider how processing security metadata such as portion markings and tearlines at access control points have the ability to filter data based on the formal authorization credentials of authenticated users. Participants shall evaluate and consider how to incorporate into OGC service standards the security standards recommendations found at:

http://www.dni.gov/index.php/about/organization/chief-information-officer/ic-cio-enterprise-integration-architecture

- REST Service Encoding Specification for Security Markings (RR-SM.V2) 14 Jan 13
- IC Full Service Directory Schema, Version 1 (14 Dec 11)
- Authorization Attribute Set, Version 2 (3 Oct 2012)
- REST Service Encoding Specification for Identity Propagation (RR-ID.V1) 17 July 12

Document Deliverable:

- Testbed 11 Implementing Common Security Across the OGC Suite of Standards ER

6.3 Geo4NIEM Thread Deliverables

The Deliverables are summarized in the Table with descriptions of the Deliverables in paragraphs following the table.

Table 3 – Geo4NIEM Thread Deliverables Summary

Reports
1. Testbed 11 Geo4NIEM Architecture Design and Implementation ER and Fact Sheet
2. Testbed 11 NIEM & IC Data Encoding Specification Assessment and Architecture ER
3. Testbed 11 Test and Demonstration Results for NIEM Using IC Data Encoding Specifications ER
4. Testbed 11 NIEM-GML-NIEM Round Trip Assessment and Recommendations ER
5. Testbed 11 NIEM-GML Feature Processing API using OGC Web Services ER
6. Testbed 11 Implementing Common Security Across the OGC Suite of Standards ER

Components
1. Client with Security (all security domain roles) for Round Trip and GML Feature Processing
2. Client (IEPD Producer / Consumer) (Round-Trip)
3. WFS-T to Process IEPD-IC Data Encoded Transactions
4. Security Tagging Transform Component
5. Policy Enforcement Point (PEP)
6. Policy Decision Point (PDP)
7. Policy Administration Point (PAP)
8. Data Policy Information Point (PIP)

6.3.1 Testbed 11 Geo4NIEM Architecture Design and Implementation Guidance ER and Fact Sheet

This report shall document the overall architecture design and implementation guidance to reflect enhancements and recommendations based on the results of Tasks 1 through 5 in this thread as described in Section 6.2.1.

6.3.2 Testbed 11 NIEM & IC Data Encoding Specification Assessment and Architecture ER

The Report shall document the results of the assessment and architecture recommendations developed as described in Section 6.2.2.

6.3.3 Testbed 11 Test and Demonstration Results for NIEM Using IC Data Encoding Specifications ER

This report shall document the results of the Test and Demonstration conducted to evaluate the use of IC Data Encoding specifications in NIEM in the recommended architecture as described in Section 6.2.3.

6.3.4 Testbed 11 NIEM-GML-NIEM Round Trip Assessment and Recommendations ER

The Report shall document the support for geospatial data exchange life-cycle workflow process to include: creation, transfer, receipt, modification, return, and acceptance as described in Section 6.2.5. The report shall describe data exchange factors and conditions that include data conversion, accuracy and precision, data loss, consistency, display, performance and other factors as determined by the government.

6.3.5 Testbed 11 NIEM-GML Feature Processing API using OGC Web Services ER

This report shall document the results of the Test and Demonstration using OGC web services to process GML feature representations leveraging NIEM components as described in Section 6.2.6.

6.3.6 Testbed 11 Implementing Common Security Across the OGC Suite of Standards ER

This report shall document the results of analysis and study to describe a consistent approach for addressing security requirements across the OGC suite of service standards as described in Section 6.2.7

6.3.7 Client with Security (all security domain roles) for Round Trip and GML Feature Processing

This Client shall provide user interface to retrieve and response to content processed in the round-trip workflow containing NIEM objects that include security markings and tearlines; and content from GML Feature processing from IEPDs for visualization and analysis.

See Sections 6.2.4, 6.2.5, and 6.2.6 for additional details.

6.3.8 Client (IEPD Producer / Consumer) (Round-Trip)

This Client shall initiate the round-trip workflow be producing an IEPD (NIEM 3.0). The client shall also receive in return an IEPD as a result of the round-trip workflow.

See Sections 6.2.4 and 6.2.5 for additional details.

6.3.9 WFS-T to Process IEPD-IC Data Encoded Transactions

This Web Feature Service Transactional (WFS-T) shall receive and process IEPD encoded transactions with security markings including tearlines, store them for retrieval by another user, and return them to the originating Client on request as fully functional NIEM 3.0 IEPDs.

See Sections 6.2.2 and 6.2.3 for additional details.

6.3.10 Security Tagging Transform Component

This component shall accept XML instance documents that contain security tags indicating different access, dissemination, and classification levels using IC standards (security markings including tearlines). The Component shall evaluate and distribute the appropriate parts to the properly authorized users/requestors. Use of XSLT to perform the transform shall be considered.

See Sections 6.2.2 and 6.2.3 for additional details.

6.3.11 Policy Enforcement Point (PEP)

The PEP provides the capability for protecting entities from unauthorized access to security-protected entities. The PEP shall perform access control by making decision requests and enforcing authorization decisions from clients.

See Sections 6.2.2 and 6.2.3 for additional details.

6.3.12 Policy Decision Point (PDP)

The PDP component produced for this requirement shall perform the following tasks:

- Receive and examine the request
- Retrieve applicable policies
- Evaluate the applicable policy and
- Return the authorization decision to the PEP

See Sections 6.2.2 and 6.2.3 for additional details.

6.3.13 Policy Administration Point (PAP)

The Policy Administration Point (PAP) component will provide the service point to manage security policies and store these policies in the repository.

See Sections 6.2.2 and 6.2.3 for additional details.

6.3.14 Policy Information Point (PIP)

The Policy Information Point (PIP) shall serve as the source to store and retrieve attribute values, or other data required for policy evaluation.

See Sections 6.2.2 and 6.2.3 for additional details.

6.4 Geo4NIEM Enterprise Viewpoint

Geospatial information technologies are increasingly a foundation for supporting Information Sharing Environment (ISE), homeland security (HLS), homeland defense (HLD), law enforcement (LE), emergency management (EM) and public safety missions. The inability to transport, deliver and exchange geospatial information for critical geospatial assets for prevention, preparedness, response, recovery and mitigation to all-hazards and all-threats increases the risk to the nation.

Many ISE HLS/HDS/LE mission partners have developed standalone geospatial information systems (GIS) or Common Operating Pictures (COPs) to support their stakeholder communities during incidents and for daily operational support. While different missions, these GIS/COP capabilities rely upon much of the same data or generate specific data during an event and/or provide dynamic updates and modifications to them as the status of the events evolve. These data are often stove piped and not exposed to a broader community that could benefit from these data resulting in duplication and delayed or incorrect decisions. While mission partners do not need to use the same GIS/COP tools, they could benefit from shared access to the common operating data and services used within these systems if they were exposed and exchanges in open standards.

NIEM stakeholders have a real-world need to share critical and timely information within and between various levels of governmental and non-governmental units and across all levels of security apparatus.

The following candidate NIEM IEPDs shall be considered as possible scenarios for this thread

- DHS Request for Information (RFI) IEPD Version 2.0
- Suspicious Activity Reporting (SAR) IEPD
- Maritime Domain Awareness (MDA) Position and Tracks Version 3.2 IEPD

These candidate IEPDs are described in the following paragraphs.

Request for Information (RFI)

On August 5, 2010, Information Sharing Governance Board (ISGB), chaired by the DHS Office of Intelligence & Analysis (I&A) endorsed the need to establish a Common Operating Picture (COP) Integrated Project Team (IPT) to provide a governance structure for information sharing across DHS COP investments. The challenge is to ensure that the 20+ COP investments are interoperable and not redundant to share data, services and infrastructure. The goal - Provide the right information at the right time to the right people in a secure manner at the right cost.

The RFI exchange is focused on the interagency processes that affect requirements, tasking and information gathering activities used to support the collections and awareness within intelligence and response operations.

The RFI IEP provides the mechanism through which intelligence analysts and operations managers can request and receive relevant information for processing and analysis. The process of collection in the intelligence cycle refers to the methods and activities used to gather raw data for the later stages of the cycle. The Collection process is driven by inputs from the Planning process as well as from other tasking and requirements activities such as RFIs.

Situational awareness involves the ability to identify, process, and comprehend the critical information about an incident -- knowing what is going on around you. Situational awareness requires continuous monitoring of relevant sources of information regarding actual incidents and developing hazards. The scope and type of monitoring vary based on the type of incidents being evaluated and needed reporting thresholds. Critical information is passed through established reporting channels according to established security protocols as shown in Figure 12.

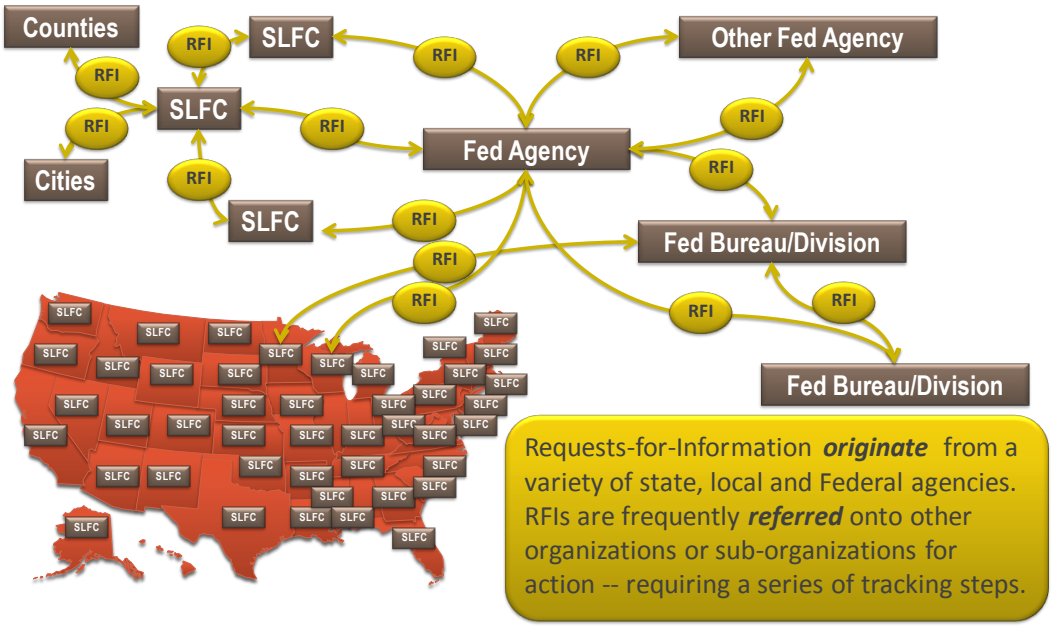


Figure 12, National Landscape of RFI Requests

Suspicious Activity Report (SAR)

Suspicious activity is defined as "*observed behavior that may be indicative of intelligence gathering or pre-operational planning related to terrorism, criminal, or other illicit intention.*"[3] A SAR requires a two-part process to determine that a SAR has a potential terrorism nexus. Some examples of the criteria for identifying SAR as having a potential terrorism nexus are listed below, but a more comprehensive list can be found in Part B of the SAR Functional Standard (ISE-FS-200).

- Surveillance

[3] ISE-FS-200, Information Sharing Environment (ISE) Functional Standard (FS) Suspicious Activity Reporting (SAR) Version 1.0

- Photography of facilities
- Site breach or physical intrusion
- Cyber attacks
- Probing of security

The complete SAR IEPD can be found at the following location:

http://niem.gtri.gatech.edu/niemtools/iepdt/display/container.iepd?ref=ntsXeIX7M6Q=

The Suspicious Activity Report (SAR) exchange is designed to support sharing of suspicious activity, incident, or behavior (hereafter referred to as activity) information that has a potential terrorism nexus throughout the Information Sharing Environment (ISE) and between State and major urban area fusion centers and their law enforcement, homeland security, or other information sharing partners at the Federal, State, local, and tribal levels to the full extent permitted by law. ISE-SARs provide for the discovery of patterns, trends, or nationally suspicious activities beyond what would be recognized within a single jurisdiction, state, or territory. Standardized and consistent sharing of suspicious activity information with the State and major urban area fusion centers is deemed vital to assessing, deterring, preventing, or prosecuting those planning terrorist activities. The ISE-SAR Functional Standard has been designed to incorporate key elements for terrorist related activities and may be potentially leveraged by other communities for other crimes.

6.4.1.1 SAR Business Process

Beginning with the observation and documentation of a suspicious activity, there are five necessary top-level processes—some of which are primarily organizational specific and others with broader implications for the ISE—that together comprise the ISE Suspicious Activity Reporting Process. These processes have been categorized as listed below and in **Figure 13**.

- Information acquisition
- Organizational processing
- Integration/consolidation
- Data retrieval/distribution
- Feedback

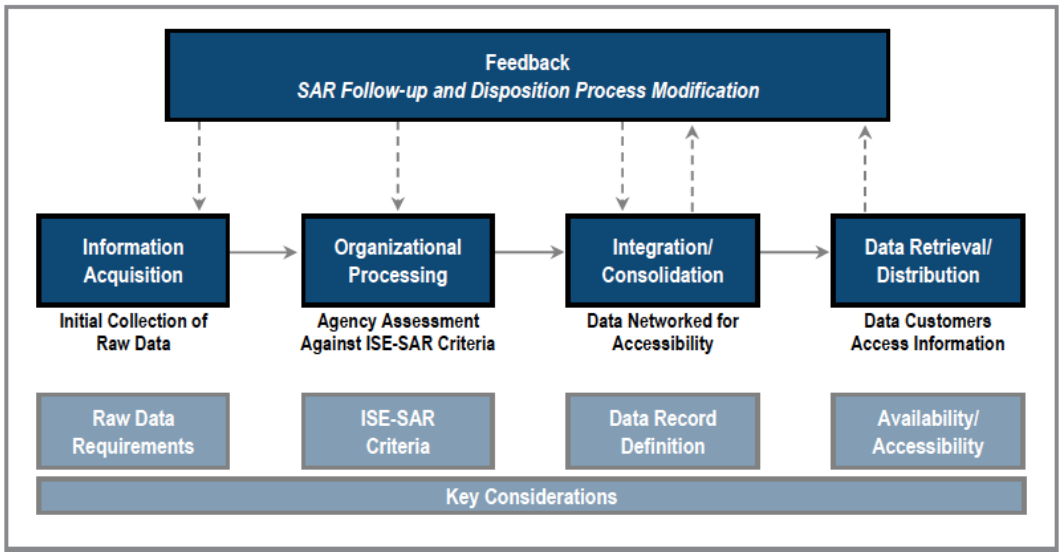


Figure 13, SAR Top-level Process

A variety of internal processes are conducted at State and major urban area fusion centers and their external interfaces to the Federal Government. **Figure 14** represents a number of the various information management and exchange processes that take place in the reporting and sharing of suspicious activities. As shown, SAR vetting and standards is one part of a number of processes that support the functional flow of information in the ISE.

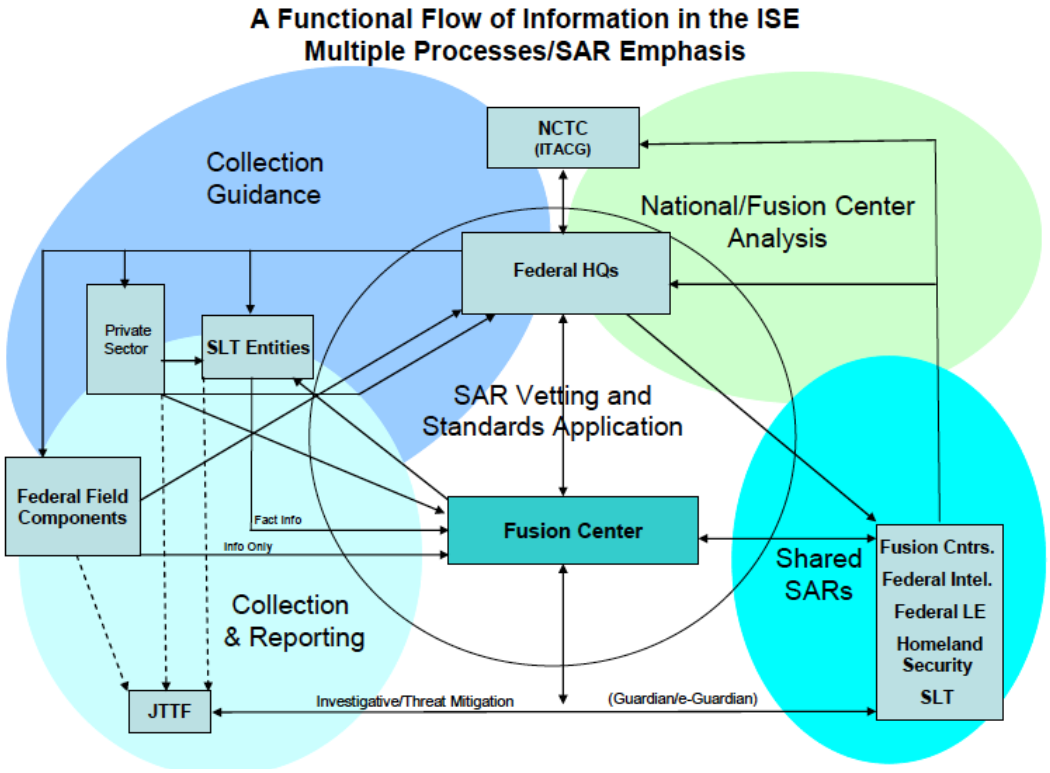


Figure 14, ISE-SAR Exchanges

Maritime Domain Awareness

The Maritime domain supports the effective understanding of anything associated with global maritime that could impact the United States' security, safety, economy, or

environment. NIEM facilitates this understanding through effective, timely sharing of vital, secure information among many key partners *by representing vessels, people, cargo, and maritime locations and activities*.

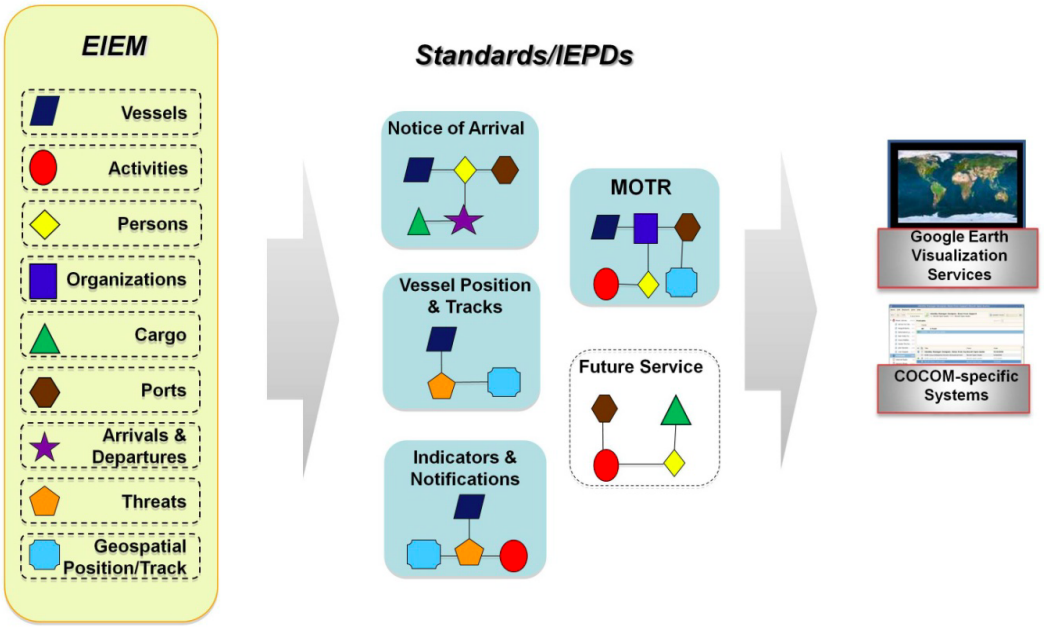
The National Plan to Achieve Maritime Domain Awareness (MDA), a by-product of the Maritime Security Policy, established the national maritime common operating picture (COP) as the primary means of displaying shared data and focused on net-centricity to achieve its goal. The MDA Data Sharing Community of Interest (DS COI) was established to leverage net-centric Web-based technology and capabilities to address complex data sharing requirements among multiple agencies. Its purpose is to implement the national net-centric data sharing strategy in order to improve maritime security. As the lead maritime agency in DHS, the Coast Guard has exercised a lead role in achieving the DS COI's goals.

The Vessel Track IEPD defines the requirements and content for a Vessel Position and Track message containing a series of one or more geospatial positions captured over time that define the movement of a vessel. It uses the definition of Vessels, Threats and Geospatial Positions from the Enterprise Information Exchange Model (EIEM) (see Section 6.5.2). It contains a restricted subset of the EIEM schema that contains only the high-level objects pertinent to Vessel Track messages.

The complete MDA-Vessel Track IEPD can be found here:

http://niem.gtri.gatech.edu/niemtools/iepdt/display/container.iepd?ref=KpOEKUaWqZE

The Vessel Track IEPD, as a member of the NIEM-Maritime family, defines a particular XML message, which is the basic unit of shared information. As shown in Figure 1, the Vessel Track IEPD uses a subset of the core entities defined in the EIEM (additional information on EIEM can be found in the Section 6.5) and assembles them into a particular record type with its own unique root element. As new requirements are defined, new IEPDs can be created that build on the same EIEM core entities.



6.5 Geo4NIEM Information Viewpoint

The Information Viewpoint describes the information models and encodings that are associated with the content of the services and exchanges to be extended or developed to support the Geo4NIEM thread activities.

Below is a listing of the specifications relevant and likely to be used in this thread. OGC standards are available on the OGC portal.

- Open Geospatial Consortium (OGC), Geography Markup Language (GML) Encoding Standard (http://www.opengeospatial.org/standards/gml)
- Intelligence Community (IC) Data Encoding Specifications (http://www.dni.gov/index.php/about/organization/chief-information-officer/ic-cio-enterprise-integration-architecture)
- NIEM Version 3.0 (http://release.niem.gov/niem/3.0)
- OASIS eXtensible Access Control Markup Language (XACML) v2.0, v3.0 (https://www.oasis-open.org/standards - xacmlv3.0 https://www.oasis-open.org/standards - xacmlv2.0)
- OASIS Security Assertion Markup Language (SAML) v2.0 (https://www.oasis-open.org/standards - samlv2.0
- Geospatial eXtensible Access Control Markup Language (GeoXACML) v1.0 Corrigendum, Extension A (GML2) Encoding, Extension B (GML3) Encoding (http://www.opengeospatial.org/standards/geoxacml)

The following table provides a list of engineering reports from previous testbeds and other documents that are relevant for this thread. All reports are available on the OGC portal.

Title	OGC Doc Number
OWS-9 Security Engineering Report	OGC 12-118
OWS-9 SSI Security Rules Service Engineering Report	OGC 12-139
Summary and Recommendations of the Geospatial Enhancement for the National Information Exchange Model (Geo4NIEM) Interoperability Program Pilot	OGC 13-054r1
OGC® Testbed 10 OWS Context in NIEM Engineering Report	OGC 14-017
Geospatial eXensible Access Control Markup Language (GeoXACML) 3.0 GML 3.2.1 Encoding Extension	OGC 13-101
Geospatial eXensible Access Control Markup Language (GeoXACML) 3.0 Core	OGC 13-100
GeoXACML and XACML Policy Administration Web Service (PAWS)	OGC 13-099
OGC® Military Operations Geospatial Interoperability Experiment (MOGIE)	OGC 13-080r3
OWS-6 GeoXACML Engineering Report	OGC 09-036r2

The following sections provide summary information about other information models and standards that are relevant to this thread.

6.5.1 NIEM Information Exchange Package Documentation (IEPDs)

Reference document:

NIEM Model Package Description (MPD) Specification, Version 3.0
http://reference.niem.gov/niem/specification/model-package-description/3.0/

An Information Exchange Package Documentation (IEPD) is an MPD that contains NIEM-conforming schemas that define one or more recurring XML data exchanges.

A NIEM IEPD is a set of valid XML schemas that may include portions of NIEM Core schemas (and updates), portions of NIEM Domain schemas, enterprise-specific or IEPD-specific extension schemas, and at least one exchange schema that defines a document element.The schemas contained in an IEPD work together to define a class of XML instances that consistently encapsulate data for information exchanges. Each XML instance in this class validates against the set of XML schemas contained within the IEPD. XML schemas in a NIEM IEPD conform to the NIEM Naming and Design Rules and may use or extend data component definitions drawn from NIEM.

An IEPD consists of a minimal but complete set of artifacts (XML schemas, documentation, sample XML instances, etc.) that together defines and describes an implementable NIEM information exchange. A complete and normative IEPD should contain all the schema definitions and instructional material necessary to:

- Understand information exchange content, semantics, and structure.
- Create and validate information exchanges defined by the IEPD.
- Identify the lineage of the IEPD and optionally its artifacts.

6.5.2 Enterprise Information Exchange Model (EIEM) and Business Information Exchange Components

Reference document:

- **NIEM-M Maritime Domain Awareness (MDA) Enterprise Information Exchange Model (EIEM)**
  http://niem.gtri.gatech.edu/niemtools/iepdt/display/container.iepd?ref=GatnX-RDHIg

As an organization develops IEPDs, the organization may realize that many of its IEPDs have similar business content. A collection of closely related business data could be organized at an object level and defined as extension data components. In NIEM, these extension components are referred to as BIECs, which are either specific to an organization's business or they represent a more general line of business that crosses organizational lines.

The use of BIECs has the potential for simplifying IEPD development and increasing consistency of the business object definitions at all steps in the process, including exchange content modeling, mapping to NIEM, creating NIEM extension components, and generating XML schemas.

An Enterprise Information Exchange Model (EIEM) is an MPD that incorporates BIECs that meet enterprise business needs for exchanging data using NIEM. An EIEM is an adaptation of NIEM schemas, tailored and constrained for and by an enterprise.

An organization that creates and maintains an EIEM authors IEPDs by reusing its EIEM content instead of (re)subsetting NIEM components and (re)creating extensions. An EIEM

may also contain business rules or constraint schemas tailored to the enterprise and designed to restrict variability in use of NIEM data components. This not only saves time, but it also ensures that enterprise IEPDs reuse NIEM and associated extensions consistently.

The NIEM Maritime EIEM defines core entities that serve as building blocks that are reused in many maritime exchanges.

The high-level entities defined by the Maritime EIEM are:

- Vessels
- Activities (e.g., an incident or MOTR response)
- Person (e.g., a crew member, person of interest or vessel owner)
- Organizations (e.g., a MOTR participating organization or vessel owner)
- Cargo
- Port
- Arrivals and Departures
- Threats
- Geospatial Position/Track

EIEM is conformant to the NIEM MPD (Model Package Description) Specification, version 1.1, and uses the file structure recommended by that document.

6.6 Geo4NIEM Computational Viewpoint

This viewpoint describes the basic service building blocks, interfaces and interactions of high-level architectures for this thread. The service interfaces shown in the following diagram represents the notional high-level functional architecture relevant for this thread.

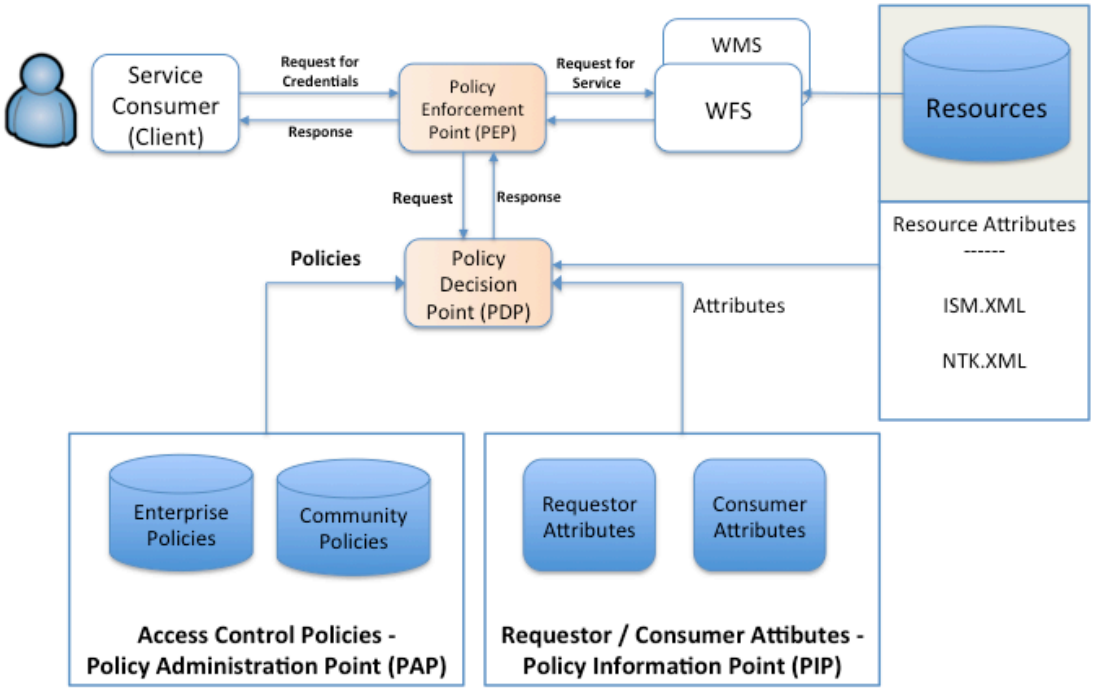


Figure 15, Geo4NIEM High-level Component Architecture

The following diagram represents a preliminary architecture as a guide to describe the component decomposition and their interactions. The diagram depicts the expected processing workflow for NIEM IEPDs containing IC encoded content at various levels of security domain. During processing, the security-encoded content is separated by classification level for delivery according to user access authorizations, need to know and other attribute criteria.

Upon receipt, the security domain user in each security domain will review and analyze the information received based on his role. In this architecture and for the round trip, the user will make updates or changes to the information, which shall be returned by transaction to the originating user. During the return of the round trip the updates or changes will be processed through the services of the architecture. The updates will be returned to the originating user as a conforming IEPD

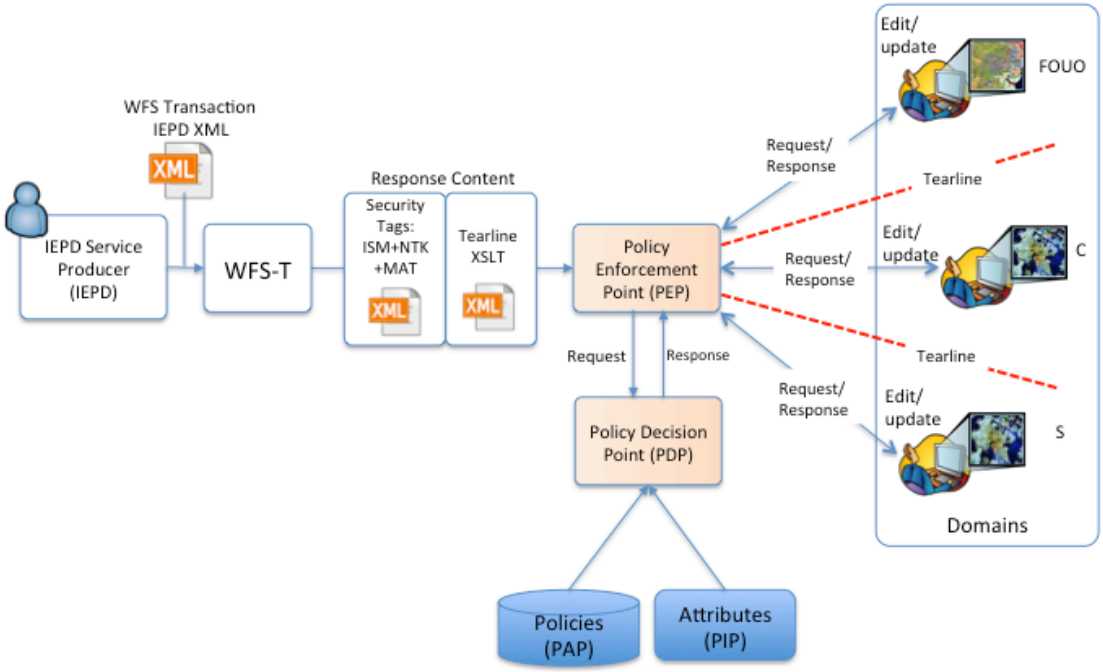


Figure 16, NIEM-IC Data Encoded Processing via Round-trip Processing Workflow

6.6.1 Web Feature Service (WFS)

The OpenGIS® Web Feature Service (WFS) Implementation Specification allows a client to retrieve geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. The specification defines interfaces for data access and manipulation operations on geographic features, using HTTP as the distributed computing platform. Via these interfaces, a Web user or service can combine, use and manage geodata -- the feature information behind a map image -- from different sources.

6.6.2 Web Feature Service with Transactions (WFS-T)

A Transactional Web Feature Service allows a client to send messages relating to making changes to a geospatial database.

The following WFS-T operations are available to manage geographic features and elements:

- Create a new feature instance

- Delete a feature instance
- Update a feature instance
- Lock a feature instance

6.6.3 Web Map Service (WMS)

The OpenGIS® Web Map Service (WMS) Implementation Specification enables the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple remote and heterogeneous sources.

6.6.4 OASIS XAXML Security Context Handler and Associated Components

The XACML Information Flow Model shown in Figure 17 illustrates the informative architecture and the sequence of messages, sent between the components of the access control system.

Additional details describing these components and interactions related to XACML 2.0 can be found at the OASIS website: https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=xacml#XACML20

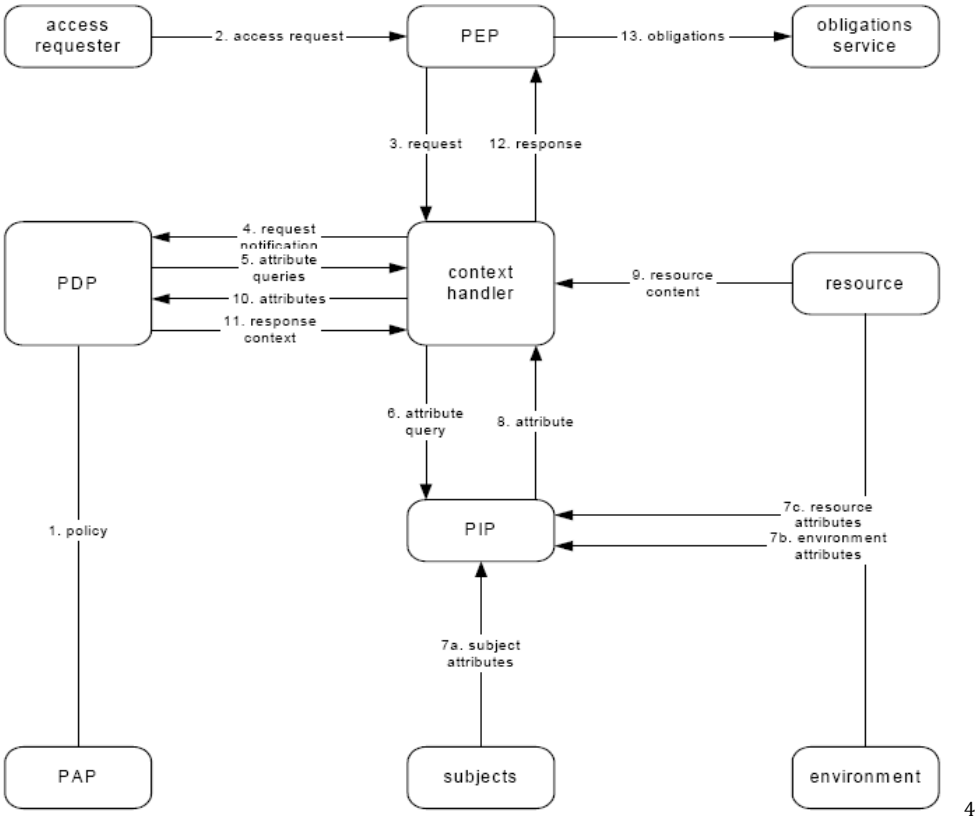


Figure 17, OASIS XACML 2.0 Flow Diagram

[4] OASIS XACML 2.0 Core Spec, http://docs.oasis-open.org/xacml/2.0/access_control-xacml-2.0-core-spec-os.pdf

6.7 Geo4NIEM Engineering Viewpoint

The engineering viewpoint is concerned with the functional decomposition of the system into a set of objects that interact at interfaces – enabling system distribution. It captures component and interface details without regard to distribution and describes an interaction framework including application objects, service support objects and infrastructure objects.

The Geo4NIEM engineering viewpoint will be defined during the testbed. Details will be developed and refined based result of design, implementation, experimentation, and problem solving during the course of the initiative.