OGC

Appendix B, OGC EC08 Pilot

EC08 Pilot As-Built Architecture

Open Geospatial Consortium (OGC)

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1 Introduction

This document describes parts of the "as-built" 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. This document's purpose is to capture 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.

References are made throughout this document to the document that preceded it: the *EC08 Concept Architecture* [1] 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.

2 Systems Interface Description (SV-1)

The SV-1 Systems Interface Description represents a high level physical lay down of the system components deployed for the OGC EC08 Pilot, an initiative within the larger EC08 demonstration, specifically focused on implementation, test and demonstration of SOA patterns and standards-based Web services for geospatial data handling.

This section contains several SV-1 views. First, it contains a system concept view that identifies network domains, external systems, and abstracts the specific deployment topologies (Figure 1). Second, it contains a set of intra-nodal views that inventory devices, servers and workstations deployed in the various network domains for EC08. Last, it contains a set of detailed inter-nodal views that highlight key patterns and functions employed for a variety of deployments demonstrated during EC08.

[1] *EC08 Concept Architecture* available online at http://www.opengeospatial.org/standards/requests/46

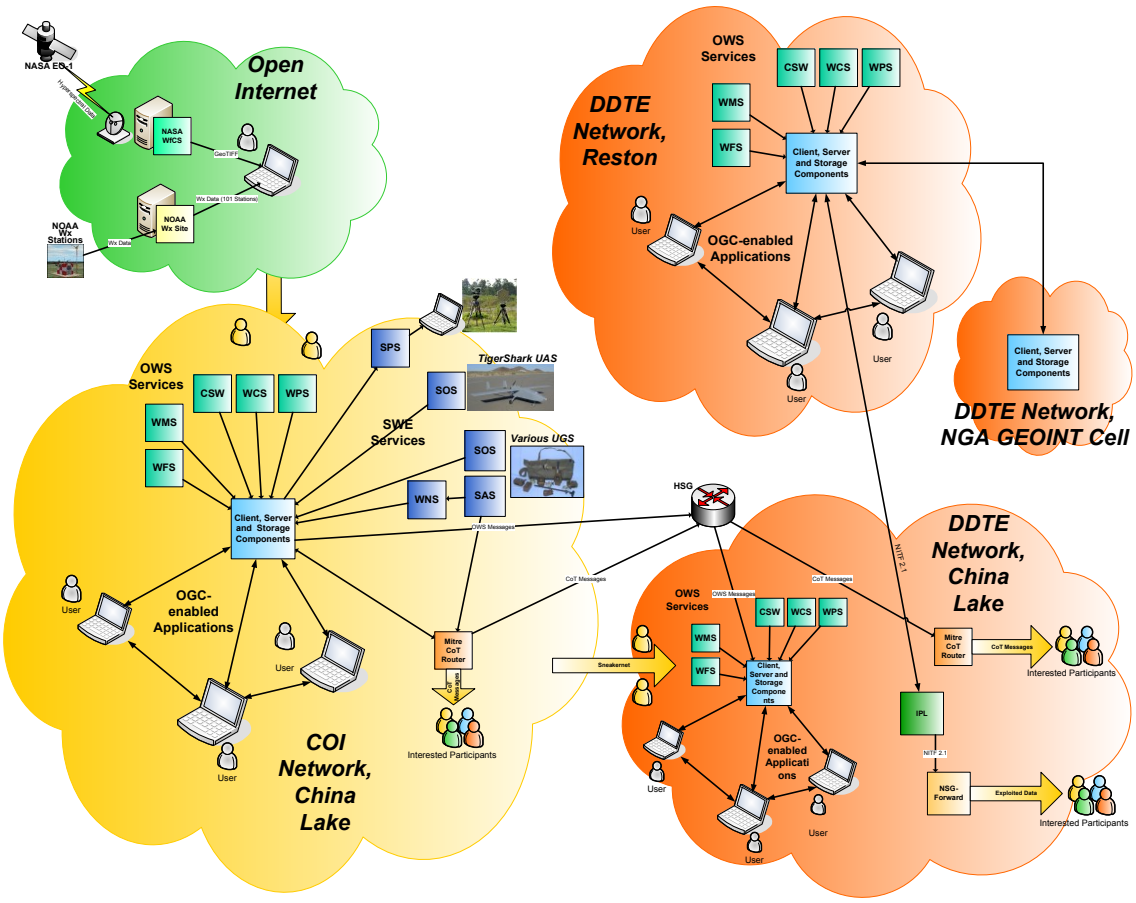

Figure 1. SV-1 System Concept

2.1 Intra-nodal Views

This section inventories deployment-specific components deployed within the key EC08 network domains at China Lake and Reston. Figure 2 below shows the deployed nodes (i.e., devices, servers, and workstations) and their relevant software components deployed on the unclassified "COI" network in China Lake. Links between nodes are not shown in this figure but will be identified and elaborated for specific deployments in the sections that follow.

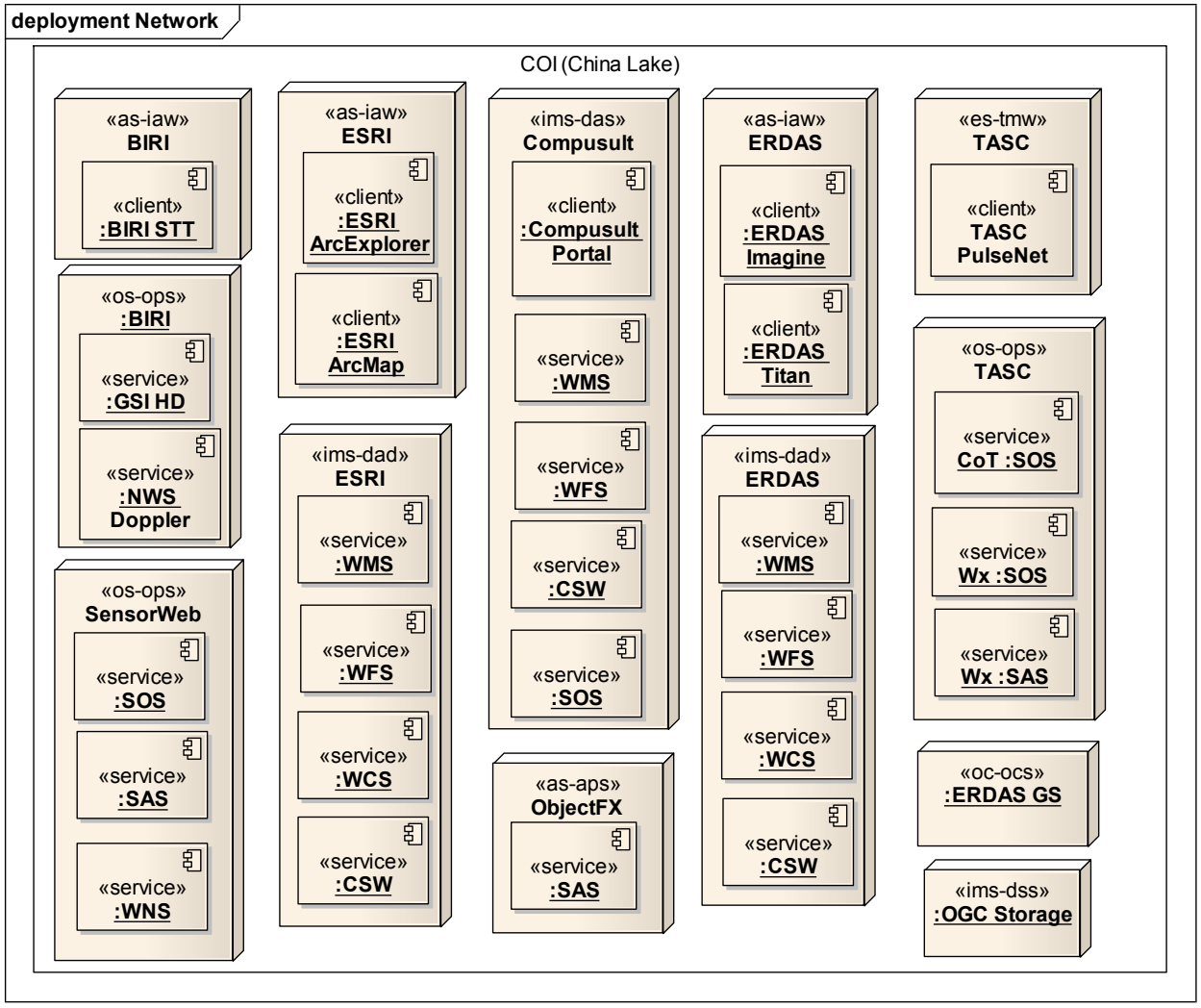

Figure 2. Nodes and Components Deployed on the COI Network, China Lake

Note that the 3d boxes using UML Deployment Model notation represent a node. A *node* is a physical piece of equipment on which the system is deployed, such as a workgroup server or workstation. A node usually hosts components and other executable pieces of code, which again can be linked to particular processes or execution spaces. Typical nodes are client workstations, application servers, mainframes, routers and terminal servers. The components contained within a node are identified as rectangular boxes. A *component* is a modular part of a system, whose behavior is defined by its provided and required interfaces; the internal workings of the Component should be invisible and its usage environment-independent.

Note that each node is labeled using UML stereotypes as a particular type of system, with specific roles and services for realizing system functions. Refer to Section 3 (SV-4) for explanation of the types of systems each of these nodes realize, their roles and functional decomposition.

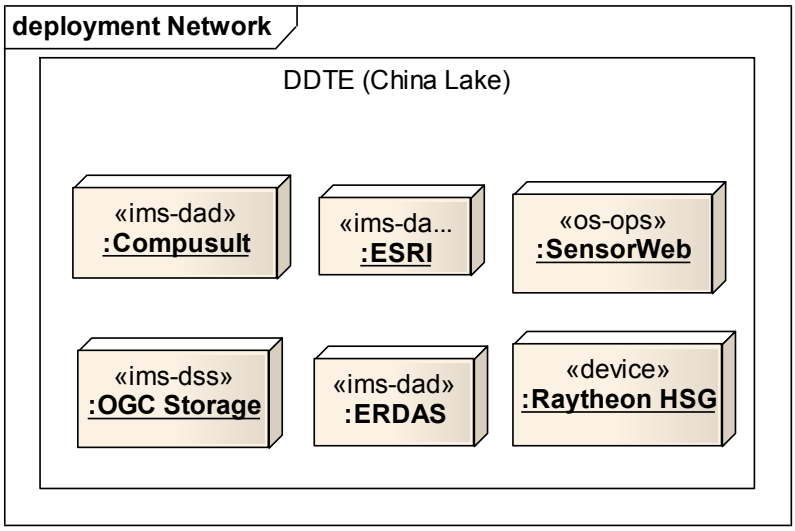

Figure 3. Nodes and Components Deployed on theDDTE Network, China Lake

Figure 3 identifies the nodes deployed within the classified DDTE network at China Lake. Note that, for brevity, the components for each of the nodes listed in the figure are not shown as they are the same as those nodes listed in Figure 2.

Figure 4 shows the nodes and their relevant constituent components deployed within the classified DDTE network at Reston Virginia. As in the preceding figures, no linkages are shown between nodes or components in this intra-nodal view.

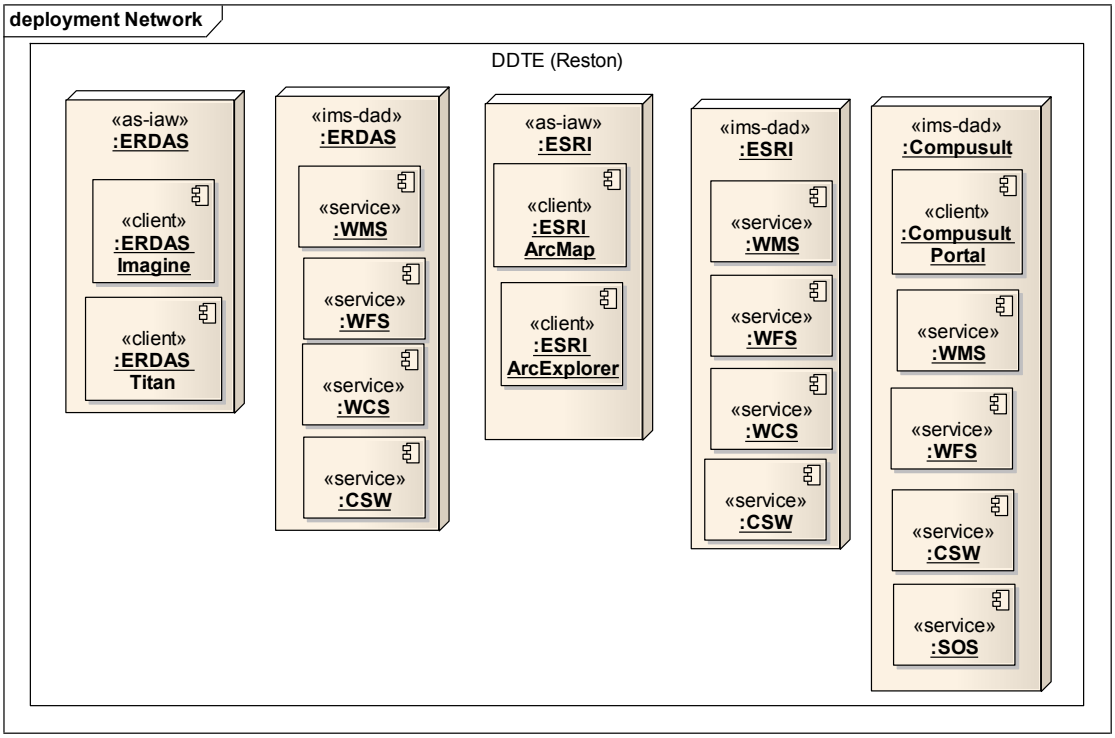

Figure 4. Nodes and Components Deployed on the DDTE Network, Reston

2.2 Functional Views

This section contains deployment-specific Inter-Nodal System Interface views for a number of key functional capabilities implemented and demonstrated during execution of the EC08 Pilot. The key functional capabilities highlighted here are:

1. TigerShark Video/Image Data Flows
2. Data Processing Flows
3. Data Alerting and Integration Flows
4. Resource Discovery Flows

Note that in the SV-1 diagrams that follow the system-system interactions (need lines) are labeled with a unique Interface Identifier that cross-references to the SV-6 System Data Exchange Matrix (see tables in Section 6). The SV-6 provides more detail including information about the producer and consumer ends of the interaction, the actual data that is exchanged, the system nodes, the system functions supported by the interface and the network domains in which the interface is realized.

2.2.1 Tiger Shark Video/Image Data Flows

This SV-1 shows the interactions and data flows for a collect, process, exploit and disseminate that was demonstrated during execution of the EC08 Pilot:

1. Tiger Shark with GSI camera collects HD imagery at a rate of 1 frame every 1.3 seconds. This data istransmitted to the ERDAS Ground Station where the data is ortho-rectified and processed into NITF format.
2. Navigation data (lat/long/altitude, pitch/roll, true-heading) and the raw JP2 image data is manually loaded onto the BIRI workstation to be served by the “GSI HD:SOS” (an implementation of the OGC Sensor Observation Service interface). Both navigation data and the raw images are served as distinct “observation offers” by the SOS.
3. Two clients applications access the BIRI “GSI HD:SOS” within the COI network domain: TASC PulseNet and BIRI Space Time Toolkit (STT)
4. The same data is manually loaded onto the “OGC Data Storage Node” within the DDTE classified network.
5. The ERDAS “Apollo” data server (an Access and Distribution Node) is equipped with OGC Web Services including, CSW, WCS, WMS and WFS. The ERDAS WMS and WCS services are configured to serve the Tiger Shark images within the DDTE.

6. The “ESRI ArcMap” and “ERDAS Imagine” client applications successfully accessed and processed the imagery served via the ERDAS WMS.

7. The network link to the DDTE in Reston, Virginia was intermittently available and significantly bandwidth-constrained to be of much use for accessing large image files hosted in the DDTE node at China Lake.

8. Tiger Shark imagery was ETL’d to Reston where it was, like at China Lake, served by the ERDAS “Apollo” Data Access and Delivery node to the “ESRI ArcMap” and “ERDAS Imagine” client applications running in Reston.

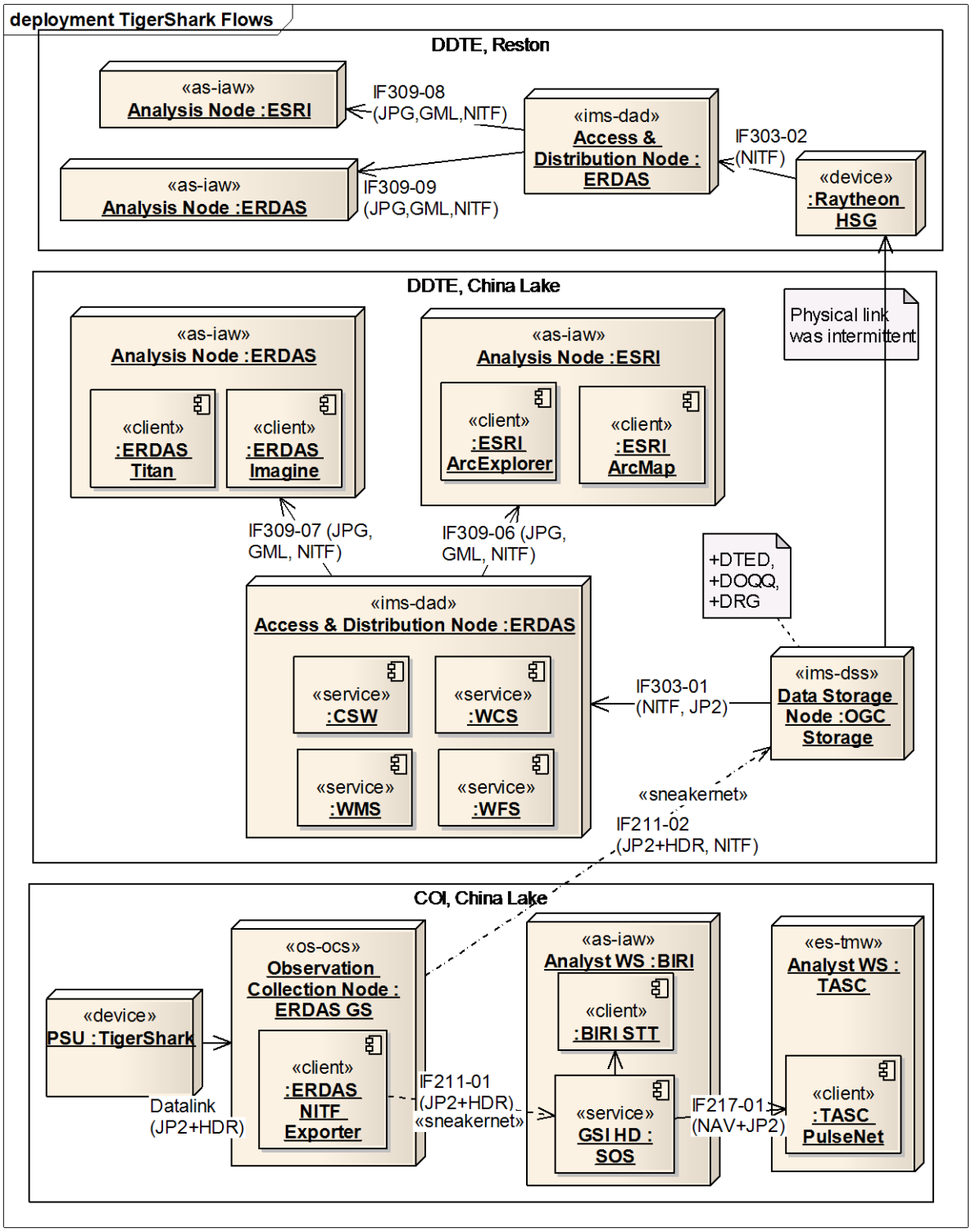

Figure 5. Tiger Shark Data Flows In and Across Network Domains

2.2.2 Data Processing Flows

This SV-1 shows the interactions and data flows for a data processing chain for georeferencing Tiger Shark imagery that was demonstrated during execution of the EC08 Pilot:

1. Navigation data (lat/long/altitude, pitch/roll, true-heading) and the raw JP2 image data is manually loaded onto the BIRI workstation to be served by the "GSI HD:SOS" (an implementation of the OGC Sensor Observation Service interface). Both navigation data and and the raw images are served as distinct "observation offers" by the BIRI SOS.

2. Doppler Radar data (sneaker net into the COI domain from the Open Internet) is likewise served by the BIRI "NWS Doppler:SOS".

3. The unprocessed imagery and the raw Doppler radar data are accessed via SOS as inputs into separate SensorML Process Chains. The "Tiger Shark HD" process chain uses Community Sensor Model framework to dynamically geolocate the imagery using the navigation observations and the raw image observations obtained from the GSI HD:SOS. Likewise, the raw Doppler radar data is input to a SensorML process chain to produce radials, direction and profile bin size data.

4. The BIRI Space Time Toolkit (STT) is used to display the geolocated imagery, the processed radar data along with Cursor-on-Target events (represented as observations of personnel, vehicle and gunshot events obtained from the TASC "CoT SOS") and basemap layers from the ESRI and ERDAS WMS implementations.

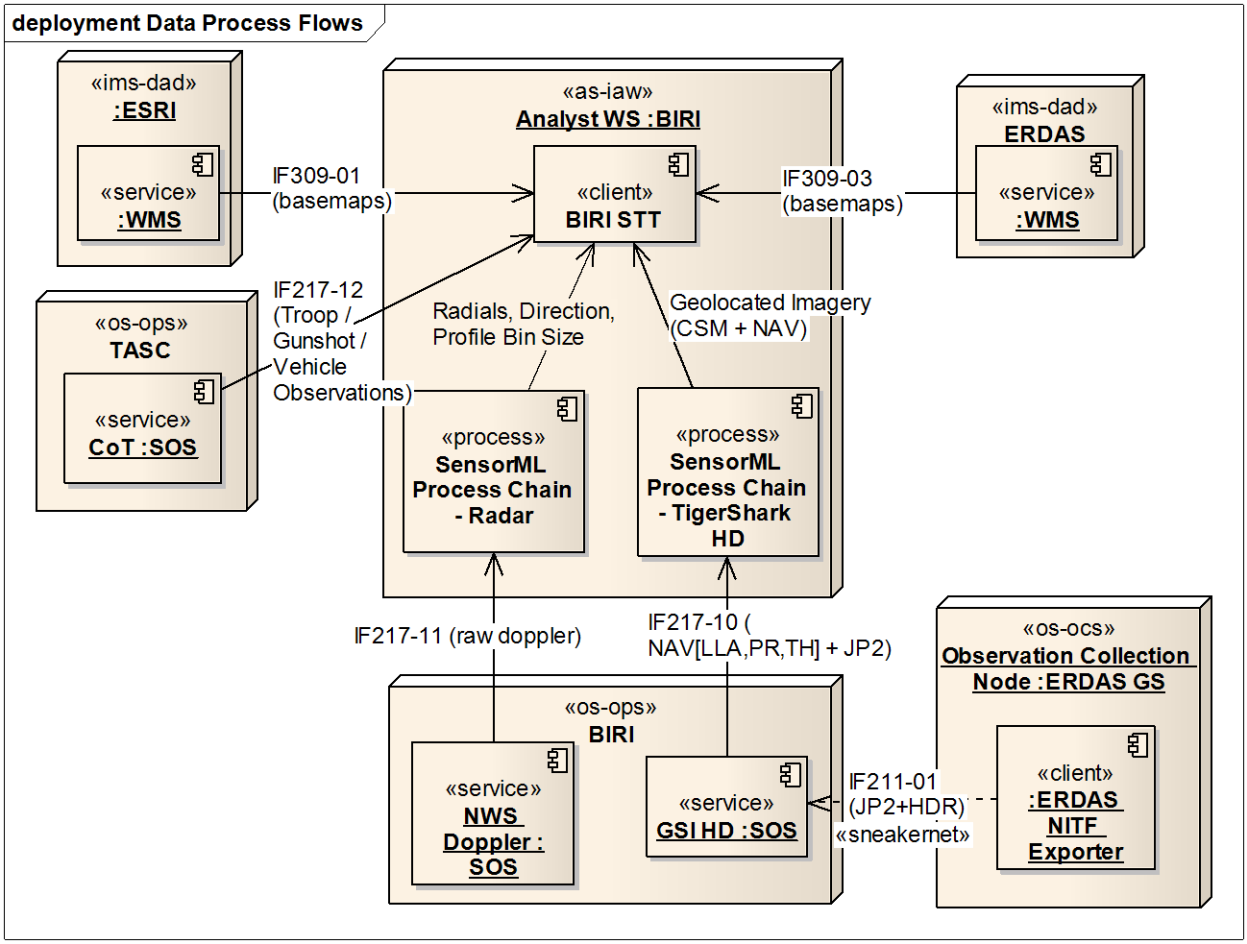

Figure 6. Data Process Flows Inside the COI Network

2.2.3 Data Alerting and Integration Flows

This SV-1 shows the interactions and data flows for generating and receiving alerts and processing them into an integrated operating picture that was demonstrated during execution of the EC08 Pilot:

1. The TASC Observation Processing System node (os-ops) is equipped with SWE services: CoT:SOS, Wx:SAS and Wx:SOS. The Wx services handle weather data obtained from the Open Internet that is periodically manually loaded onto the TASC server running in the COI domain. The CoT:SOS serves observations such as personnel movements, vehicle movements or gunshots events received from the Mitre CoT Router.

2. The SensorWeb Observation Processing System node (os-ops) is equipped with SWE services: SAS, SOS and WNS. The these services serve Unattended Ground Sensor (UGS) data obtained from the Open Internet and manually loaded onto the TASC server running in the COI domain.

3. The BIRI Observation Processing System node (os-ops) is equipped with the GSI HD:SOS and serves up the georeferenced imagery and navigation data obtained from the Tiger Shark/GSI UAS.

4. The ObjectFX Analysis Processing System node (as-aps) is equipped with the ObjectFX SpatialRules engine and an implementation of the OGC Sensor Alert Service (SAS) interface. SpatialRules processes weather data (from the TASC Wx:SOS) and Chem/Bio plume observations obtained from the SensorWeb SAS according to configurable rules to generate alerts that are made available via SAS to subscribers.

5. The TASC Exploitation System Track Manager Workstation (es-tmw) is equipped with the TASC PulseNet client application designed to receive alerts, process sensor observations (imagery, weather, CBRN, blue/red-force tracking, movement/detection events, etc) and visualize all this information into an integrated operating picture.

6. The BIRI ISR Analyst Workstation node (as-iaw) is equipped with the BIRI Space Time Toolkit (STT) application used for advanced visualization and analysis of terrain, imagery, weather, and time-sensitive observations (such as troop, vehicle or gunshot events).

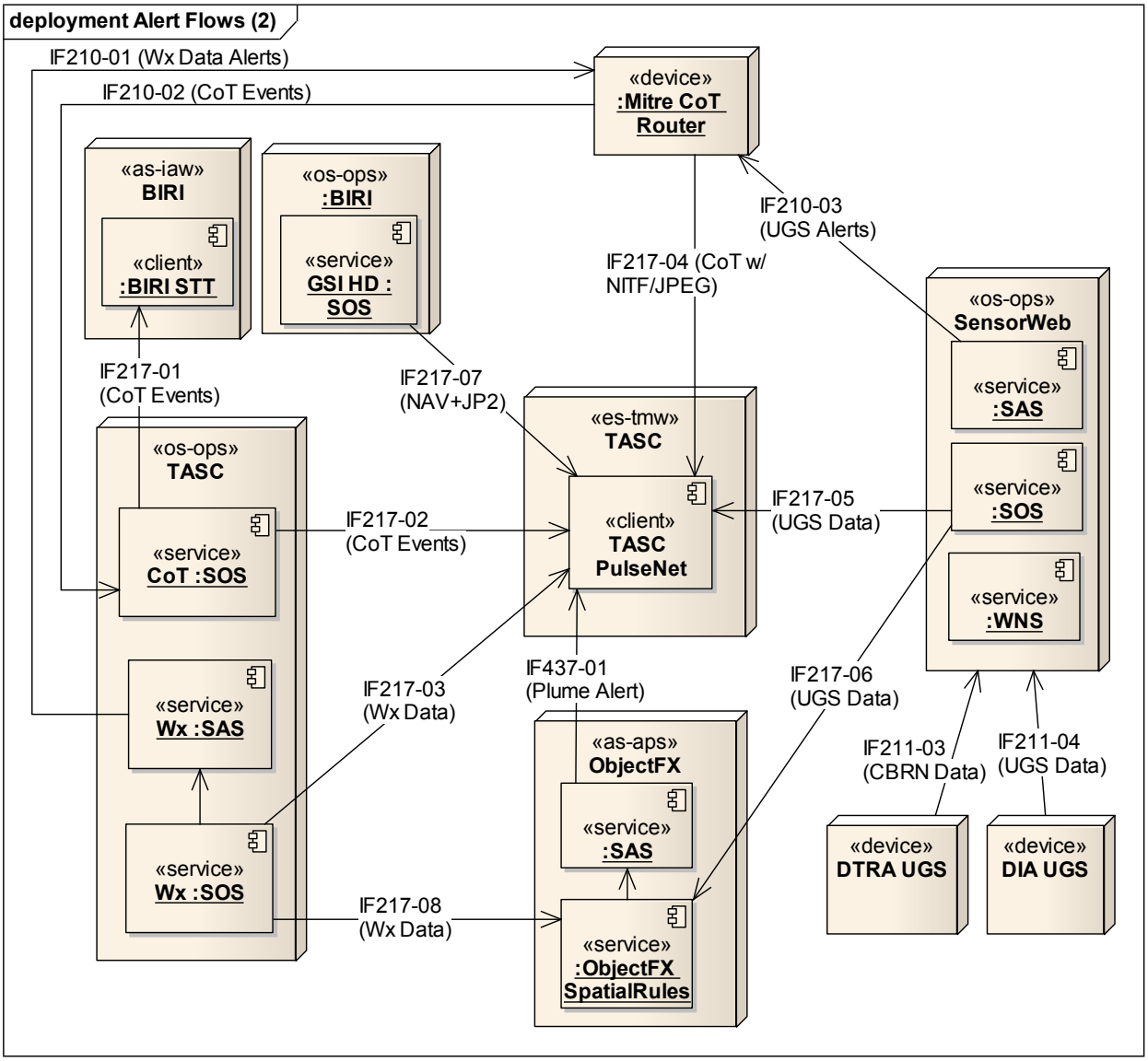

Figure 7. Alert and Other Data Flows Inside the COI Network

2.2.4 Resource Discovery Flows

This SV-1 shows the interactions and data flows for resource (sensor, data and service) discovery that were demonstrated during execution of the EC08 Pilot:

1. The ERDAS, ESRI and Compusult Data Access and Distribution system nodes are each equipped with OGC Catalog Service for the Web (CSW) implementations. The Compusult Catalog advertises sensor services and sensor system metadata. The ERDAS and ESRI Catalogs advertise services and associated datasets.

2. The Compusult Portal, TASC PulseNet and ERDAS Imagine applications search the respective Catalogs for available resources, appropriate resources, or changed resources.

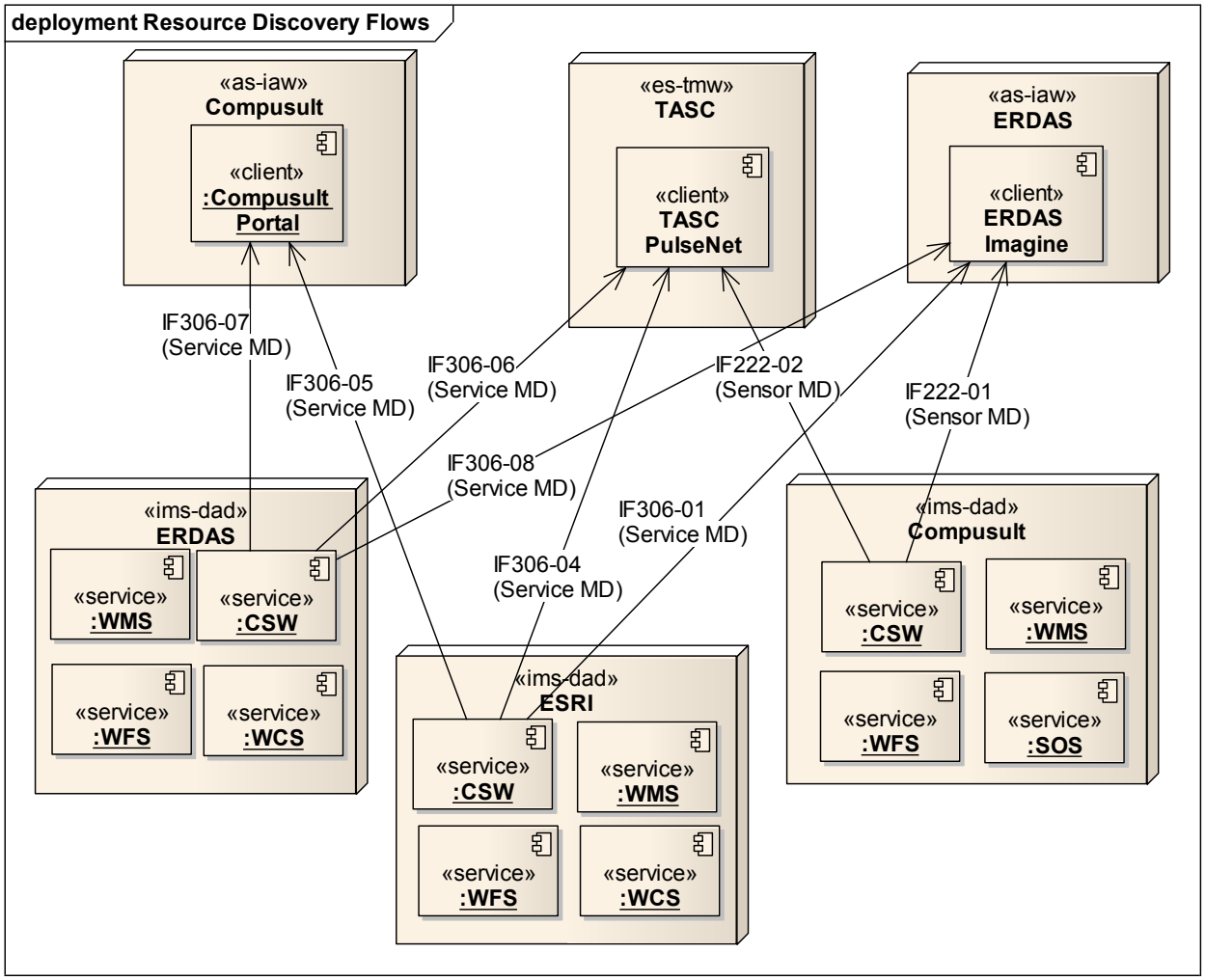

Figure 8. Resource Discovery Flows

3 Functions-Functions Matrix (SV-3)

The Functions-Functions Matrix, Table 1, shows the major interfaces between the systems *functions*. Note: We realize this is a different twist on the DoDAF Systems-Systems Matrix SV-3 product but, for purposes of identifying generic (i.e., reusable, standards-based) *interfaces* for data exchange and processing connections, we opt to focus on the key functions (and not systems) required to enable interoperable and opportunistic combinations of services for support of emerging SOA-based C4ISR systems.

The SV-1 views show a high level concept view of the system interfaces. The SV-3 matrix provides more detail by showing the functional system connections and the information exchanges between the systems represented in the SV-1. Analysis of the EC08 Concept Architecture use cases, the EC08 JMT scenarios, and the implementation demonstrated for EC08 validated the system interactions and provided the detail mapped in the SV-6 Data Exchange Matrix.

The rows and columns of this SV-3 matrix represent the system functions as inventoried in the SV-4 product (Section 4) below and described more fully in the EC08 Concept Architecture product. Each row in the matrix represents a source (producer) of information in an interface while each column represents a destination (consumer). Each cell contains the interfaces between the source row and destination column. The interfaces and information flows are described in greater detail in the SV-6. The Interface Identifiers found in the SV-3 matrix can be used to identify appropriate entries in the SV-6 tables.

Note that the Interface Identifiers listed in the table are referenced in the SV-1 functional views (as-built deployments for EC08) as well as in the SV-6 System Data Exchange Matrix.

Table 1. Function-Function Matrix

Function v Function (Producer-Consumer Interfaces)	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
Scenarios																									
7.1.2 Sensor System																									
7.1.2.1 Sensor Advertising		IF201	IF203	IF205							IF222								IF222						
7.1.2.2 Sensor Capability Discovery		IF202	IF204	IF206	IF208						IF214					IF219			IF214					IF219	
7.1.2.3 Collection Nomination and Tasking				IF207	IF209								IF216			IF220					IF216			IF220	
7.1.2.4 Sensor Data Collection, Alert and Forward					IF210		IF211	IF212	IF213			IF215		IF217	IF218		IF221			IF215		IF217	IF218		IF221
7.1.3 Information Management System																									
7.1.3.1 Store and Process							IF301	IF303						IF308			IF311					IF308			IF311
7.1.3.2 Retrieve: Access and Distribute							IF302	IF304				IF307		IF309			IF312			IF307		IF309			IF312
7.1.3.3 Advertise: Notify and Catalog									IF305		IF306			IF310			IF313		IF306			IF310			IF313
7.1.4 Analysis System																									
7.1.4.1 Discover Resources (Sensors and Data)			IF437	IF401	IF402			IF407			IF412			IF416		IF422	IF435		IF412			IF416		IF422	IF435
7.1.4.2 Open Channel for Live Video								IF408				IF413		IF417	IF420					IF413		IF417	IF420		
7.1.4.3 Tune ISR Resource				IF403																					
7.1.4.4 View, Measure and Analyze ISR Observations								IF409					IF414	IF418	IF421	IF433					IF414	IF418	IF421	IF433	
7.1.4.5 Store Findings								IF410	IF411					IF437			IF436					IF437			IF436
7.1.4.6 Cross-cue Assets				IF404	IF406																				
7.1.4.7 Retrieve Findings				IF405									IF415	IF419		IF434					IF415	IF419		IF434	
7.1.5 Exploitation System																									
7.1.5.1 Discover Resources (Sensors and Data)			IF537	IF501	IF502			IF507			IF512			IF516		IF522	IF535		IF512			IF516		IF522	IF535
7.1.5.2 Open Channel for Live Video								IF508				IF513		IF517	IF520					IF513		IF517	IF520		
7.1.5.3 Tune ISR Resource				IF503												IF537								IF537	
7.1.5.4 View, Measure and Analyze ISR Observations								IF509					IF514	IF518	IF521	IF533					IF514	IF518	IF521	IF533	
7.1.5.5 Store Findings								IF510	IF511			IF538		IF539			IF536			IF538		IF539			IF536
7.1.5.6 Cross-cue Assets				IF504	IF506																				
7.1.5.7 Retrieve Findings				IF505									IF515	IF519		IF534					IF515	IF519		IF534	

4 Systems Functionality Description (SV-4)

This section documents the functions of the system of systems described in the EC08 Concept Architecture. The system functions identified in that document and here focus on what the system will do to implement C4ISR business processes. As described throughout this document, aspects of this overall architecture and the systems functions have been implemented and demonstrated for EC08.

4.1 Systems

In the SV-1 views of Section 2.1, each node is labeled (using UML stereotypes) with a mnemonic that identifies the kind of system and sub-system it realizes. The systems and subsystems are identified in the EC08 Concept Architecture and are listed here as a key for the node stereotype labels used in the SV-1 views.

Table 2. Systems Description

Stereotype Label	System-Subsystem Name	Description
os	Observation System (OS)	System responsible for advertising, tasking, collection, storage, and processing of observations and related resources
os-ocs	Observation Collection System (OCS)	Collect observations on fixed or mobile, terrestrial, waterborne, airborne or satellite platforms; may provide standard services for Observation Processing System nodes to receive or access Observations.
os-sas	Sensor Advertising System (SAS)	Publishes metadata about sensors and sensor platforms (sensor characteristics, capabilities, calibrations, protocols, procedures, etc) for discovery by external system nodes
os-oss	Observation Storage System (OSS)	Stores, caches and indexes, archives collected observation data.
os-ops	Observation Processing System (OPS)	Provide command and control for one or more Observation Collection System nodes; receives collection tasking from the Resource Management System; contains metadata about capabilities of attached Observation Collection System nodes (i.e., platforms and sensors) and the Observation objects that are received and processed;
os-rmm	ISR Resource Mission Manager Workstation (RMM)	Workstation used by ISR Mission Managers to consolidate platform operations for particular multimode ISR resources.
os-row	ISR Resource Operator Workstation (ROW)	Workstation used by ISR Resource Operators to consolidate platform operations for particular multimode ISR resources.
ims	Information Management System (IMS)	System responsible for storage, processing and advertising of observations and related resources

ims-dss	Data Storage System (DSS)	Preserves ISR information datasets for access and use by a designated community or within a network security domain
ims-dps	Data Processing System (DPS)	Enable transformation and other specific processing of ISR data artifacts (e.g., Observation, Imagery, Features, other).
ims-das	Data Advertising System (DAS)	Publish metadata about stored datasets for discovery by external system nodes (e.g., Resource Management System, Analysis System, etc).
ims-dad	Data Access & Distribution System (DAD)	Enable discovery and access to raw and processed ISR data as —normalized representations of Feature, Coverage and/or Observation objects (and their metadata), independent of their source collector or system.
rms	Resource Management System (RMS)	System responsible for advertising, discovering, nominating and allocating resources.
rms-ras	Resource Advertising System (RAS)	Advertise to external systems and users the existence, availability, capabilities and other characteristics of ISR Resources (sensors and data); may also harvest (replicate locally) metadata descriptions of ISR Resources from other system nodes (e.g., Observation System or Information Management System nodes).
rms-rds	Resource Discovery System (RDS)	Enable subscription to and notification by external system nodes (e.g., Observation System node) when ISR Resources become available or unavailable; enable active searching of external system nodes (e.g., Information System Management node) to discover resources of value and interest to users and systems within C4ISR operations.
rms-rts	Resource Tasking System (RTS)	Invokes tasking of ISR activities such as ISR Collection and ISR Analysis under the purview of the Resource Tasking System.
rms-rps	Resource Planning System (RPS)	Receives and manages nomination requests for Collection and Analysis tasking from external systems and users (e.g., Analysis System or Exploitation System nodes); enables Collection Managers and ISR Resource Mission Managers to review tasking nominations, view the COP and conduct planning activities that lead to specific and tasking of ISR activities and resources
rms-cmw	Collection Manager Workstation (CMW)	System used by Collection Managers assigned to assist users with acquiring ISR products for analysis and exploitation; provides access to a wealth of knowledge on sensor operations and capabilities; enables purview and tasking nomination rights over theater organic or national assets

rms-irm	ISR Resource Manager Workstation (IRM)	System that performs functions of or is used by ISR Resource Mission Managers to consolidate platform operations for particular multimode ISR resources; used to optimize and broker the use of an in-demand asset.
as	Analysis System (AS)	Systems responsible for queuing analysis activities, finding resources, nominating resources for allocation, and processing data to generate findings.
as-ars	Analysis Requirements System (ARS)	Receives, from an attached Resource Management System node, tasking for analysis activities to commence; nominate collection activities to the Resource Management System.
as-rds	Resource Discovery System (RDS)	Support search/discovery of ISR Resources (datasets and sensors) known to an attached Resource Management System node.
as-aps	Analysis Processing System (APS)	Support analysis activities such as: advertising dataset products produced as output from analysis tasks for use by interested system actors; performing assessment activities, performing common analysis activities such as precise geopositioning, measurement, image processing; viewing the COP and observations (e.g., live or archived video streams).
as-iaw	ISR Analyst Workstation (IAW)	System designed to assist the Exploitation Analysts and Track Managers to read out sensor products such as FMV and perform enhancement functions, mensuration, product annotation and capture, and reporting. In many cases the system can also operate/control ISR resources.
es	Exploitation System (ES)	Systems responsible for queuing analysis activities, finding resources, nominating resources for allocation, and processing data to generate findings.
es-rrs	Resource Requiremenets System (RRS)	Support nomination activities for collection and analysis to the Resource Management System.
es-rds	Resource Discovery System (RDS)	Support search/discovery of ISR Resources (datasets and sensors) known to an attached Resource Management System node.
es-eps	Exploitation Processing System (EPS)	Support analysis activities such as: advertising dataset products produced as output from exploitation tasks for use by interested system actors; performing assessment activities, performing common analysis activities such as precise geopositioning, measurement, image processing and viewing the COP and observations (e.g., live or archived video streams); executing activities for tracking, targeting, and reporting.

es-tmw	Track Manager Workstation (TMW)	System used by Track Managers to locate potential targets and hold them in a tracked state; supports ability to identify, classify, characterize, and maintain the location of possible targets; provides awareness of blue and grey forces, movement controls, lines of communication, and the results of intelligence preparation of the battlespace; supports TST operations planning on expected track locations and probable velocity vectors.
es-tw	Targeteer Workstation (TW)	System used by Targeteers to assist with determining whether actually considered time-sensitive targets, the selection of appropriate effects to bring to the target, the development and correlation of tracks with intelligence sources, and vetting targets through a validation process.
es-epw	Engagement Planning Workstation (EPW)	System used by Engagement Mission Planners to plan missions for engagement assets such as strike aircraft; supports review of targeting materials to include FMV to better understand the target and its environment; supports construction of briefings and mission rehearsal materials.
es-tem	TST Execution Manager Workstation (TEM)	System used by TST Execution Manager to manage the TST execution for the TST Cell; provides direct contact with the strike platform, weapons system operators, or AWACS; used to ensure that all coordination steps have been taken and that the engaged target meets the JFC's definition of a TST and that the rules of engagement are met.
es-eso	Engagement System Operation Workstation (ESO)	System used by Engagement System Operators to control engagement systems used to bring effects to targets; workstations may be collocated with ISR operations, remoted, or en route.

4.2 System Functions

In Section 7.1 of the EC08 Concept Architecture, a short list of key system functions are 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 EC08, this is the system function inventory for the systems identified in the table above.

Table 3. System Function Inventory

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

The EC08 Concept Architecture, and specifically the “P-F2T2EA” (Planning-Find-Fix-Target-Track-Engage-Assess) use-cases, as well as the EC08 Pilot project objectives provided the source material used in deriving the SV-4 system functions listed above. The system functions listed, albeit incomplete, are a start at inventorying the essential functions of a modular, interoperable, and opportunistic SOA for C4ISR activities. These functions focus on what the system will do to implement C4ISR business processes. See SV-5 for the traceability between the system side functions and the operational side activities.

5 Operational Activity to Systems Function Traceability Matrix (SV-5)

The Operations Activity to Systems Function Traceability Matrix is a specification of the relationships between the set of operational activities applicable to the EC08 Concept Architecture and the set of system functions applicable to that architecture. It is a mapping between the operational functional requirements and system requirements in that it shows what purposeful actions must be performed by the system to satisfy required operational activities.

The rows in the matrix represent operational activities from the use-cases elaborated in the EC08 Concept Architecture. The columns represent the system functions as inventoried in the SV-4 above. The individual matrix cells represent the intersection of a particular operational activity and system function. If a cell is colored black then the system function (column) is used in implementing the operational activity (row). Gray cells represent top-level activities and functions in their respective hierarchies. White cells indicate that the implementation of the operational activity does not use the corresponding system function.

Table 4. SV-5 Activity-Function Traceability Matrix

Activity v Function	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 Status Information	7.1.2.5 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
Activities (from Use Cases)																									
1 Deliberate Tgt Dev Use Cases																									
1.1 Tgt Dev: Retrieve FMV From Archive					x		x	x	x		x	x		x	x				x	x		x	x		
1.2 Tgt Dev: Analyze Product														x								x			
1.3 Tgt Dev: Archive FMV to Target Folder														x								x			
2 Deliberate Cap Analysis Use Cases																									
2.1 Cap Analysis: Retrieve FMV From Archive					x		x	x	x		x	x		x	x				x	x		x	x		
2.2 Cap Analysis: Analyze Product														x								x			
2.3 Cap Analysis: Archive FMV to Target Folder														x								x			
3 Deliberate Cdrs Decision FA Use Cases																									
3.1 Deliberate Cdrs Decision FA: Collection Planning				x	x		x	x	x			x	x	x	x	x				x	x	x	x	x	
4 Dynamic Plan Phase Use Cases																									
4.1 Find: Query for ISR Resource Capabilities		x	x								x								x						
4.2 Find: Determine ISR Resource Availabilities		x	x								x								x						
4.3 Find: Plan FMV Capture				x				x	x		x		x			x			x		x			x	
4.4 Find: Execute ISR Plan		x	x		x		x	x	x			x		x	x					x		x	x		
5 Dynamic Find Phase Use Cases																									
5.1 Find: Determine ISR Resource Availabilities		x	x								x								x						
5.2 Find: Feed FMV					x							x								x					
5.3 Find: Tune FMV Resource				x								x	x			x					x			x	
5.4 Find: Analyze FMV					x							x		x						x					
5.5 Find: Measure from FMV														x								x			
5.6 Find: Store Findings					x		x					x		x	x					x		x	x		
5.7 Find: Cross-Cue Assets		x	x																						
5.8 Find: Retrieve Findings					x			x	x		x	x					x		x	x					x
5.9 Find: Search for Potential Targets																									
6 Dynamic Fix Phase Use Cases																									
6.1 Fix: Determine ISR Resource Availabilities		x	x								x								x						
6.2 Fix: Feed FMV					x							x								x					
6.3 Fix: Tune FMV Resource				x								x	x			x					x			x	
6.4 Fix: Analyze FMV					x							x		x						x					
6.5 Fix: Measure from FMV														x								x			
6.6 Fix: Store Findings					x		x					x		x	x					x		x	x		
6.7 Fix: Cross-Cue Assets		x	x																						
6.8 Fix: Retrieve Findings					x			x	x		x	x					x		x	x					x
7 Dynamic Track Phase Use Cases																									
7.1 Track: Determine ISR Resource Availabilities		x	x								x								x						
7.2 Track: Feed FMV					x							x								x					
7.3 Track: Tune FMV Resource				x								x	x			x					x			x	
7.4 Track: Analyze FMV					x							x		x						x					
7.5 Track: Measure from FMV														x								x			
7.6 Track: Store Findings					x		x					x		x	x					x		x	x		
7.7 Track: Cross-Cue Assets		x	x																						
7.8 Track: Retrieve Findings					x			x	x		x	x					x		x	x					x
7.9 Track: Track Potential Targets																									
8 Dynamic Target Phase Use Cases																									
8.1 Target: Determine ISR Resource Availabilities		x	x								x								x						
8.2 Target: Feed FMV					x							x								x					
8.3 Target: Tune FMV Resource				x								x	x			x					x			x	
8.4 Target: Analyze FMV					x							x		x						x					
8.5 Target: Measure from FMV														x								x			
8.6 Target: Store Findings					x		x					x		x	x					x		x	x		
8.7 Target: Cross-Cue Assets		x	x																						
8.8 Target: Retrieve Findings					x			x	x		x	x					x		x	x					x
9 Dynamic Engage Phase Use Cases																									
9.1 Engage: Plan FMV Capture				x				x	x		x		x			x			x		x			x	
9.2 Engage: Determine ISR Resource Availabilities		x	x								x								x						
9.3 Engage: Feed FMV					x							x								x					
9.4 Engage: Tune FMV Resource				x								x	x			x					x			x	
9.5 Engage: Analyze FMV					x							x		x						x					
9.6 Engage: Measure from FMV														x								x			
9.7 Engage: Store Findings					x		x					x		x	x					x		x	x		
9.8 Engage: Cross-Cue Assets		x	x																						
9.9 Engage: Retrieve Findings					x			x	x		x	x					x		x	x					x
10 Dynamic Assess Phase Use Cases																									
10.1 Assess: Determine ISR Resource Availabilities		x	x								x								x						
10.2 Assess: Feed FMV					x							x								x					
10.3 Assess: Tune FMV Resource				x								x	x			x					x			x	
10.4 Assess: Analyze FMV					x							x		x						x					
10.5 Assess: Measure from FMV														x								x			
10.6 Assess: Store Findings					x		x					x		x	x					x		x	x		
10.7 Assess: Cross-Cue Assets		x	x																						
10.8 Assess: Retrieve Findings					x			x	x		x	x					x		x	x					x
11 Deliberate Combat Assessment Use Cases																									
11.1 Combat Assessment: Retrieve FMV From Archive					x			x	x		x	x		x			x		x	x		x			x
11.2 Combat Assessment: Analyze Product														x								x			
11.3 Combat Assessment: Archive FMV to Target Folder							x							x	x							x	x		
12 Resource Architecture Change Use Cases																									
12.1 New Unanticipated Resource Added		x	x		x		x	x	x		x	x		x	x		x		x	x		x	x		x
12.2 Anticipated Resource Added		x	x		x		x	x	x		x	x		x	x		x		x	x		x	x		x
12.3 Incompatible Resource Added			x								x								x						
13 Architecture Variation Use Cases																									
13.C Commercialization of Node		x	x	x	x		x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x
13.I Internationalization of Node		x	x	x	x		x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x
13.R Remoting of Node		x	x	x	x		x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x
13.S Securing of Node		x	x	x	x		x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x

6 Systems Data Exchange Matrix Views (SV-6)

The Systems Data Exchange Matrix provides a relationship with the systems, system functions, and data flows between the interfaces. The system interfaces originate from the SV-3 Functions-Functions Matrix.

The System Data Exchange Matrix is represented in tabular form. Each interface from the SV-3 has its own Interface Identifier. The system interfaces may be bi-directional (e.g., request/response). In these cases, the Information Exchange Identifier provides a more detailed identifier. The data description column explains the different types of data which may be sent through each interface between the Producer and Consumer systems along with the functions being performed.

6.1 Tiger Shark Video/Image Data Flow

This System Data Exchange Matrix is keyed to the SV-1 diagram for the Tiger Shark Video/Image Data Flow (Figure 5).

Table 5. Tiger Shark Video/Image Data Flow Interfaces

TigerShark Video/Image Data Flows								
Interface ID	**Information Exchange ID**	**Data Description**	**Producer System**	**Producer Component**	**System Functions**	**Consumer System**	**Consumer Component**	**Network Domain**
IF211-01	IE211-01	Sneakernet and load JP2+HDR video from Tigershark to GSI HD:SOS	os-ops	ERDAS NITF Exporter	7.1.2.4	os-ops	BIRI GSI HD:SOS	COI
IF217-01	IE217-01a	SOS request for HD JP2 images and navigation observations	es-tmw	TASC PulseNet	7.1.4.4	os-ops	BIRI GSI HD:SOS	COI
IF217-01	IE217-01b	SOS response of JP2 images and navigation (LLA, PR, TH) observations	os-ops	BIRI GSI HD:SOS	7.1.2.4	es-tmw	TASC PulseNet	COI
IF211-02	IE211-02	Sneakernet and load JP2+HDR images from Tigershark to DDTE network	os-ops	ERDAS NITF Exporter	7.1.2.4	ims-dss	OGC Data Storage Node	COI -> DDTE/China Lake
IF303-01	IE303-01	Access NITF and JP2 images via WCS and WMS	ims-dss	OGC Data Storage Node	7.1.3.1	ims-dad	ERDAS Access and Distribution Node	DDTE/China Lake
IF309-06	IE309-06a	WMS request for imagery	as-iaw	ESRI ArcExplorer	7.1.4.4	ims-dad	ERDAS WMS	DDTE/China Lake
IF309-06	IE309-06b	WMS response (JPEG of Tigershark imagery)	ims-dad	ERDAS WMS	7.1.3.2	as-iaw	ESRI ArcExplorer	DDTE/China Lake
IF309-07	IE309-07a	WCS request for imagery	as-iaw	ERDAS Imagine	7.1.4.4	ims-dad	ERDAS WCS	DDTE/China Lake
IF309-07	IE309-07b	WCS response (NITF of Tigershark imagery)	ims-dad	ERDAS WCS	7.1.3.2	as-iaw	ERDAS Imagine	DDTE/China Lake
IF303-02	IE303-02	Access NITF and JP2 images via WCS and WMS	ims-dss	OGC Data Storage Node	7.1.3.1	ims-dad	ERDAS Access and Distribution Node	DDTE/China Lake -> DDTE/Reston
IF309-08	IE309-08a	WMS request for imagery	as-iaw	ESRI ArcExplorer	7.1.4.4	ims-dad	ERDAS WMS	DDTE/Reston
IF309-08	IE309-08b	WMS response (JPEG of Tigershark imagery)	ims-dad	ERDAS WMS	7.1.3.2	as-iaw	ESRI ArcExplorer	DDTE/Reston
IF309-09	IE309-09a	WCS request for imagery	as-iaw	ERDAS Imagine	7.1.4.4	ims-dad	ERDAS WCS	DDTE/Reston
IF309-09	IE309-09b	WCS response (NITF of Tigershark imagery)	ims-dad	ERDAS WCS	7.1.3.2	as-iaw	ERDAS Imagine	DDTE/Reston

6.2 Systems Data Exchange Matrix: Data Process Flows

This System Data Exchange Matrix is keyed to the SV-1 diagram for the Data Process Flows (Figure 6).

Table 6. Data Process Flow Interfaces

Data Process Flows								
Interface ID	**Information Exchange ID**	**Data Description**	**Producer System**	**Producer Component**	**System Functions**	**Consumer System**	**Consumer Component**	**Network Domain**
IF309-01	IE309-01a	WMS request for basemap layers	as-iaw	BIRI STT	7.1.4.4	ims-dad	ESRI WMS	COI
IF309-01	IE309-01b	WMS response (basemap layers)	ims-dad	ESRI WMS	7.1.3.2	as-iaw	BIRI STT	COI
IF217-12	IE217-12a	SOS request for Cot Events	ims-dad	BIRI STT	7.1.4.4	os-ops	TASC CoT:SOS	COI
IF217-12	IE217-12b	SOS response of CoT Events (troop location/tracks, gunshots, vehicles, etc)	os-ops	TASC CoT:SOS	7.1.3.2	ims-dad	BIRI STT	COI
IF309-03	IE309-03a	WMS request for basemap layers	as-iaw	BIRI STT	7.1.4.4	ims-dad	ERDAS WMS	COI
IF309-03	IE309-03b	WMS response (basemap layers)	ims-dad	ERDAS WMS	7.1.3.2	as-iaw	BIRI STT	COI
IF217-11	IE217-11a	SOS request for Doppler radar observations	as-iaw	BIRI STT	7.1.4.4	os-ops	BIRI NWS Doppler:SOS	COI
IF217-11	IE217-11b	SOS response of raw Doppler radar observation data	os-ops	BIRI NWS Doppler SOS	7.1.2.4	as-iaw	BIRI STT	COI
IF217-10	IE217-10a	SOS request for HD JP2 images and navigation observations	as-iaw	BIRI STT	7.1.4.4	os-ops	BIRI GSI HD:SOS	COI
IF217-10	IE217-10b	SOS response of JP2 images and navigation (LLA, PR, TH) observations	os-ops	BIRI GSI HD:SOS	7.1.2.4	as-iaw	BIRI STT	COI
IF211-01	IE211-01	Sneakernet and load JP2+HDR images from Tigershark to GSI HD:SOS	os-ops	ERDAS NITF Exporter	7.1.2.4	os-ops	BIRI GSI HD:SOS	COI

6.3 Systems Data Exchange Matrix: Alerting and Integration Flows

This System Data Exchange Matrix is keyed to the SV-1 diagram for the Data Alerting and Integration Flows (Figure 7).

Table 7. Alerting and Integration Flow Interfaces

Data Alerting and Integration Flows								
Interface ID	**Information Exchange ID**	**Data Description**	**Producer System**	**Producer Component**	**System Functions**	**Consumer System**	**Consumer Component**	**Network Domain**
IF217-03	IE217-03a	SOS request for weather observations	es-tmw	TASC PulseNet	7.1.4.4	os-ops	TASC Wx:SOS	COI
IF217-03	IE217-03b	SOS response (weather observations)	os-ops	TASC Wx:SOS	7.1.2.4	es-tmw	TASC PulseNet	COI
IF210-02	IE210-02	Receive CoT events (e.g.,Troop / Gunfire / Vehicle observations)	device	Mitre CoT Router	7.1.3.2	os-ops	TASC CoT:SOS	COI
IF217-02	IE217-02a	SOS request: CoT events (e.g.,Troop / Gunfire / Vehicle observations)	es-tmw	TASC PulseNet	7.1.4.4	os-ops	TASC CoT:SOS	COI
IF217-02	IE217-02b	SOS response: CoT events (e.g.,Troop / Gunfire / Vehicle observations)	os-ops	TASC CoT:SOS	7.1.2.4	es-tmw	TASC PulseNet	COI
IF217-07	IE217-07a	SOS request: TigerShark HD JP2 Imagery	es-tmw	TASC PulseNet	7.1.4.4	os-ops	BIRI GSI HD:SOS	COI
IF217-07	IE217-07b	SOS response: TigerShark HD JP2 Imagery	os-ops	BIRI GSI HD:SOS	7.1.2.4	es-tmw	TASC PulseNet	COI
IF217-04	IE217-04a	Receive CoT Events with embedded NITF/JPEG images	device	Mitre CoT Router	7.1.3.2	es-tmw	TASC PulseNet	COI
IF217-05	IE217-05a	SOS request: UGS data	es-tmw	TASC PulseNet	7.1.4.4	os-ops	SensorWeb SOS	COI
IF217-05	IE217-05b	SOS response: UGS data	os-ops	SensorWeb SOS	7.1.2.4	es-tmw	TASC PulseNet	COI
IF217-06	IE217-06a	SOS request : UGS data	as-aps	ObjectFX SpatialRules	7.1.4.4	os-ops	SensorWeb SOS	COI
IF217-06	IE217-06b	SOS response: UGS data	os-ops	SensorWeb SOS	7.1.2.4	as-aps	ObjectFX SpatialRules	COI
IF217-08	IE217-08a	SOS request for weather observations	as-aps	ObjectFX SpatialRules	7.1.4.4	os-ops	TASC Wx:SOS	COI
IF217-08	IE217-08b	SOS response (weather observations)	os-ops	TASC Wx:SOS	7.1.2.4	as-aps	ObjectFX SpatialRules	COI
IF437-01	IE437-01	SAS alert (plume alert)	as-aps	ObjectFX SAS	7.1.4.5	es-tmw	TASC PulseNet	COI
IF217-01	IE217-01a	SOS request: CoT events (e.g.,Troop / Gunfire / Vehicle observations)	as-iaw	BIRI STT	7.1.4.4	os-ops	TASC CoT:SOS	COI
IF217-01	IE217-01b	SOS response: CoT events (e.g.,Troop / Gunfire / Vehicle observations)	os-ops	TASC CoT:SOS	7.1.2.4	as-iaw	BIRI STT	COI
IF210-01	IE210-01	Post weather data alerts	os-ops	TASC CoT:SOS	7.1.3.2	device	Mitre CoT Router	COI
IF210-03	IE210-03	Post UGS Alerts (e.g.,Troop / Gunfire / Vehicle observations)	os-ops	SensorWeb SOS	7.1.3.2	device	Mitre CoT Router	COI

6.4 Systems Data Exchange Matrix: Resource Discovery Flows

This System Data Exchange Matrix is keyed to the SV-1 diagram for the Resource Discovery Flows (Figure 8).

Table 8. Resource Discovery Flow Interfaces

Resource Discovery Flows								
Interface ID	Information Exchange ID	Data Description	Producer System	Producer Component	System Functions	Consumer System	Consumer Component	Network Domain
IF222-01	IE222-01a	CSW request: sensor discovery	as-iaw	ERDAS Imagine	7.1.4.1	ims-das	Compusult CSW	COI
IF222-01	IE222-01b	CSW response: sensor metadata	ims-das	Compusult CSW	7.1.2.1	as-iaw	ERDAS Imagine	COI
IF222-02	IE222-02a	CSW request: sensor discovery	es-tmw	TASC PulseNet	7.1.4.1	ims-das	Compusult CSW	COI
IF222-02	IE222-02b	CSW response: sensor metadata	ims-das	Compusult CSW	7.1.2.1	es-tmw	TASC PulseNet	COI
IF306-05	IE306-05a	CSW request: service discovery	as-iaw	Compusult Portal	7.1.2.2	ims-dad	ESRI CSW	COI
IF306-05	IE306-05b	CSW response: service metadata	ims-dad	ESRI CSW	7.1.4.1	as-iaw	Compusult Portal	COI
IF306-06	IE306-06a	CSW request: service discovery	es-tmw	TASC PulseNet	7.1.2.2	ims-dad	ERDAS CSW	COI
IF306-06	IE306-06b	CSW response: service metadata	ims-dad	ERDAS CSW	7.1.4.1	es-tmw	TASC PulseNet	COI

7 Technical Standards Profile (TV-1)

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

Table 9. OGC Specifications

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