The Open Geospatial Consortium (OGC®)

Request For Quotation

And

Call For Participation

In the

GEOSPATIAL ENHANCEMENT FOR THE NATIONAL INFORMATION EXCHANGE MODEL (NIEM)

(GEO4NIEM)

Annex B: Technical Architecture

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Annex B: Geo4NIEM Architecture

1   Introduction

1.1   Purpose

This document describes the architecture for standards and technology to guide the analysis, testing, development and demonstration of geospatial enhancements for the National Information Exchange Model (NIEM) based on existing or to be developed OGC standards and practices. The Sponsors'objectives in this OGC Interoperability Program initiative are to:

- Develop recommendations for the inclusion and standard use of embedded GML with NIEM IEPDs.
- Develop recommendations for the standardized use of Naming and Design Rules and the use of adaptors (e.g. NIEM wrapper for GML)
- Test and demonstrate use of a standardized embedded GML and adaptors within NIEM IEPDs.
- Develop architecture documentation and fact sheet for the use of embedded GML and adaptors for use with NIEM IEPDs
- Develop recommendations for the inclusion of a Geospatial Domain within NIEM

1.2   About This Document

The architecture in this document is presented using the Reference Model for Open Distributed Processing (RM-ODP), ISO/IEC 10746. This document's structure is organized using four RM-ODP viewpoints.

The *enterprise viewpoint* explains the business reasons for this project, who should be involved, and what should be done in simple terms. It is intended primarily for high-level decision makers.

The *information viewpoint* lists and briefly describes the encodings and information models most applicable for the system, based on the use cases described in the enterprise viewpoint.

The *computational viewpoint* similarly describes a basic set of components (including web services) and other interfaces/protocols most applicable for this initiative, based on the use cases, but stopping short of "wiring the system together".

The information and computational viewpoints would not, of themselves, constitute an operational model of a proposed solution. In this initiative, the objective is not to build or demonstrate a functional system, rather to develop and demonstrate enhanced geospatial information practices based on use case examples represented by exemplar NIEM IEPDs.

An *engineering viewpoint* is prepared to show how various components of a system architecture would fit together. This represents a conceptual model of the system architecture, not at the level of detail needed for a physical implementation, but rather a template that should be as platform-neutral as possible. For this Geo4NIEM initiative, an *engineering viewpoint* is not required.

A *technology viewpoint* is concerned with the deployed system, describing hardware and software components to be used. For this Geo4NIEM initiative, a *techology viewpoint* is not required.

2   Geo4NIEM Requirements

To further advance and foster geospatial information sharing and the adoption and use of NIEM, the PM-ISE is sponsoring this OGC initiative with the NIEM Program Management Office and the DHS Geospatial Management Office (GMO) to enhance NIEM domain architecture for geospatial by developing, testing, and documenting embedded GML architecture reference guidance. The following paragraphs provide details of requirements to be addressed to meet sponsors' objectives for this initiative.

2.1   NIEM Embedded GML and Adaptor Assessment and Recommendations

The purpose of this task is to assess the support for geospatial data and embedded GML structure within NIEM to determine if the current 'fragmented' structure allows for the most efficient and effective identification, location, extraction, linkage, modification and use of location information to enable exchange and user/developer understanding. The assessment will include the review of real word IEPDs, where the Extensible Markup Language (XML) is populated and includes supporting documentation to allow a comprehensive review and assessment.

During this task participants will also assess the NIEM Naming and Design Rules for the efficient and effective use of adaptors where the use of a 'wrapper' around a GML component may impact the access and use of the GML.

The NIEM PMO sponsor has identified real world IEPDs to be used for the evaluation during this initiative. Candidate IEPDs include, but are not limited to Reques for Information (RFI) IEPD, Maritime Domain Vessel Track IEPD and Law Enforcement Domain Suspicious Activity Reporting (SAR) IEPD.

Results of this task will be documented in an OGC Engineering Report (ER) of Findings and Recommendations, a Fact Sheet and recommendations to determine the need for a geospatial domain, architectural design for embedded GML, and the use of adaptors within NIEM. The result of this task will provide the necessary proposed architecture structure that will be tested and demonstrated in as described in Section 2.2, which follows.

During this task, participants create elements of the IEPD packages that include GML in particular IEPD XML schemas with embedded GML. These draft schemas will be delivered to support testing as described in Section 2.2.

2.2   NIEM Embedded GML and Adaptor Test and Demonstration

The purpose of this task is to use the findings and recommended architecture structure for embedded GML and adaptors identified in Section 2.1 and perform a test and demonstration of the recommended architecture. The Test and Demonstration activities will include participation by National Geospatial Intelligence Agency (NGA), The United States Geological Survey (USGS), and the United States Environmental Protection Agency, and other OGC members as may be identified. Results of this task will be included in the OGC Engineering Report containing findings and recommendations reflecting refinements to the originally proposed architecture defined in Section 2.1.

In performance of this task, participants will:

1) Produce instances of NIEM IEPDs that implement the recommendations for GML in NIEM in Task 1.

2) Exchange IEPD instances between producers and consumers as attachments to e-mail messages or similar file transfer function.

3) Consumer IEPD instances and confirm the GML geometry is correct.

3   Enterprise Viewpoint: Context and Use Cases

3.1   Context of Geo4NIEM

The sponsors have identified important Information Exchange requirements to be analyzed and used as case study exemplars for development of recommendations to enhance the interoperability of geospatial information use in information exchanges developed in accordance with the National Information Exchange Model (NIEM). Sponsors have identified specific Information Exchange Package Documents (IEPDs) from Department of Homeland Security (DHS), Justice/Law Enforcement domain and Maritime domain as representative examples for investigation in this initiative. The focus of these requirements is 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.

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*.

Justice/Law Enforcement. The Justice domain provides an XML-based framework that enables the entire justice and public safety communities to effectively share information at all levels. The Justice domain is defined by a model that evolved through a reconciliation of definitions that began as the Global Justice XML Data Model (Global JXDM which originated in March 2001. The Justice domain continues to provide the criminal justice system with the data elements, objects, and properties it needs to share critical information between jurisdictions and levels of government.

3.1.1   Operational Context

Geo4NIEM initiative aims to enhance interoperability involving geospatial information based on OGC standards and information exchanges developed in accordance with requirements of NIEM. The operational context for the Geo4NIEM initiative will focus on Use Cases associated with the following NIEM Information Exchange Package Documents (IEPDs):

- DHS I&A - Request for Information (RFI)
- Law Enforcement - Suspicious Activity Report (SAR)
- Maritime Domain Awareness – Vessel Track

These Use Cases describe information exchanges to be addressed during the Geo4NIEM Project. The Use Cases will be used as the basis for analysis, testing and demonstration of recommended enhancements to promote improved interoperability for geospatial information used in information exchanges developed in accordance with NIEM. The activities in this initiative will be performed according to the plans set forth in the Concept of Operations, contained in Section 4 of Annex A to this RFQ/CFP. Deliverable requirements are provided in Section 5 of the RFQ/CFP Main Body.

3.1.2 Technical Context

Participants in this initiative will bring available or proposed application software, develop XML Schema and related XML instance documents as needed to support analysis, testing and validation of the Use Cases described in Annex B. Based on the architecture described in Annex B, participants will have flexibility to design the test environment, test harnesses, validation and assessment tools to for use in demonstrations associated with the operational context. Specific technical requirements are provided in Annex A.

3.2   Information Exchange Package Documentation (IEPD) Use Cases

3.2.1 DHS I&A - Request for Information (RFI)

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 as shown in .
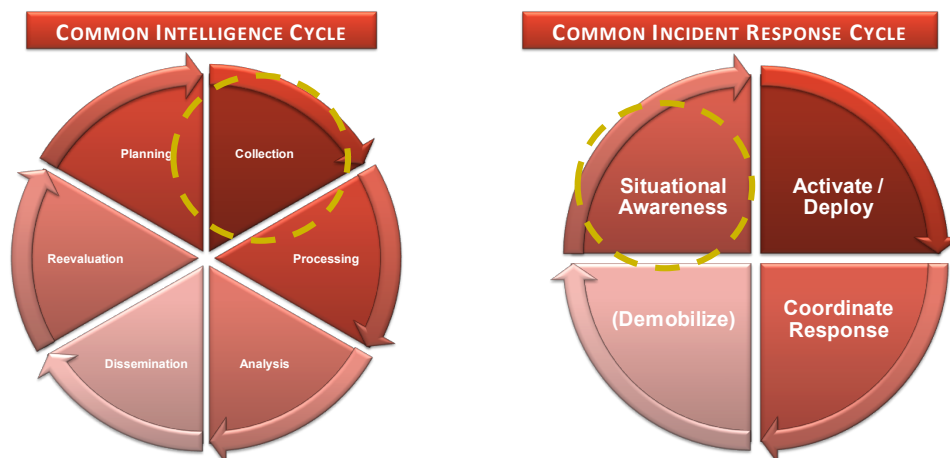

Figure 1, Aligning Common Intelligence Cycle with Common Incident Response Cycle

RFI is a process that provides input into the following:

a.   Collection step of the Intelligence Cycle
b.   Situational Awareness step of the Incident Management Cycle

This is 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, including State and Local Fusion Centers (SLFCs) according to established security protocols, as shown in Figure 2.
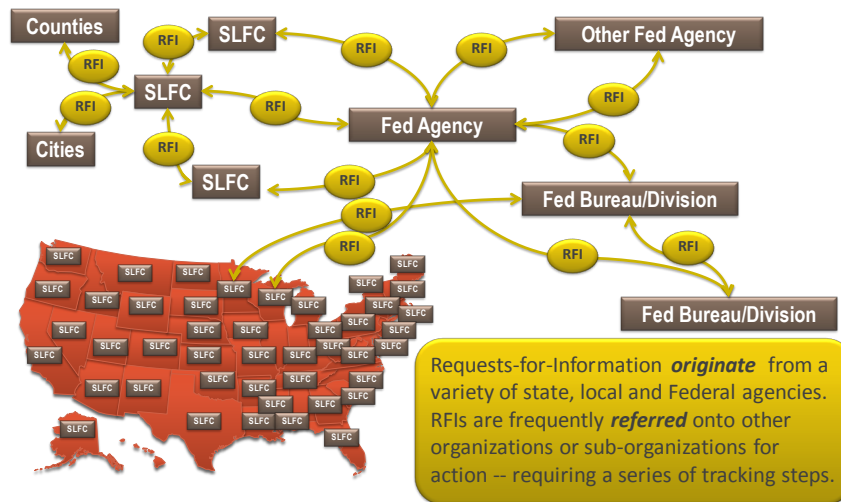

Figure 2, National Landscape of RFI Requests

Role of SLFCs in Information Exchanges[1]

State and Local Fusion Centers (SLFCs), created by the States and Major Urban Areas, provide a way to address the unique information needs of State, local, tribal, and territorial authorities, along with their stakeholders, including the private sector. This information sharing challenge was recognized by the 9/11 Commission. A fusion center is defined as a "collaborative effort of two or more Federal, State, local, or tribal government agencies that combines resources, expertise, and information with the goal of maximizing the ability of such agencies to detect, prevent, investigate, apprehend, and respond to criminal and terrorist activity." Currently, many states have at least one fusion center – several states have multiple centers, an increasing number of cities and counties also have fusion centers, and more are anticipated. The fusion centers are established, managed, and controlled by State and local entities and are subject to political and legal constraints within their respective jurisdictions. Each fusion center is developed to meet the unique needs of its area of responsibility. Today, SLFCs serve a pivotal role within their States for the sharing and fusing of homeland security-related information and intelligence.

The notional business process for a Request for Information (RFI) exchange is shown in Figure 3

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[1] Department Of Homeland Security Interaction With State And Local Fusion Centers - Concept Of Operations, December 2008
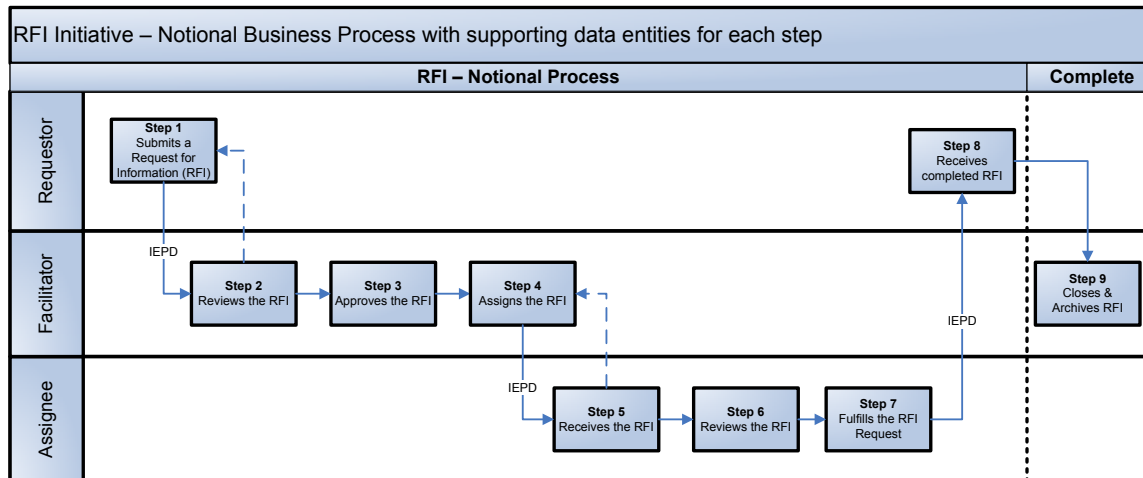
Figure 3, Notional Process for RFI

3.2.2 Justice/Law Enforcement - 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.*"[2] 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
- 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.

3.2.2.1 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 4.

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

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

Figure 4, 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 5 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 5, ISE-SAR Exchanges

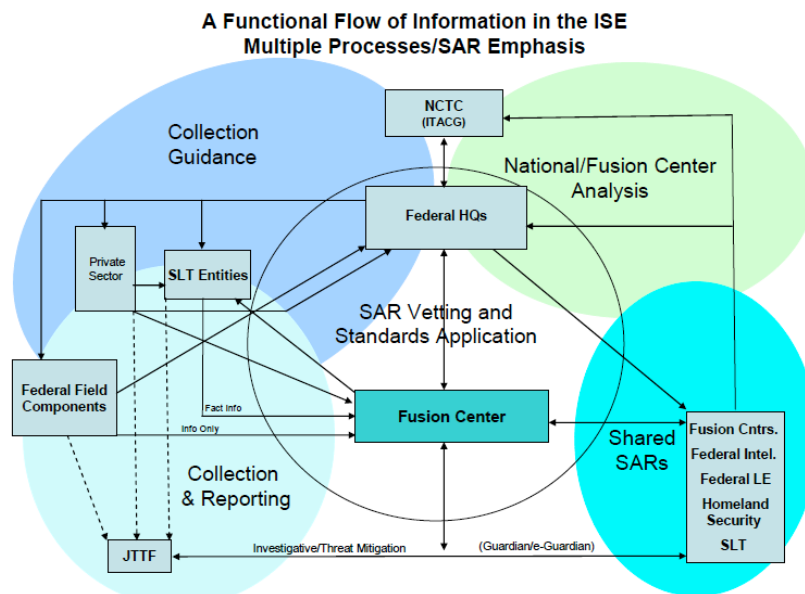### *3.2.3 Maritime Domain Awareness (MDA) – Vessel Track*

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 4.3.1.5). 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 4) 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.
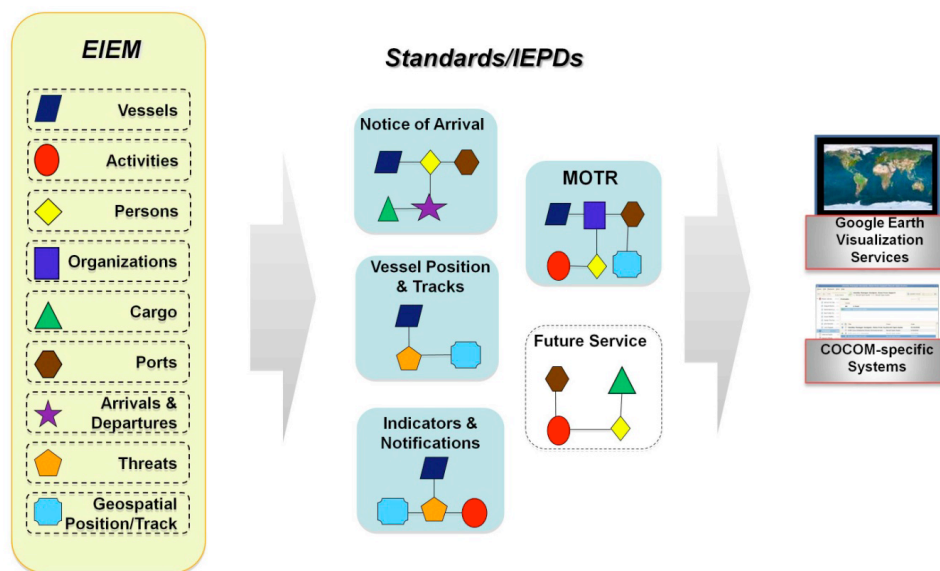
4   Information Viewpoint

4.1   Overview

The information viewpoint is concerned with the semantics of information and information processing. It defines conceptual schemas for geospatial information and methods for defining application schemas. The conceptual, or base, schemas are formal descriptions of the model of any geospatial information. Application schemas are information models for a specific information community. Applications schemas are built from the conceptual schemas.

This viewpoint also describes NIEM information models, model package requirements and encodings, including the NIEM Naming and Design Rules (NDR).

4.2   OGC Information Models and Encodings

The Geography Markup Language (GML)

- **The OpenGIS® Geography Markup Language Encoding Standard (GML) , Version 3.2.1 (OGC 07-036)**
  http://portal.opengeospatial.org/files/?artifact_id=20509

The Geography Markup Language (GML) is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet. As with most XML based grammars, there are two parts to the grammar – the schema that describes the document and the instance document that contains the actual data. A GML document is described using a GML Schema. This allows users and developers to describe generic geographic data sets that contain points, lines and polygons. However, the developers of GML envision communities working to define community-specific application schemas [en.wikipedia.org/wiki/GML_Application_Schemas] that are specialized extensions of GML. Using application schemas, users can refer to roads, highways, and bridges instead of points, lines and polygons. If everyone in a community agrees to use the same schemas they can exchange data easily and be sure that a road is still a road when they view it. Clients and servers with interfaces that implement the OpenGIS® Web Feature Service Interface Standard[http://www.opengeospatial.org/standards/wfs] read and write GML data. GML is also an ISO standard (ISO 19136:2007)
[http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=32554]

- **Geography Markup Language (GML) simple features profile (with Corrigendum), (OGC 10-100r3)**
  http://portal.opengeospatial.org/files/?artifact_id=42729

This OGC standard defines the GML Simple Features profile of the Geography Markup Language version 3.2. This Simple Features Profile has been aligned with the OGC Simple Features standard for SQL version 1.2. Simple Features include:

- Point
- Curve (LineString)
- Surface (Polygon)
- Geometry
- MultiPoint
- MultiCurve
- MultiSurface
- MultiGeometry

The detailed abstract model for OGC features and geometry can be found in the OGC Abstract Specification, Topic Volume 1: Features (which is equivalent to ISO 19107).

- **OGC® Geography Markup Language (GML) — Extended schemas and encoding rules, Version 3.3 (OGC 10-129r1)**
  https://portal.opengeospatial.org/files/?artifact_id=46568

GML 3.3 builds on GML 3.2, published by ISO as ISO 19136:2007, and extends it with
additional schema components and requirements. These additional components and requirements are listed below:

- Additional basic types
- Compact Encodings of Commonly Used GML Geometries
- Triangulated Irregular Networks
- Linear Referencing
- ReferencableGrid
- Code lists, dictionaries and definitions

- Encoding rules and Extensions

The following paragraphs describe material from clauses in the GML standards that are relevant to scope of work to be performed in this initiative, but are not intended to be inclusive of all clauses that might apply in this initiative.

GML Profiles (Clause 20)
Depending on the requirements of a specific domain, an application may not need to use the entire GML schema, rather may chose to employ a subset of constructs from GML corresponding to relevant requirements, called a Profile.

A profile of GML may be defined to enhance interoperability and to curtail ambiguity by allowing only a specific subset of GML. Application schemas may then be created to conform to such a profile in order to take advantage of any interoperability or performance advantages that it offers in comparison with a complete GML. Such profiles may be defined for application schemas that are included in other specifications.

Rules for GML application schemas (Clause 21)

GML object elements in other XML documents:
Elements of GML objects may occur in XML documents that are not GML documents. The XML document shall validate against an XML Schema document that imports directly or indirectly the GML schema or a GML profile and optionally one or more GML application schemas.

NIEM Use of GML
NIEM includes a set of GML Simple Feature geometry objects based on GML version 3.2.1. These objects have been incorporated into NIEM using the External Standards Adapter Pattern, as defined in the NIEM Naming and Design Rules (NDR). See additional information in Section 4.3

In addition, GML Application Schema have been developed as part of UCore led by US Department of Defense (DoD), US Department of Justice (DOJ), US Department of Homeland Security (DHS) and the US Office of the Director of National Intelligence (ODNI) to address combat support requirements. See Section 4.4 for additional details.

4.3   NIEM Content and Architecture

Reference documents and models:

- **National Information Exchange Model (NIEM) Release, Version 2.1**
  http://release.niem.gov/niem/2.1/
- **NIEM Naming and Design Rules (NDR), Version 1.3**
  http://www.niem.gov/pdf/NIEM-NDR-1-3.pdf
- **NIEM Type Augmentation Supplement to NDR 1.3, Version 1.0**
  http://reference.niem.gov/niem/specification/naming-and-design-rules/1.3/type-augmentation/niem-type-augmentation-1.0.pdf
- **NIEM Model Package Description (MPD) Specification, Version 1.0**
  http://reference.niem.gov/niem/specification/model-package-description/1.1/model-package-description-1.1.pdf

4.3.1.1   NIEM Data Model – Overview

Reference documents and models:

- **National Information Exchange Model (NIEM) Release, Version 2.1**
  http://release.niem.gov/niem/2.1/

The NIEM data model provides the reference vocabulary for consistent and reusable intra- and interdomain information exchanges. The structure and meaning of NIEM data are defined by the model and dictionary and are represented as XML schema, thereby providing a common framework for information exchange. As part of the

NIEM 2.1 release, the model can also be viewed as a spreadsheet or in a database format. The fundamental building block of NIEM is a data component. Data components are the basic business data items that describe common concepts used in general business activities as shown in Figure 6 below..[3]

Figure 6, High-level view of NIEM

The NIEM architecture consists of two sets of vocabularies—NIEM Core and the individual NIEM domains. NIEM Core contains all data components determined to have relevance to and semantic agreement by most or all participating domains. Examples include comonents such as dates, times, and locations. They do not have to appear in every exchange and do not have to apply all the time—they simply have to be well-defined and well-known enough to be understood by all (or the majority of) domains.

By contrast, NIEM domains are governered by a specific line-of-business, community-of-interest, or other similar grouping that is assigned a NIEM XML namespace. These entities have responsibility to act as an authoritative source and steward of domain-specific data components and can propose promotions of data components to the NIEM Core namespace.

NIEM 2.1 currently contains 10 domains, as shown in Figure 7, with published content including Chemical/Biological/Radiological/Nuclear (CBRN), Emergency Management, Children Youth & Family Services (CYFS), Immigration, Infrastructure Protection, Intelligence, International Trade, Justice, Maritime and Screening. Domains that are currently developing a governance structure, or are in the process of developing domain-specific data componetns are known as emerging domains. These domains, not currently found in the NIEM 2.1 release, include Agriculture, Biometrics, Cyber, Government Resources Management, Health, and Human Services. Additional domains will be added as policy evolves and operational requirements emerge.

NIEM key concepts

The following are key concepts necessary to understand the purpose, architecture, processes, and other capabilities of NIEM, and to establish a common knowledge base for use NIEM.

NIEM Core. The NIEM namespace (or corresponding XML schema) that contains all data components determined to have relevance to and semantic agreement by most or all participating domains. Notionally, NIEM Core contains all reusable data components that are not domain-specific and are governed by the NIEM Business Architecture Committee (NBAC).

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[3] National Information Exchange Model (NIEM) User Guide Volume 1

NIEM Domain. A line-of-business, community-of-interest, or other similar grouping that is assigned a NIEM namespace, has responsibility to act as an authoritative source and steward of domain-specific data components, and can propose promotions of data components to the NIEM Core namespace.

Communities of Interest. Communities of interest (COIs) are collaborative groups of users who exchange information in pursuit of shared goals, interests, missions, or business processes and who therefore must have a shared vocabulary for the information they exchange. COIs reuse data components and artifacts found in NIEM to document their information exchanges. One or more COIs can coordinate to develop new domain content as they identify gaps in the data components needed for documenting information exchanges.

NIEM Conformance. Adherence to the NIEM Naming and Design Rules (NDR), Model Package Description Specification (MPD), and the more general NIEM Conformance Specification is required when developing a NIEM release, domain update, core update, IEPD (for an information exchange), or an EIEM composed of Business Information Exchange Components (BIECs) and their associated artifacts.
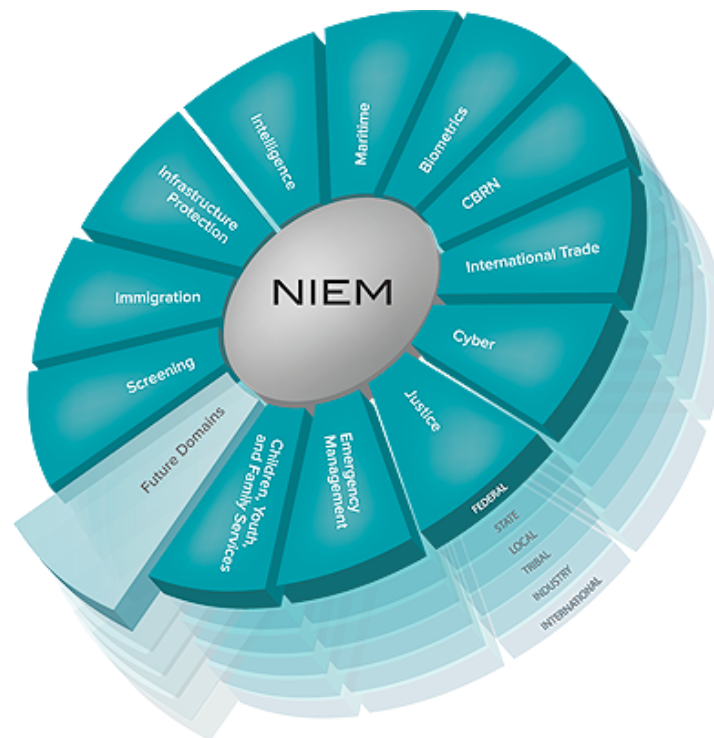

Figure 7, NIEM Core and Domains

4.3.1.2 NIEM Naming and Design Rules (NDR)

Reference document:

- **NIEM Naming and Design Rules (NDR), Version 1.3**
  http://www.niem.gov/pdf/NIEM-NDR-1-3.pdf

The NIEM Naming and Design Rules (NDR) document specifies how XML Schema documents are prepared for use with the National Information Exchange Model (NIEM). NIEM is an information sharing framework based on the World Wide Web Consortium (W3C) Extensible Markup Language (XML) Schema standard. In February 2005, the U.S. Departments of Justice (DOJ) and Homeland Security (DHS) signed a cooperative agreement to jointly develop NIEM by leveraging and expanding the Global Justice XML Data Model (GJXDM) into multiple domains.

The NDR document specifies principles and enforceable rules for NIEM data components and schemas. Schemas and components that obey the rules set forth here are considered to be NIEM-conformant.

4.3.1.3   NIEM Model Package Description (MPD) Specification

Reference document:
- **NIEM Model Package Description (MPD) Specification, Version 1.1**
  http://reference.niem.gov/niem/specification/model-package-description/1.1/model-package-description-1.1.pdf

The NIEM Model Package Description (MPD) Specification promotes consistency, ensuring all users know the basics of NIEM and how to best use it to meet business needs. The specification formalizes requirements around the packaging of information exchanges (IEPDs), domain and core updates to the data model, and enterprise information exchange models (EIEMs). It provides community users with assurance that when they use an information exchange (or domain update, core update, etc.), all required artifacts and documentation are available in a standard format.

The MPD Specification defines terminology, identifies both required and optional artifacts, describes schemes and syntax, and provides guidance to develop these artifacts. The rules and guidance described in the specificaiton are designed to encourage NIEM use by balancing consistency, simplicity, and flexibility, making MPDs easy to design correctly, build rapidly, and find easily. This flexibility allows developers to design MPDs for complex data requirements.

4.3.1.4   Information Exchange Package Documentation (IEPDs)

Reference document:
- **NIEM Model Package Description (MPD) Specification, Version 1.1**
  http://reference.niem.gov/niem/specification/model-package-description/1.1/model-package-description-1.1.pdf

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 define and describe 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.

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

Reference document:
- **NIEM Model Package Description (MPD) Specification, Version 1.1**
  http://reference.niem.gov/niem/specification/model-package-description/1.1/model-package-description-1.1.pdf
- **IEM-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. Specifically, the file structure is shown in Figure 8:

- *catalog.xml is a machine-readable list of files included in the EIEM, conformant to the MPD specification.*
- *catalog.xsl provides a human-readable rendering of the catalog.xml document.*
- *catalog.html and metadata.xml are generated from catalog.xml in order for the EIEM to be supported by non-MPD-aware tools.*
- *changelog.pdf lists changes in the EIEM.*
- *master-document.pdf is this document.*
- *XMLSchemas*
    - *extension*
        - *external/ISMV6*
            - *This folder contains the IC-ISM V. 6 schemas, which are treated as NIEM external schemas.*
        - *mda/3.0*
            - *mda.xsd is the EIEM extension schema.*
        - *mda-codes/3.0*
            - *mda-codes.xsd is the EIEM codelist schema.*
    - *subset*
        - *wantlist.xml is the list of components reused from NIEM.*
        - *niem*
            - *This folder contains the NIEM subset used in the EIEM.*

Figure 8, NIEM MPD File Structure

4.3.1.6   NIEM-UML Profile

- **Object Management Group (OMG) ® Unified Modeling Language (UML) Profile for NIEM**
  http://www.omg.org/spec/NIEM_UML/

The Unified Modeling Language (UML) Profile for NIEM, also known as NIEM-UML, is an emerging standard being developed for NIEM by the Object Management Group (OMG) to assist in modeling and development of information exchanges with NIEM. The NIEM-UML profile is currently an OMG Adopted Beta Specification.

The following paragraphs provide an overview of this UML profile as described in the current version of the NIEM-UML specification.

UML has been chosen to represent NIEM as part of the NIEM Program Management Office's (PMO) strategy in support of the NIEM community and intended to broaden NIEM adoption and in aligning to industry standards. NIEM-UML embraces the Model Driven Architecture (MDA) ® standards of the Object Management Group (OMG) ® to facilitate the separation of concerns between business needs and technology implementations.

NIEM-UML is designed to allow modelers and developers to apply NIEM-UML with minimal effort in order to create new models or change existing models and ultimately to produce NIEM MPD artifacts.

When modeling information exchanges, there are two distinct sets of requirements that lead to two approaches to modeling.

- Business requirements of an organization
    - This set is relatively constant and consistent over time and entails modeling the capabilities the organization has, the processes the organization employs and the information the organization leverages.
- Technical implementation of an organization
    - capabilities, processes and information and varies as platforms and technologies change.

These approaches are defined by Model Driven Architecture (MDA®) as the Platform Independent Model (PIM) and the Platform Specific Model (PSM) approaches, respectively. The "platform" for NIEM is considered to be XML Schema structured according to the NIEM Naming and Design rules (NDR) for XML Schema.

NIEM-UML Profile consists of four sub-profiles, as shown in Figure 9. Each sub-profile is a subset of UML 2.4 constructs that are extended by UML stereotypes. The subset identifies those NIEM v2.1 concepts for which an analogous representation exists in UML.
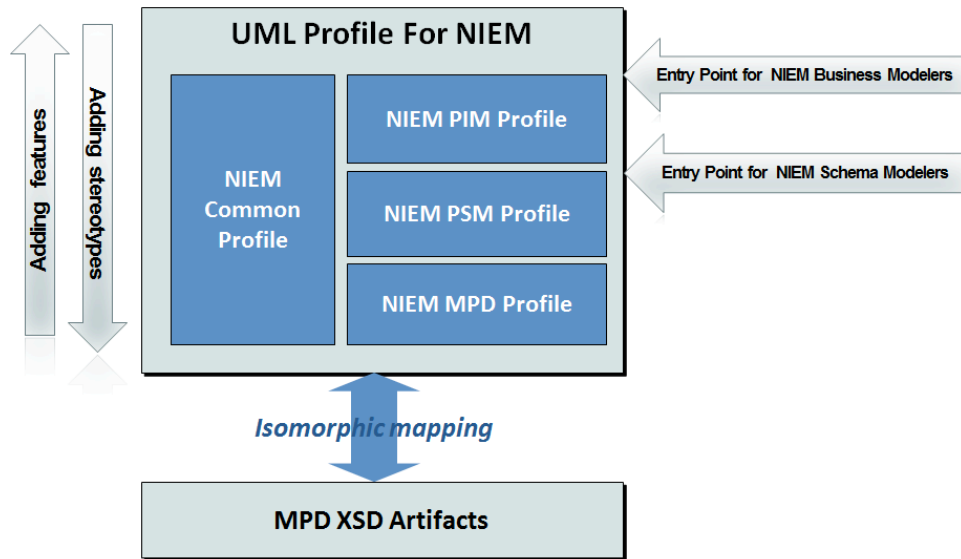

Figure 9, Components of the NIEM-UML Specification[4]

Additional details about the NIEM-UML profile may be obtained here: http://www.omg.org/spec/NIEM_UML/

4.4   UCore

Universal Core (UCore) is a US national security and preparedness initiative led jointly by the Department of Defense (DoD), Department of Justice (DOJ), Department of Homeland Security (DHS) and the Office of the Director of National Intelligence (ODNI) staffs. It is designed to improve information sharing between federal, state, regional, local governments, civil and non-governmental organizations, as well as our coalition partners and allies. The initiative focuses on improving national readiness and international security by developing a common technical approach to inter-agency information sharing.

The UCore Conceptual Data Model (CDM) is depicted in Figure 10. It is composed of two parts, the UCore Vocabulary and message framework. The area bounded by the dotted line represents the UCore Vocabulary. This Vocabulary describes concepts universally understood across domains and includes associated metadata. The area bounded by the solid line represents the UCore Message Framework, which provides an approach for information sharing, supports levels of understanding, and incorporates a construct for structured extensions of the UCore Vocabulary.

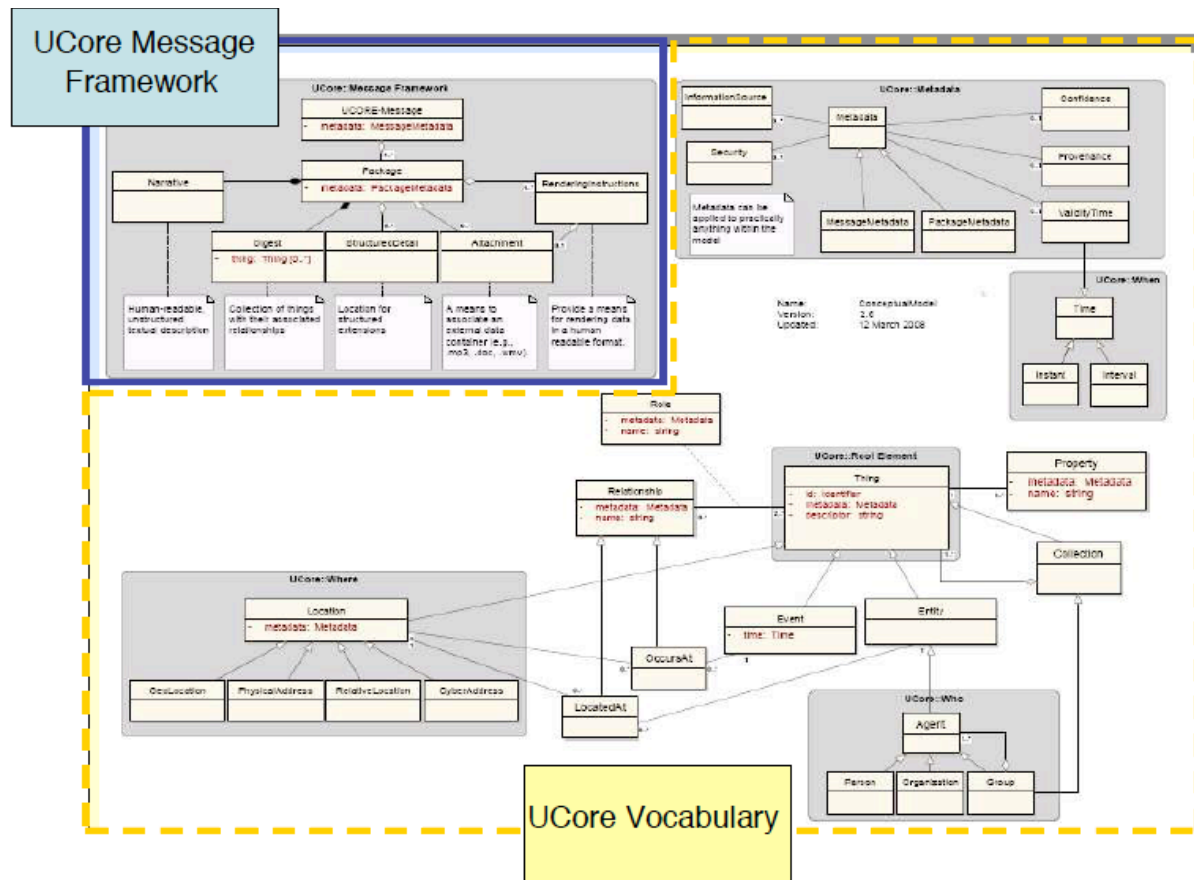[4] UML Profile for NIEM (NIEM-UML), July 2012 (Beta 1)

Figure 10, UCore Conceptual Data Model

The UCore Vocabulary portion of the CDM depicts the concepts What, When, Where, Who and associated metadata.

UCore leverages the following commercial and government standards:

- **Intelligence Community Information Security Markings (IC ISM)** - IC ISM is an XML implementation consisting of a set of attributes that may be used to associate security related metadata with XML elements in documents, web-service transactions, or data streams. UCore incorporates IC ISM throughout to enable the security tagging at a variety of levels.
- **DoD Discovery Metadata Specification (DDMS)** - UCore reuses elements defined within the DDMS which defines discovery metadata elements for resources posted to community and organizational shared spaces.
- **Geography Markup Language (GML)** - UCore leverages the GML profile defined by DDMS as a standard format to define geographic location data.

5   Computational Viewpoint

The computational viewpoint is concerned with the functional decomposition of the system into components, which allow clients and servers to interact at interfaces. This viewpoint captures the details of these components and interfaces without regard to actual distribution.

5.1   Overview

This Geo4NIEM initiative is being conducted to develop, test and demonstrate enhanced geospatial capabilities for NIEM. These efforts will use application software or software components contributed by participants and sponsors to produce and consume XML schema documents that conform to IEPs identified in Section 3.2. The objective of this initiative is not to develop a prototype system of components for an end-to-end exchange using information contained in an NIEM conformant IEPD schema instance document.

The following diagram shows the transfer of files between components in Geo4NIEM. The specific method for transferring of files is not prescribed and can be chosen by the participants, e.g., ftp, e-mail attachments, dropbox, etc. For this phase of Geo4NIEM the focus is on the content of the files and not web services. It may be useful for demonstration purposes that the content be made available, e.g., using WFS.
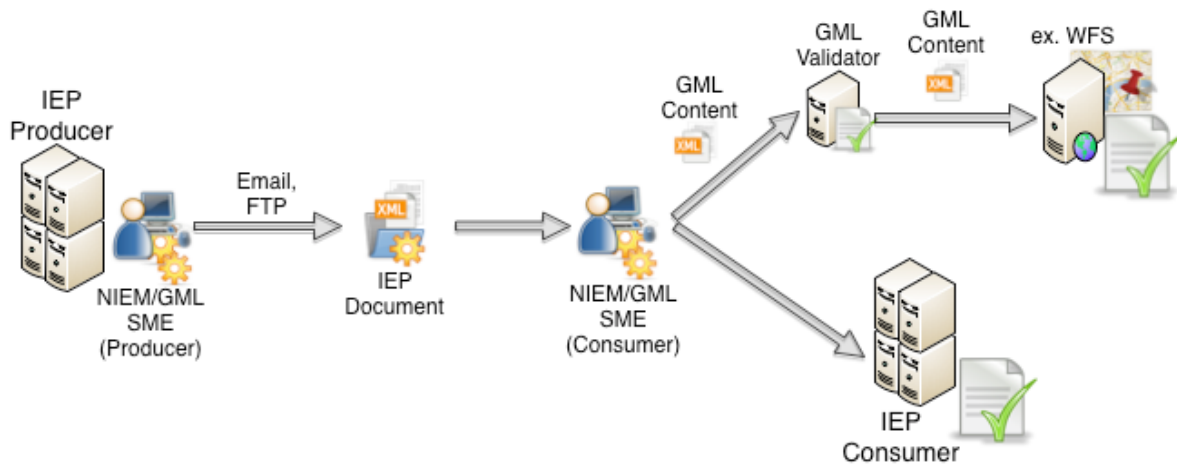

Figure 11, Computational Process - notional

Contributions of application software and tools that would become participants in the Computational Viewpoint will be identified and refined during the Geo4NIEM Task Initiation Workshop.

The service standards identified below represent examples service components that *might* be a part of application software used in development and testing of XML schema and instance documents associated with the IEP exchanges to be tested.

5.2   OGC Service Standards

This section identifies OGC web service standards that handle data types, standards, and other geospatial information sources that may be involved in use cases and specified in the Enterprise Viewpoint. These standards represent services and protocols that may be applicable in operational contexts, which use the information exchanges described in Section 3.2. A partial list follows:

Interface Standards:

- OpenGIS ® Web Map Service (WMS)
- OpenGIS ® Web Feature Service (WFS)
- OpenGIS ® Web Feature Service – Transactional (WFS-T)

5.2.1 Web Mapping 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.

When client and server software implements WMS, any client can access maps from any server. Any client can combine maps (overlay them like clear acetate sheets) from one or more servers. Any client can query information from a map provided by any server.

In particular WMS defines:

- How to request and provide a map as a picture or set of features (GetMap)
- How to get and provide information about the content of a map such as the value of a feature at a location (GetFeatureInfo)
- How to get and provide information about what types of maps a server can deliver (GetCapabilities)

5.2.2 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.

5.2.3 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   Engineering Viewpoint

The Enterprise, Information, and Computation viewpoints describe a system in terms of its purposes, its content, and its functions. The Enginering viewpoint specifies the design "solution" to problems posed by applying the information and computation elements of the architecture to the requirements of the use cases.

For this Geo4NIEM initiative, the Engineering viewpoint is largely schematic and notional in nature. Details will be developed and refined based on responses to the RFQ/CFP and then as the result of design, implementation, experimentation, and problem-solving during the course of the initiative.

7   Technology Viewpoint

The technology viewpoint is concerned with the deployed system, describing the hardware and software components used. This architectural view will not be addressed during the course of this Geo4NIEM initiative.

Appendix A: Geo4NIEM Architecture References

Refer to the OGC website (http://www.opengeospatial.org/specs/?page=baseline) for the authoritative listing of adopted documents.

Note: Please contact the OGC Tech Desk if you need assistance in gaining access to these documents (techdesk@opengeospatial.org).

OGC Specifications and Supporting Documents Relevant to Geo4NIEM:

1) OpenGIS® Geography Markup Language (GML) Implementation Specification (version 3.0), available at: http://www.opengeospatial.org/specs/?page=specs

2) Geography Markup Language (GML) simple features profile (with Corrigendum), (OGC 10-100r3) http://portal.opengeospatial.org/files/?artifact_id=42729

3) OGC® Geography Markup Language (GML) — Extended schemas and encoding rules, Version 3.3 (OGC 10-129r1) https://portal.opengeospatial.org/files/?artifact_id=46568

4) OpenGIS® Web Map Service (WMS) Implementation Specification, version 1.1.1, available at: http://www.opengeospatial.org/specs/?page=specs

5) OpenGIS® Map Context Documents Implementation Specification, version 1.0, available at: http://www.opengeospatial.org/specs/?page=specs

6) OpenGIS® Web Feature Server (WFS) Implementation Specification, version 1.0, available at: ***http://www.opengeospatial.org/specs/?page=specs***

Other OGC Specifications and Supporting Documents

7) OpenGIS® Abstract Specification Topic 11: OpenGIS® Metadata (ISO/TC 211 DIS 19115) May 2001, <http://www.opengeospatial.org/techno/abstract/01-111.pdf>

8) OpenGIS® Abstract Specification Topic 12: OpenGIS® Service Architecture (Version 4.3), Percival, G. (ed.), January 2002, < http://www.opengeospatial.org/techno/abstract/02-112.pdf>

9) OGC Cookbooks website: http://www.opengeospatial.org/resources/?page=cookbooks

10) OGC Interoperability Program Concept Development Policies and Procedures" (also available from http://www.opengeospatial.org/ogc/policies/ippp), Percivall, George. 2005

ISO Specifications

11) ISO 19101:2002 (Reference Model): http://webstore.ansi.org/ansidocstore/product.asp?sku=ISO+19101:2002

12) ISO 19107 (Spatial Schema) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19107_(E).pdf

13) ISO 19108 (Temporal Schema) : http://www.isotc211.org/protdoc/DIS/DIS19108.pdf

14) ISO 19109 (Rules for Application Schema) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19109_(E).pdf

15) ISO 19115 (Metadata) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19115_(E).pdf

16) ISO 19119 (Services) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19119_(E).pdf

17) ISO 19125-1 (Simple Features Access - Part 1: Common Architecture):
http://www.isotc211.org/protdoc/DIS/DIS19125-1.pdf

18) ISO 19125-2 (Simple Features Access - Part 2: SQL option):
http://www.isotc211.org/protdoc/DIS/DIS19125-2.pdf

Other Related Specifications:

19) Uniform Resource Identifiers (URI): Generic Syntax (RFC 2396) T. Berners-Lee, R. Fielding, L. Masinter, available at: http://www.ietf.org/rfc/rfc2396.txt

20) Extensible Markup Language (XML) 1.0, Second Edition, Tim Bray et al., eds., W3C, 6 October 2000. See http://www.w3.org/TR/2000/REC-xml-20001006

21) XML Schema Part 1: Structures. World Wide Web Consortium (W3C). W3C Recommendation (2 May 2001). Available [online]: http://www.w3.org/TR/xmlschema-1/

22) XML Linking Language (XLink) Version 1.0, DeRose, S., Maler, E., Orchard, D., available at http://www.w3.org/TR/xlink/

Related Supporting Documents:

23) Reference Model of Open Distributed Processing [ISO/IEC 10746]