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Request For Quotation

And

Call For Participation

In the

OGC EMPIRE CHALLENGE 2009 INTEROPERABILITY PILOT (EC09 IP)

Annex B: EC09 IP Architecture

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Table Of Contents

Annex B: EC08 Pilot Architecture

1 Introduction

The EC09 Pilot is specifically focused on implementation, test and demonstration of SOA patterns and standards-based Web services for geospatial data handling. The EC09 Pilot Architecture presented in this Annex is based upon the collaborative efforts of the EC09 Pilot Sponsors, OGC's IPTeam and participants of the EC08 Pilot Project. The EC09 Architecture described in this Annex will ultimately be realized through collaborative engineering activities executed as part of the EC09 Pilot Project. The EC09 Architecture presented here is based directly on previous works prepared for Empire Challenge, specifically:

- *EC08 Concept Architecture* [1]
- *EC08 Pilot As-Built Architecture*[2]

The *EC08 Concept Architecture* captures the essential architectural details of a to-be ISR architecture based on established SOA principles and OGC standards. The EC08 Concept Architecture cataloged a series of use cases that comprise the Operational Activity Model (OV-5) for the EC08 Pilot initiative. The use cases decomposed both the JP 3-60 deliberate adaptive targeting cycle and the popular Plan, Find, Fix, Track, Target, Engage, Assess (P-F2T2EA) model for time-sensitive targeting. The use cases proved useful in identifying relevant actors, assumptions, activities, and typical activity sequences. This document references and builds on those use cases and the other key concepts elaborated in the EC08 Concept Architecture. This document, however, brings a level of realism to the architecture as all the components and capabilities described herein were implemented, tested and demonstrated during the execution of the EC08 Pilot project.

The *EC08 Pilot As-Built Architecture* describes parts of the EC08 Architecture as implemented, deployed and demonstrated for the OGC EC08 Pilot project that concluded during the Empire Challenge 2008 (EC08) demonstrations in July 2008. This document collects a series of architectural artifacts designed to describe key aspects of the EC08 Pilot, highlighting where open geospatial technology and standards can be leveraged toward the greatest gain. It captures the details of the as-built capabilities with the EC08 operational node infrastructure, functions of expected systems and the structure of COTS products and other technologies that support or otherwise implement OGC specifications. DoDAF artifacts are used to articulate the various dimensions of the architecture.

Appendix A, Concept Architecture, of this Annex is comprised of references to the EC08 Concept Architecture and supporting materials.

Appendix B, EC08 Pilot Materials, of this Annex is comprised of references to the EC08 Pilot As-Built Architecture, supporting briefings, and other materials.

Appendix C, EC09 Pilot Specification Baseline, of this Annex is comprised of references to documents comprising the interoperability specification baseline for the project.

[1] *EC08 Concept Architecture* link available in Annex A.

[2] *EC08 As-Built Architecture* available to non-members on request. Send query to techdesk@opengeospatial.org

2 Enterprise Viewpoint

The enterprise viewpoint describes business perspective, purpose, scope and policies.

2.1 Overview

The goal of the EC09 Pilot project is to validate open geospatial technologies and standards for specific ISR capabilities suitable for insertion into the EC09 program. As with the EC08 Pilot, the results of this pilot will drive future Empire Challenge activities for insertion of standards-based SOA standards and technologies.

This document contains a set of use cases that describe activities associated with the EC09 Joint Mission Threads (JMT), specifically the Multi-Domain Awareness thread. As in EC08, we again stress the use of Motion Video as it is expected to figure prominently in the EC09 sensor architecture.

This annex contains architectural artifacts designed to describe key aspects of the expected EC09 Pilot and highlight where open geospatial technologies and standards can be leveraged toward the greatest gain. The methodology used to extend and adapt these architectural products as the nature of EC09 becomes better defined is also described herein. This information thereby provides system context for insertion, into the EC09 demonstration environment, of technologies that implement and support the NGA Spatial Data Infrastructure 1.0 (SDI 1.0) profile of OGC Web Services (OWS) specifications and the OGC Sensor Web Enablement (SWE) family of specifications.

Figure 1 represents a high level system concept view of target systems and components to be deployed for the OGC EC09 Pilot. While subject to significant changes, the figure identifies network domains, external systems, and abstracts the specific deployment topologies of the target architecture.

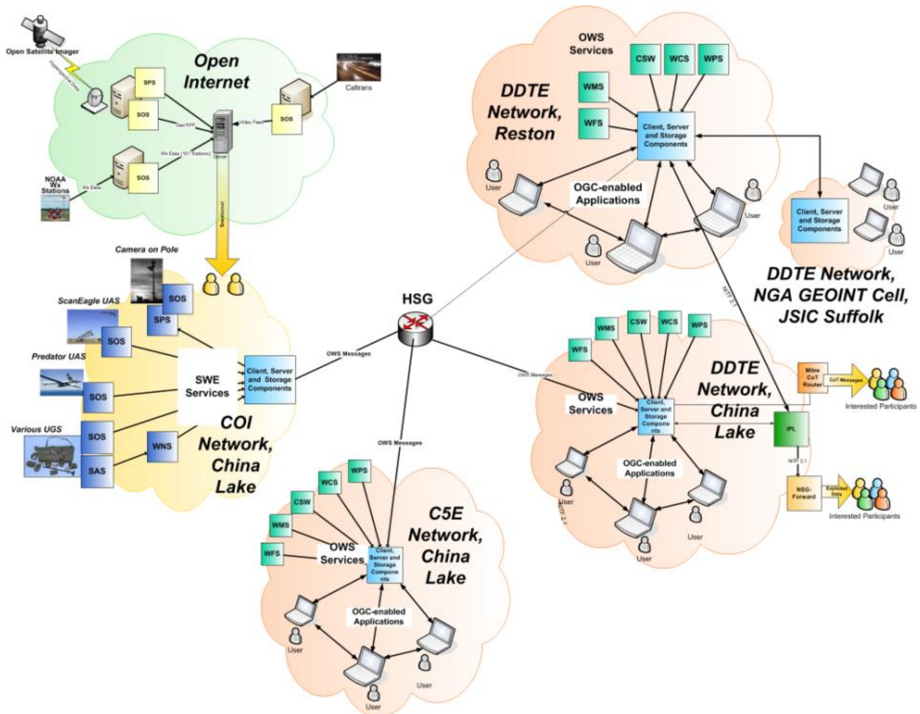


Figure 1. High-Level System Concept

2.2 Stakeholders and participants

2.2.1 Stakeholders

EC09 Pilot stakeholders include:

- U.S. Intelligence Community
- DoD components
- Coalition partners
- NATO

2.2.2 DCGS Providers

The Distributed Common Ground Systems (DCGS) is the existing family of enterprise architectures with which the sensor systems will interact in order to realize a DoD network centric environment. It includes the following concepts:

- Sensor data repositories

- Data discovery and retrieval
- Technical standards

This pilot project is concerned with defining, implementing and demonstrating DCGS interfaces based on OGC standards.

2.2.3 Implementers

An important aim of OGC interoperability intiatives such as the EC09 Pilot is to involve OGC members (vendors, developers, researchers and others) in collaboratively solving interoperability problems which arise in the course of actually applying OGC standards.

2.3 Use Cases

The following use cases were selected because they represent a logical, sequential means to expose the core activities we expect to see performed during the EC09 evolution and the underlying interoperability and adaptability of a true standards-based SOA architecture. The use cases represent a repeatable activities that a users or "actors" perform when using the system. A use case typically includes one or more "steps" which describe the interactions that go on between the Actor and the System, and documents the results and exceptions that occur from the user's perspective. Use cases may include other use cases as part of a larger pattern of interaction and may also be extended by other use cases to handle exceptional conditions.

2.3.1 System Actors

There are many actors involved in the C4ISR enterprise and those thought to specifically support the Find-Fix-Track-Target-Engage-Assess (F2T2EA) use cases of the EC08 Concept Architecture are listed here:

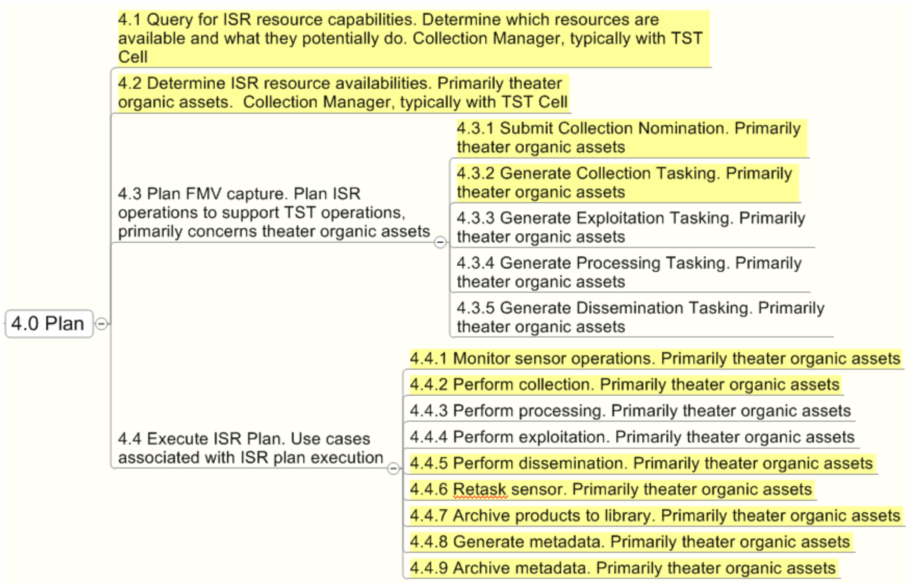
Collection Manager(s)	Track Manager(s)	Targeteer(s)
Execution Manager(s)	Exploitation Analyst(s)	Combat Assessment Analyst(s)
ISR Operations Staff	ISR Resource(s)	ISR Resource Mission Manager(s)
ISR Resource Operator(s)	Engagement Mission Planners	Legal Staff
Unanticipated User(s)	Resource Owner/Sponsor	Engagement System
Engagement System Operator(s)	Product Archive	Shared Track Database
Shared Targeting Database	Electronic Target Folder	ISR Capability Catalog
Commercial ISR Resource	Coalition ISR Resource(s)	Remoted ISR Resource(s)
Secured ISR Resource(s)	Incompatible ISR Resource(s)	

The reader is referred to the EC08 Concept Architecture for more detailed description of these actors and an explanation of their role in F2T2EA use cases.

2.3.2 Use Case 1: ISR Planning

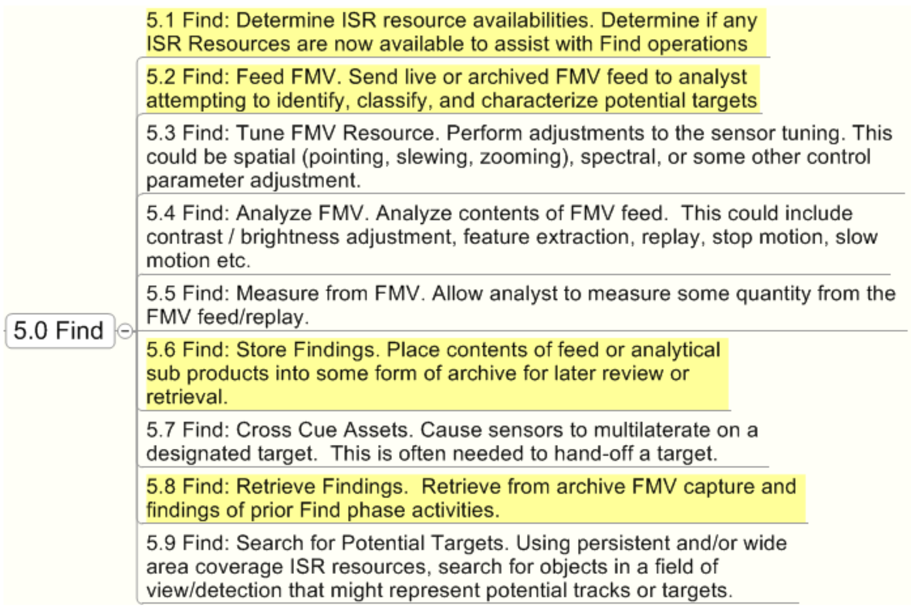
These use cases describe ISR interactions during the Plan phase of dynamic targeting. The Plan phase usually involves characterizing the TST environment, defining the rules of engagement, and planning ISR resource utilization to cover expected target activity and engagement dynamics. Each of the use cases and sub-cases are more fully described in the Part 2, Use Case Exposition, volume of the EC08 Concept

Architecture. Cases highlighted in yellow show particularly strong potential for open geospatial technology insertion.



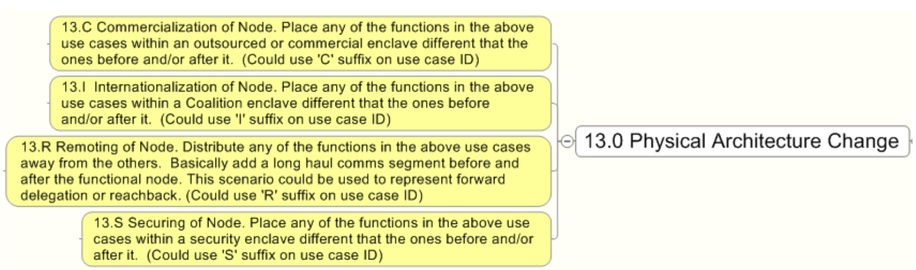
2.3.3 Use Case 2: ISR Finding

These use cases describe ISR interactions during the Find phase of dynamic targeting. The Find Phase attempts to identify, classify, and characterize potential targets. Each of the use cases and sub-cases are more fully described in the Part 2, Use Case Exposition, volume of the EC08 Concept Architecture. Cases highlighted in yellow show particularly strong potential for open geospatial technology insertion.



2.3.4 Use Case 3: Securing an ISR Node

These use cases deal with generic perturbations to the greater C4ISR enterprise. Interest here is specifically in the 13.R, Remoting of Node, and 13.S, Securing of Node, use cases. Each of the use cases and sub-cases are more fully described in the Part 2, Use Case Exposition, volume of the EC08 Concept Architecture. Cases highlighted in yellow show particularly strong potential for open geospatial technology insertion.



The following provides additional detail for use case 13.S. This is a case that must be addressed in the EC09 Pilot. OWS request and response messages (XML encodings with optional inline or out-of-band data) will ultimately need to be accredited to pass between security domains via the High Speed Guard (HSG) technology of the EC09 architecture. This use case outlines an initial (early) capability that will be used to develop feasible profiles of OWS specifications and test interoperability in a multiple enclave environment such as DCGS.

Sending Data Across Security Domains

Summary

During this demonstration it will be necessary securely exchange information between different security enclaves. A High Speed Guard will be used to facilitate this cross security domain information sharing. Cursor on Target, TML

Preconditions

External entity had discovered the location of necessary data via DIB and/or CS/W

Triggers

A request for data has been received from an external domain

Basic course of events

1) A request for sensor data is received by demonstration data store component. The source of the request is determined to be from a different security domain via the HSG

2) The request is handled and specific data is retrieved.

3) The requested data is sent to the HSG

4) The HSG receives the data, parses the content and approves/disapproves forwarding of content

5) If the content has been approved for transfer to the destination network, then the data if forwarded to the requestor

Post conditions

Notes

Without standardized sensor metadata and message payloads it is infeasible for a client or intermediate process to utilize data from a heterogeneous network of sensors and services.

2.4 System Functions

In Section 7.1 of the EC08 Concept Architecture, a short list of key system functions is identified and a conceptual realization as an inter-working set of system services is explained. The key systems functions are listed in the table below. For purposes of EC09 Pilot, this is the system function inventory for the capability to be demonstrated in support of ISR activities identified in the use cases above. Refer to Appendix A and Appendix B of this Annex for more information.

7.1.2 Sensor System
7.1.2.1 Sensor Advertising
7.1.2.2 Sensor Capability Discovery
7.1.2.3 Collection Nomination and Tasking
7.1.2.4 Sensor Data Collection, Alert and Forward
7.1.3 Information Management System
7.1.3.1 Store and Process
7.1.3.2 Retrieve: Access and Distribute
7.1.3.3 Advertise: Notify and Catalog
7.1.4 Analysis System
7.1.4.1 Discover Resources (Sensors and Data)
7.1.4.2 Open Channel for Live Video
7.1.4.3 Tune ISR Resource
7.1.4.4 View, Measure and Analyze ISR Observations
7.1.4.5 Store Findings
7.1.4.6 Cross-cue Assets
7.1.4.7 Retrieve Findings
7.1.5 Exploitation System
7.1.5.1 Discover Resources (Sensors and Data)
7.1.5.2 Open Channel for Live Video
7.1.5.3 Tune ISR Resource
7.1.5.4 View, Measure and Analyze ISR Observations
7.1.5.5 Store Findings
7.1.5.6 Cross-cue Assets
7.1.5.7 Retrieve Findings

Table 1. System Function Inventory

2.5 Data Rights

The acknowledgement, transfer, reservation, and exercise of usage rights on geospatial data are an important but complex topic of numerous OGC testbed threads and other activities. Most of these concerns are beyond the scope of the IP; however there should be nominal coverage of some of these concerns, at least as a placeholder for future work.

2.5.1 Terms of Use

The OGC Empire Challenge 2009 Pilot will be initially organized around the unclassified OGC Network and access will be provided to all selected participants. Participants will need to agree to the terms and conditions stated on the OGC Network portal.

Subsequently the Empire Challenge demonstration will be conducted in a classified environment. Selected participants will need to go through an approval and certification process in order to participate in the classified demonstration. It will be necessary for participants to agree to the terms and conditions associated with the security policies of the networks which they will be accessing.

2.5.2 Access Control

Control of access to application functions and service operations is also a complex and “live” topic, particularly its spatial and granular aspects. For the purposes of this pilot program, a coarse-grained access control accomplished using the above Basic Authentication should suffice.

3 Information Viewpoint

3.1 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.

In this case, the specifics of the information viewpoint will be developed as a work item of the Pilot. The information viewpoint will be augmented to take into account the existing information models/schema. Key elements of the information model are identified here. Refer also to section 6.3 of the EC08 Concept Architecture[Error! Bookmark not defined.] for description of ISR data objects and OGC conceptual schema and specifications.

3.2 Sensor Schema

In order to facilitate describing sensor systems and sensor observations it will be necessary to define schemas using SensorML, TransducerML and O&M. Appendix A establishes the standards baseline to be used for this pilot.

3.3 Sensor and Observation Metadata

Metadata is data about data. Data producers use metadata elements and schema to characterize their geographic data. Metadata enables the use of geographic data in the most appropriate and efficient way by knowing its basic characteristics. Metadata facilitates data discovery, retrieval and reuse. Metadata also enables users to determine whether geographic data in a holding will be of use to them.

Metadata is applicable to independent datasets, aggregations of datasets, sensors, and sensor systems, as well as their state and appropriate behavior. Pilot participants will design and implement the metadata needed to facilitate the use cases described above.

3.4 Service Metadata

The most basic operation an information service must provide is the ability to describe itself. The services implemented in this project shall follow the OGC standard of providing a service operation called *GetCapabilities* that offers a rich set of service-level metadata to the caller. This is described generally in the *OGC Web Services Common Specification*. Service-specific metadata is described in the specification document for the particular service being implemented.

3.5 Key OGC Data Objects

This section highlights key OGC information model elements that are considered most relevant to the C4ISR domain and the EC09 demonstration priorities. These information model elements are fully documented in their respective OGC implementation specification and relevant OGC Abstract Specification topic volumes.

3.5.1 Geography Information Elements

See Section 6.3.2.1, Geography Information Elements, of the EC08 Concept Architecture.

4 Computational Viewpoint

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

4.1 OWS Service Framework Overview

Reference section 6.3.3, OWS Service Framework, of the EC08 Concept Architecture

4.2 Operational Service Interfaces

In Figure 2, a very high-level depiction of OWS components operating at notional DCGS nodes: an "Observation System Node" and an "Information Management System Node". OWS services and encodings are depicted within each.

Within the "Observation System Node" element, the OWS service components provide common services for nominating/tasking sensor resources and accessing the resulting ISR data products. These services present a normalized representation of collected data from sensors, sometimes unprocessed or only minimal processed, sometimes fully processed and ready for analysis and exploitation. The OWS components at this node expose a standard set of capabilities (system behaviors) and a normalized, well-known means for describing the data and representing it for access and sharing across networks.

Within the "Information Management System Node" element, OWS services provide common behaviors for processing and accessing data and normalized representations of the basic geospatial data types (Metadata, Coverage, and Feature).

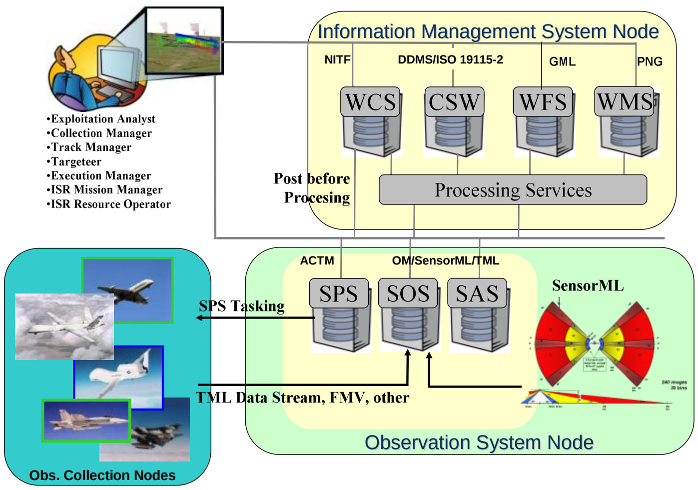


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Figure 2, SV1 - OGC Web Service View

Resource managers, analysts and decision-makers, through the common behaviors exposed by OWS components and normalized representations of the data, can access either the unprocessed, minimally processed or specially-processed data from the same application and can synthesize these data into new and dynamically changing information products that may, in turn, be stored, processed, shared and exploited.

4.2.1.1 SDI Framework

Reference section 6.3.3.1, SDI Framework, of the EC08 Concept Architecture

5 Engineering Viewpoint

The Enterprise, Information, and Computation viewpoints describe a system in terms of its purposes, its content, and its functions. The Engineering viewpoint relates these to specific components linked by a communications network. This viewpoint is concerned primarily with the interaction between distinct computational objects: its chief concerns are communication, computing systems, software processes and the clustering of computational functions at physical nodes of a communications network. The engineering viewpoint also provides terms for assessing the "transparency" of a system of networked components – that is, how well each piece works without detailed knowledge of the computational infrastructure.

In a sense, this viewpoint examines the specific engineering "solutions" to problems posed by applying the information and computation elements of the architecture to the requirements of the use cases. Aspects of these solutions involve choice of technology, but also involve development of specific component interactions and workflows which support the desired user interactions.

In the context of a concept plan, this viewpoint is largely schematic and outline in nature. Further details will be filled in and refined for the purposes of the RFQ/CFP and then as the result of design, implementation, experimentation, and problem-solving during the course of the pilot.

5.1 Components

The characteristics of classes of software component are defined here.

Reference section 6.4.1, Conceptual C4ISR Component Model, of the EC08 Concept Architecture

5.2 Protocols

5.2.1 HTTP Transport

Most interactions between distributed components in the EC08 Pilot will be via HTTP protocol, using the HEAD, GET, or POST methods.

5.2.2 Authentication & Authorization

Requirements for authorization will be determined at a later date. It is expected that this will involve using usernames and passwords exchanged via HTTP Basic, possibly using certificates and SSL-encrypted HTTP protocol for this purpose.

5.3 Workflows

5.3.1 Overview

Workflows are often the "solution" matching information transformations with user actions, particularly across distributed processing components.

5.3.2 Observations to Features Workflow

The workflow shown below characterizes a series of processes which add value to initial sensor observations to produce information used to facilitate decision support.

- Receipt of raw observations from sensors. These sensors could be on any type, ranging from in-situ motion sensors to space-born imaging sensors. In this pilot and associated demonstration there is a focus on FMV and as such the sensor systems will represent this thrust.
- Storing raw or minimally processed observations in a data repository. This SOS may be accessed by other systems and components which will perform process on this data.
- Schema transformations may be required to facilitate processing. Schema transformations facilitate converting from the data schema provided by the SOS or source system to the schema required by the processing system.
- Processing observations to produce actionable information
- Publish alerts based on sensor observations
- Dissemination of resulting features

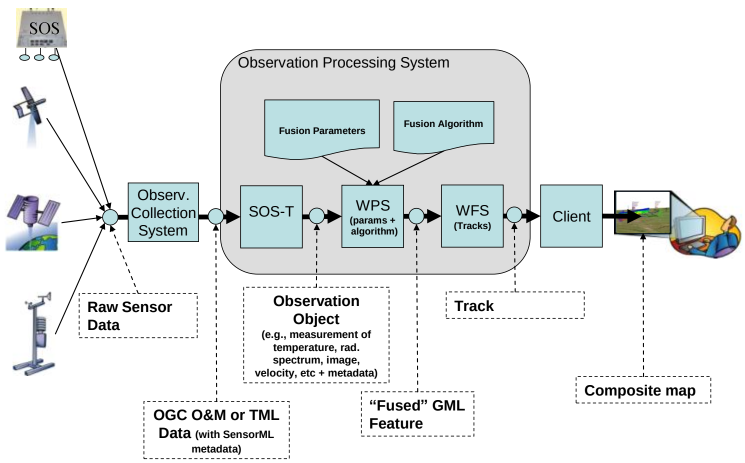

Figure 3, SWE Workflow

5.3.3 Tasking and Observation Access

The Sensor Planning Service (SPS) will be used to perform tasking of sensors. In all use cases tasking and feasibility assessment is performed through the same path. A tasking request will be made to a Sensor Net via the SensorWeb Data Center or other client. The SPS will respond indicating if and when the collection is possible.

Once the collection is complete there are two paths through which the observations can be accessed. The first option shown in figure 3 involves SPS providing a notification of collected data availability using WNS. In this case the associated observations are stored in an SOS local to the Observation System and are accessed by a client or agent at the SensorWeb Data Center which received notification of the observation availability.

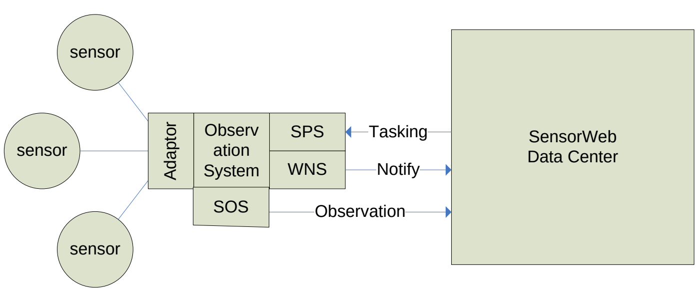

Figure 4 - SPS w/ SOS

The second option for accessing observations is shown in figure 4. This involves SPS tasking as before, but instead of the SPS publishing a notification of data availability, the observations are published directly to an external SOS-T. In this scenario the SOS-T is part of the SensorWebData Center. There would likely be an alerting mechanism, such as SAS, connected to the SOS-T which will notify subscribers of the new observation. Not requiring the Observation System to support publishing notifications and not maintaining a local SOS provides the advantage of allowing the Sensor Net to be simpler, but more tightly coupled with external components.

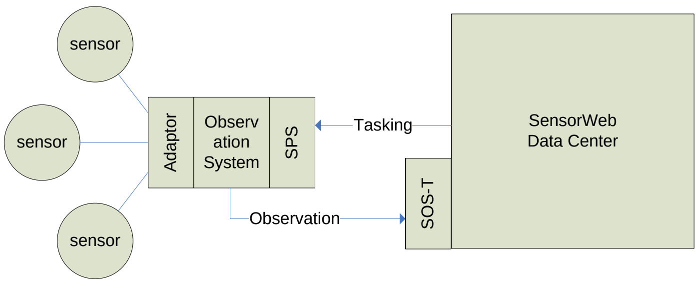

Figure 5 - SPS w/ SOS-T

5.3.4 Publishing Sensor Observations Across Domains

An important aspect of this demonstration is to assess how the SWE interfaces can interact with existing systems such as the High Speed Guard (HSG), DCGS Integrated Backbone (DIB) and DGGS in a multi-level security environment. It is expected that advancements will be made in this area during the pilot. The two fundamental uses cases involve having either a reference to data published to another domain or having both the metadata and observations being published. The first would involve a system like SensorWeb publishing sensor and observation metadata to a DIB and CS/W in a different security domain as shown in Figure 5. This metadata would be sent through a HSG. Once the metadata is out of the HSG it would then be published to the appropriate repository. In this case data may be published to the DIB and/or the CS/W. A short record may be included in the DIB which references a CS/W or a full record may be published to the DIB which reference the SWE or OWS service which is capable of providing the data. In either case it may be useful to use both the CS/W and DIB to facilitate use by a more diverse set of clients. Once a reference to the service has been obtained, the client will then make a request through the HSG for the actual data. The requested data will be returned to the HSG and eventually to the user. This approach potentially decreases the amount of data which needs to be transferred across the HSG, but increases the number of request sent back through the HSG. The feasibility of this approach will be driven by network topology, data volume and data access characteristics.

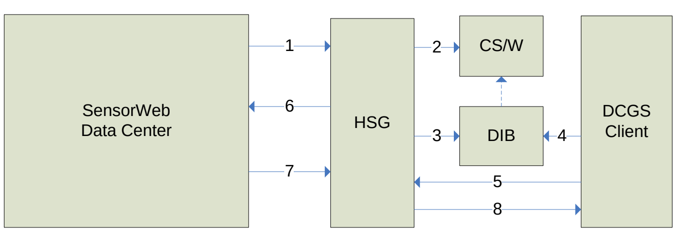

Figure 6 - Publish Reference to External Data

The other use case involves having the sensor or observation metadata and actual observation data published to an external security domain, depicted in Figure 6. This case involves all of the steps of the previous use case (transfer to HSG, publishing to DIB and CS/W) and includes the additional step of persisting the observation data to a SOS-T data store. The data references published to the DIB and CS/W will point to a data repository in the repository's security domain. This approach potentially increases the amount of data which is transferred across the HSG, and negates the need for a client to access an external domain to retrieve the observations. The feasibility of this approach will be driven by network topology, data volume and data access characteristics.

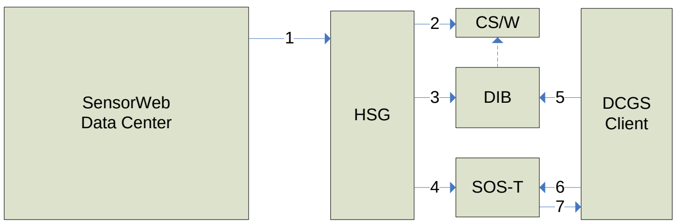

Figure 7 - Publish Reference to Local Data

It may be most effective to utilize a hybrid approach which is based on the data characteristics and primary use cases.

6 Technology Viewpoint

The technology viewpoint is concerned with the underlying infrastructure of a system, describing the hardware and software components used. The specific details of this architectural view will continue to be filled out throughout the course of the pilot work, culminating in the completed pilot report at the end of the project.

Reference section 6.1.2, DCGS "To-be", of EC08 Concept Architecture (see Appendix A).

Reference section 7, Implementation Scenarios, of EC08 Concept Architecture (see Appendix A).

Appendix A: Concept Architecture

The documents comprising the EC08 Concept Architecture are found on the OGC Portal (http://portal.opengeospatial.org) in the "Empire Challenge Architecture" folder of the "Defense and Intelligence WG" space:

1) "OGC Web Services (OWS) in Support of the C4ISR Enterprise," version 1.0, 26 November 2007. Available online at: http://portal.opengeospatial.org/files/?artifact_id=24137
2) "OGC Empire Challenge 08 Use Case Exposition," version 6.5, 5 November 2007. Available online at: http://portal.opengeospatial.org/files/?artifact_id=24138

Informative briefings presented at recent OGC TC meetings can be found on the OGC Portal:

1) "Empire Challenge OGC Pilot," 11 December 2007. Briefing presented to D&I WG at 63rd OGC Technical Committee Meeting in Stresa, Italy. Available online at: http://portal.opengeospatial.org/files/?artifact_id=25639
2) "OGC Specifications at Empire Challenge," 20 September 2007. Briefing presented to D&I WG at 62nd OGC Technical Committee Meeting in Boulder, Colorado (USA). Available online at: http://portal.opengeospatial.org/files/?artifact_id=23857

Appendix B: EC08 Pilot Materials

The document comprising the EC08 Pilot As-Built Architecture is found on the OGC Portal (http://portal.opengeospatial.org) in the "Empire Challenge Architecture" folder of the "Defense and Intelligence WG" space:

1) "EC08 Pilot As-Built Architecture," version 1.0, 25 September 2008. Available online on request.

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Appendix C : EC09 Pilot Standards Baseline

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).

The Technical Standards Profile identifies the standards that help implement and design the system architecture.

OGC Standards

Organization	Spec Name	Version	Spec ID	Date Published
OGC	Corrigendum for SensorML Version 1.0 schema; Corrigendum "a"	1.0.1	07-122r1	2007
OGC	CSW-ebRIM Registry Service - Part 1: ebRIM profile of CSW	1.0.0	07-110r2	2007
OGC	Web Coverage Service (WCS) Implementation Specification	1.1.1c1	07-067r2	2007
OGC	Observations and Measurements – Part 1 - Observation schema	1.0	07-022r1	2007
OGC	OpenGIS® Sensor Planning Service Implementation Specification	1.0	07-014r3	2007
OGC	Catalogue Services (CS-Web)	2.0.2	07-006r1	2007
OGC	Observations and Measurements – Part 2 - Sampling Features	1.0	07-002r3	2007
OGC	OpenGIS® Sensor Model Language (SensorML) Implementation Specification	1.0.0	07-000	2007
OGC	OGC Web Services Common Specification	1.1.0 w/Corrigendum	06-121r3	2006
OGC	Draft OpenGIS® Web Notification Service Implementation Specification (Best Practices Paper)	0.0.9	06-095	2006
OGC	OpenGIS® Web Map Server Implementation Specification	1.3.0	06-042	2006
OGC	OGC® Sensor Alert Service Implementation Specification	1.0.0	06-028r4	2007
OGC	OpenGIS® Transducer Markup Language (TML) Implementation Specification	1.0.0	06-010r6	2007
OGC	Sensor Observation Service	1.0	06-009r6	2007
OGC	OpenGIS® Filter Encoding Implementation Specification	1.1	04-095	2005
OGC	Web Feature Service Implementation Specification	1.1.0	04-094	2005
OGC	OpenGIS® Geography Markup Language (GML) Implementation Specification	3.1.1	03-105r1	2004

ISO Specifications

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

2) ISO 19110 (Methodology for Feature Cataloguing) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19110_(E).pdf

3) ISO 19111 (Spatial Referencing by Coordinates) : http://www.isotc211.org/protdoc/DIS/DIS19111.pdf

4) ISO 19112 (Spatial Referencing by Geographic Identifiers) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19112_(E).pdf

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

6) ISO 19117 (Portrayal) : http://www.isotc211.org/protdoc/DIS/ISO_DIS_19117_(E).pdf

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

8) ISO 19123 (Schema for Coverage Geometry and Functions): http://www.isotc211.org/protdoc/211n1227/readme.htm

9) ISO 19115-2 *Extensions for Imagery and Gridded Data*

10) ISO 19139 *XML Schema Implementation of ISO 19115:2003*

11) ISO 19130 Sensor and Data Models for Imagery and Gridded Data

STANAG

1) STANAG 7023 – NATO Primary Imagery Format

2) STANAG 7085 – Interoperable Data Link for Imagery

3) STANAG 4607 – NATO GMTI Format

4) STANAG 4609 – Motion Imagery

5) STANAG 4545 – NATO Secondary Imagery Format (NSIF)

6) STANAG 3277 – Aircraft Collection Tasking Message

7) STANAG 4633 – NATO Common Emitter Reporting Format

8) STANAG 4575 – NATO Advanced Data Storage (NADS)

9) STANAG 4559 – NATO Standard Imagery Library Interface

10) STANAG 7024 – Air Recce Tape Recorder Standard

Other Related Specifications:

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2) FGDC-STD-001-1988, Content Standard for Digital Geospatial Metadata (version 2), US Federal Geographic Data Committee, http://www.fgdc.org/metadata/contstan.html

3) ANSI/NISO Z39.50 Application Service Definition and Protocol Specification [ISO 23950 http://lcweb.loc.gov/z3950/agency/document.html]

4) IETF RFC 2109: HTTP State Management Mechanism
   http://www.w3.org/Protocols/rfc2109/rfc2109

5) IETF RFC 1729: Using the Z39.50 Information Retrieval Protocol in the Internet Environment [ftp://ftp.ietf.org/rfc/rfc1729.txt]

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

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

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

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14) Registry Services Specification v2.1. OASIS/ebXML Registry Technical Committee (Approved Committee Specification, June 2002). See http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=regrep