



Appendix A EC08 OGC Pilot After Action Report

OGC Web Services (OWS) in Support of the C4ISR Enterprise

EC08 Concept Architecture

Developed by the Open Geospatial Consortium (OGC)

Version: 1.0

Version Date: November 26, 2007

Table of Contents

1 DOCUMENT PURPOSE 1

2 PURPOSE AND SCOPE 2

2.1 BACKGROUND 2

2.2 PURPOSE 3

2.3 SCOPE 3

3 ARTIFACTS OF THE CONCEPTUAL ARCHITECTURE DOCUMENTATION 4

4 DEVELOPMENT METHODOLOGY AND DOCUMENTATION 6

4.1 NEEDS AND ENVIRONMENT 8

4.2 RELEVANT AVAILABLE TECHNOLOGIES 9

4.3 MODELING ACTIVITIES 10

5 OPERATIONAL VIEWS 10

5.1 OVERVIEW 10

5.1.1 DCGS "As-is" 11

5.1.2 DCGS "To-be" 12

5.2 USE CASES 14

6 SYSTEM VIEWS 24

6.1 OVERVIEW 24

6.2 SYSTEM FUNCTIONS 25

6.3 INFORMATION MODEL 31

6.3.1 Key ISR Data Objects 31

6.3.2 Key OGC Data Objects 32

6.3.3 OWS Service Framework 36

6.4 COMPONENT MODEL 40

6.4.1 Observation System 42

6.4.2 Information Management System 43

6.4.3 Resource Management System 44

6.4.4 Analysis System 45

6.4.5 Exploitation System 46

7 IMPLEMENTATION SCENARIOS 47

7.1.1 Overview 47

7.1.2 Sensor System Scenarios 48

7.1.3 Information Management System 58

7.1.4 Analysis System 65

7.1.5 Exploitation System 69
8 TECHNICAL VIEWS 70
8.1 TECHNICAL STANDARDS PROFILE (TV-1) 70
8.2 EMERGING STANDARDS PROFILE (TV-2) 71
APPENDIX A GLOSSARY (AV-2) 72

1 Document Purpose

Empire Challenge (EC) affords the GEOINT community a valuable means to experiment with and validate promising technologies that have the potential to enrich and empower coalition C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) activities. EC08, scheduled for the summer of 2008 will feature a strong focus on integrated Intelligence Surveillance and Reconnaissance (ISR) operations in support of joint targeting, non-traditional ISR (NT-ISR), and multi-domain awareness (MDA). EC08 will also stress coalition information sharing, the growing role of Network Centric Enterprise Services (NCES), the dynamics of persistent surveillance, and a functional assessment of the family of Distributed Common Ground Stations (DCGS).

This document collects together a series of architectural artifacts designed to describe key aspects of the expected EC08 ISR enterprise and highlight where open geospatial technologies and standards can be leveraged toward the greatest gain. We also describe the methodology we are using to extend and adapt these architectural products as the nature of EC08 becomes better defined. In this sense, this document is a living repository for architectural products that will ultimately define the operational alignment and system/services detail of an OGC demonstration pilot initiative.

This document's purpose is to capture the details of a concept architecting process that is attempting to link EC08 capability initiatives with expected operational node infrastructure, the functions of expected systems, and the structure of OGC services, systems, and standards. This is not the entire Architecture of EC08, rather that of an emerging pilot for open geospatial standard/service enablement. Figure 1 introduces the overall drivers of this document's detail.

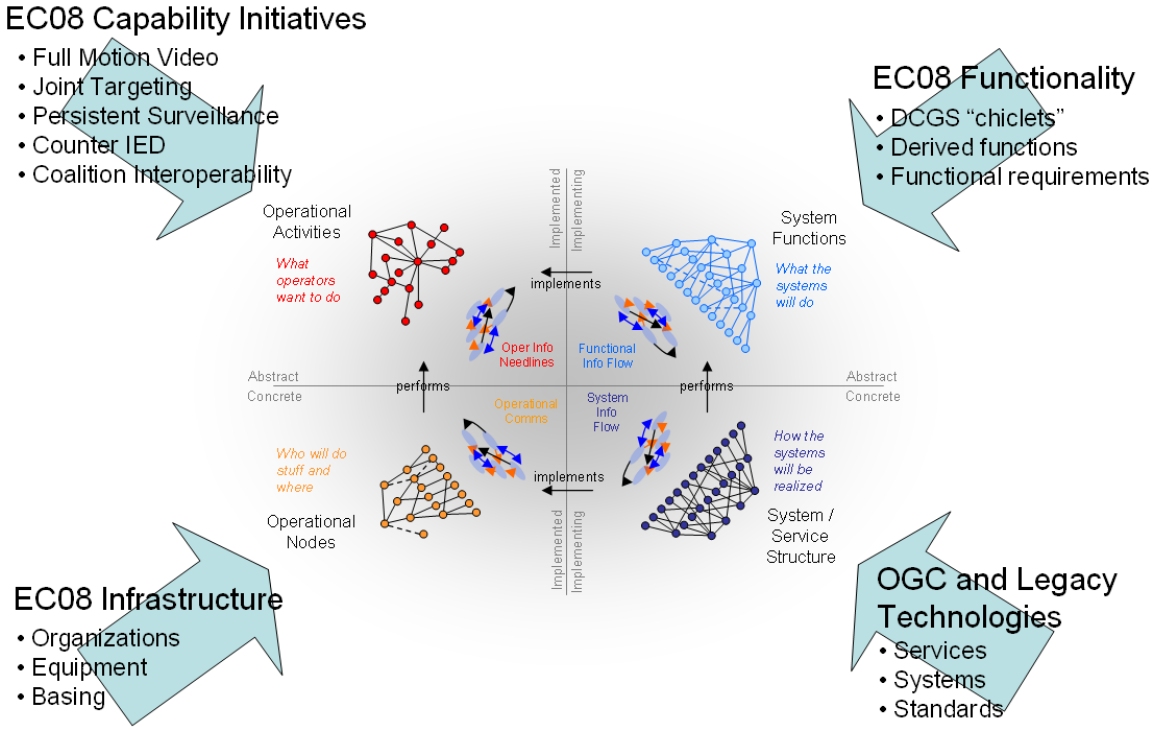


Figure 1 EC08 Open Geospatial Pilot Concept Architecture and Drivers

2 Purpose and Scope

2.1 Background

OGC has conducted a concept development initiative designed to illustrate to NGA and organizations participating in Empire Challenge (EC) the value of 1) adopting OGC and other open standards to improve plug and play interoperability to meet mission needs and 2) engaging OGC industry collaborative programs to further enable the Empire Challenge activity to help mobilize needed capability. This initiative provides specific recommendations for leveraging OGC and complimentary standards based capabilities and collaborative industry standards processes in future Empire Challenge demonstration spirals. The activities of the concept development initiative were designed to:

- Increase EC participant awareness of and commitment to EC the use of open standards-based solutions including those of the OGC
- Expand EC access to OGC standards based technology offerings available from industry
- Provide NGA and EC participants with impartial “white hat” resource to formulate and communicate a target Empire Challenge standards architecture as guidance for future EC spirals and
- Develop a Concept Architecture for an OGC Pilot Initiative that would deliver demonstration capability for EC’08.

We also believe that the deliverables from the concept development initiative (i.e., this document and associated briefings) will aid in illustrating the value of applying consistent policy and architectural guidance on the use of open standards to significantly enhance the ability of the D&I community to rapidly improve interoperability of legacy systems, and rapidly insert new technologies as they are needed.

The concept development approach begins with the project goals:

- Develop “to-be” Concept Architecture for EC08 (and beyond) based on interoperability specifications that are implemented, used, and supported by industry.
- Plan and conduct OGC Pilot Initiative to identify, test and integrate OGC standards based industry components into EC
- Engage industry, and specifically the Empire Challenge participants, to influence, implement, test, and adopt standards-based interoperability specifications in support of EC08.

The initial objectives in this planning phase were to:

- Understand the EC07/08 requirements, scenarios, and architecture (activities, technologies, services and information);
- Evaluate level of interoperability achieved in EC07 and identify areas for improvement based on existing and emerging standards

- Develop concepts, patterns and strategies for insertion, integration, testing and eventual deployment of systems that implement OGC interoperability specifications.

2.2 Purpose

> *"The goal is that we get ISR to the point where the warfighter doesn't have to worry about where his information is coming from, he just knows that we have the capability to "plug and play" ISR capabilities in to the mix so that his information needs are met – with timeliness and precision."* [1]

In addition to the common need to support delivery of data and services to end-users via Internet standards and Service Oriented Architecture (SOA), the "to-be" architecture must also specifically address a challenging set of organizational, operational and technical constraints that the ISR community operates within to fulfill the mission. These advanced and unique needs include:

- Integration of existing C4ISR Enterprise organizations, people, systems, software components, and algorithms
- Support for concurrent processing across distributed computing clusters for scalable ISR collection, processing, analysis and exploitation and for time-efficient delivery to end-users
- Discovery and access of disparate and loosely coupled resources from multiple locations and potentially operated or controlled by coalition partners and commercial interests
- Secured and authenticated access and distribution of datasets with classified or otherwise sensitive distribution constraints
- Support for distributed messaging infrastructure capable of supporting high volumes of message/data traffic and deployment on mixed computing platforms, networks and security domains
- Leverage open standards and maximize use of COTS products
- Support operation within network-austere environments (e.g., limited/unpredictable availability, bandwidth-constrained, multi-level security).
- Support inherent and pervasive human-oriented decision making processes and workflows

In addition to the above issues, the architecture must provide a firm foundation for dynamically changing tactical and strategic ISR activities, providing the ability to scope and estimate the resources required to instantiate the architecture and deploy for operational use.

2.3 Scope

This Concept Architecture is intended to provide system context for insertion, into the EC08 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) specifications.

OGC specifications capture general purpose capabilities independent of any particular operational environment. For many organizations, however, these general capabilities are not sufficient and additional engineering is required to provide developers the design details and guidance they need to apply OGC specifications within the specific operational context of the

[1] J28 division chief from http://www.jfcom.mil/newslink/storyarchive/2007/pa071607.htm

target system. OGC Implementation Profiles provide that guidance. This document provides the context for definition and testing of Implementation Profiles.

This document is intended to provide a high-level architectural concept for the application of OGC Implementation Profiles to support the operational objectives of the C4ISR Enterprise in general and, specifically, those of the EC08 demonstration.

This document may be offered for consideration as a Best Practice Document by the OGC Specification Program.

3 Artifacts of the Conceptual Architecture Documentation

An architecture specification or description is a set of "rules" defining the structure, behaviors and relationships among the parts of a system. The architectural rules must allow for variability but otherwise provide the basic framework for scoping, designing, justifying, and planning the instantiation of a system. Architecture descriptions are ultimately communication tools and are meant to draw stakeholder attention to key aspects of a system design that address stakeholder needs and concerns. A concept architecture, like its name implies, attempts this same function for an emerging concept that is not yet sufficiently defined to be considered a discrete system. Supposing the design for an EC08 pilot initiative requires this approach as many factors will ultimately determine the true form of the EC08 ISR enterprise and the systems that comprise it. In this context, a concept architecture must continually adapt as aspects of the system become known and as strategic decisions are made concerning exercise themes, players, and objectives. Ultimately, as the exercise becomes more concretely designed, this concept architecture will approach the rigor and depth of an integrated system architecture detailing correct operational, system, and service topologies. Due to the emerging and perhaps wandering nature of the initial phases of this concept architecture it contains a repository of architectural artifacts that reflect the current state of knowledge or hypotheses concerning eventual aspects of the EC08 enterprise. To this end, we have elaborated key aspects of both the expected EC08 ISR enterprise and places where we believe there to be rich possibilities for OGC technology enablement.

The DoD Architecture Framework v1.5 specifies an orderly method to describe architectures in a normalized fashion that promotes reuse, integration, and direct comparison with the descriptions of other related DoD systems. DoDAF products are collected into four views, each with a group of standardized products that in total can describe the essential nature of any proposed or extant system. Generally, not all DoDAF products are needed or required to describe an architecture with sufficient detail to relay key design aspects or driving issues. Rather, specific products are chosen to amplify certain aspects of a design. Applied to the task of evolving a concept architecture, we have chosen DoDAF products that we feel codify what is known to date about the EC08 ISR enterprise and where we speculate operational contributions of open geospatial services and standards can be made.

Figure 2 diagrams how some of DoDAF's modeling products, in particular the Operational View (OV series) and Systems and Services View (SV Series) capture the details of pieces of the concept architecture and the many relationships between these pieces. Section 5 will describe these in greater detail as a means to review key aspects of the architecture.

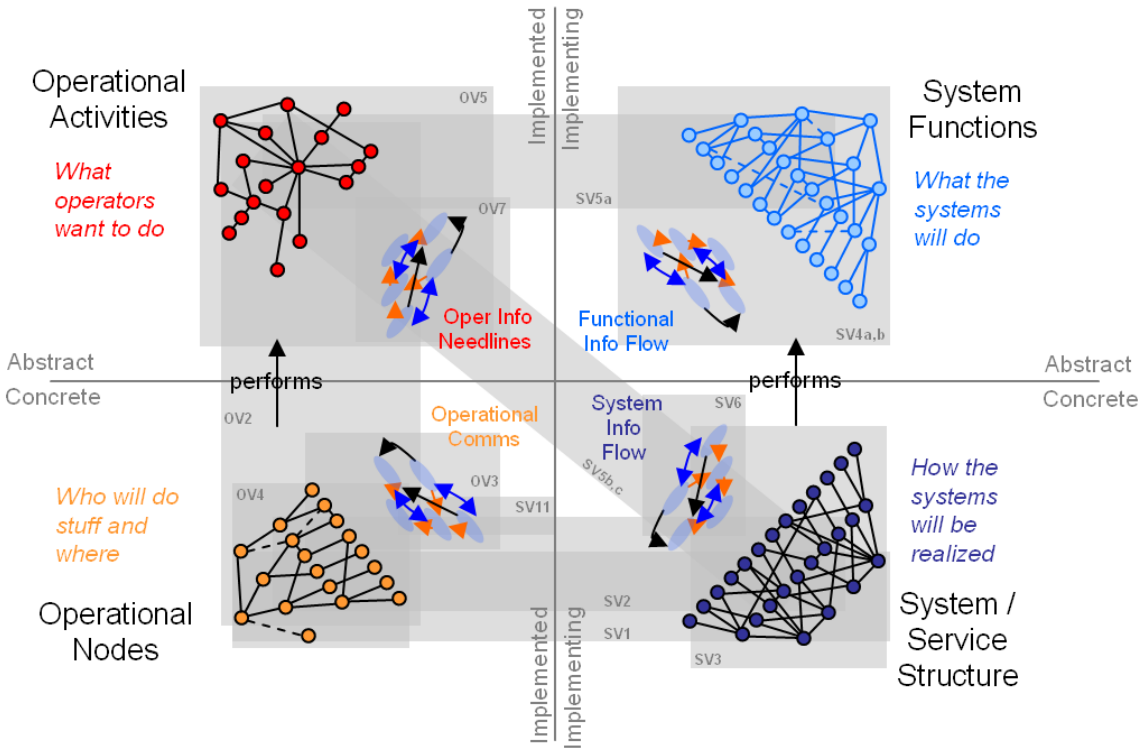


Figure 2 DoDAF Products Describing a Concept Architecture

Underpinning the development of the DoDAF products we present beginning in Section 5, we collected or began assembly of the following work products:

- **System Context** – represents the entire system in a few diagrams and identifies the interfaces between the system and external entities, their information and control flows, the events, users, inputs and outputs, external devices, data received and produced by the system, etc. This info was used to detail and scope the overall operational and system views.
- **System Actors** – identifies and describes the intended users and entities that will ultimately interact with pilot capabilities and describes characteristics relevant to their interaction with the system. The purpose of this information is to provide baseline guidance to developers on user interface design, establish performance standards for usability evaluations, define test scenarios for usability test plans and usability testing. User profiles initially guide interface design, performance standards and usability testing. System actors were used to elaborate and develop the operational nodes of the system and how they are linked to operational activities.
- **Use Case Models** – specify how users in specific roles use the system and how the system responds and interacts with users and external actors. The basic business need(s) and detailed business requirements, assumptions and constraints are the primary input to the process and are typically provided by C4ISR stakeholders, subject matter experts, and lessons learned from previous campaigns. Use Cases were also used to develop operational views as they describe operational activities and system actors, and suggest operational information flows.
- **Functional and Non-Functional Requirements** – describe desired functional behaviors of pilot system capabilities (derived from use cases) and addresses those aspects of the system that can have a profound effect on how the system is accepted by stakeholders.

The major non-functional themes include: performance, scalability, availability (robustness), maintainability, security, privacy, usability, data integrity, etc.

- **Systems and Services Overview** – depicts the governing ideas and candidate building blocks of the system, and provides an overview of the main conceptual elements and relationships, including subsystems, components, nodes, connections, data stores, users and external systems. Also documents important decisions about aspects of the architecture and design, including the structure of the system, provision and allocation of function, contextual fitness of the system, business or technical assumptions and constraints, adherence to standards, technologies, 3rd-party products, design patterns, etc. This information is used to populate the Systems and Services Views.
- **Information Model** – provides a structural representation of the information concepts, data objects and the static relationships comprising the "to-be" system. While this work product is iteratively refined over the lifecycle of the project, the initial conceptual view focuses on the analysis of what is needed for the solution (i.e., what aspects of the business model are to be included in the software system). This work product refines the system boundary, creates a starting point for design of other architectural layers, improves the understanding of the design and system intent, etc. The information model is used in the Systems and Services Views and can be linked to needlines in the Operational Views.
- **Component Model** – while this work product is iteratively refined over the lifecycle of the project, the initial conceptual view starts to describe the role, responsibilities, characteristics, interfaces, dependencies and collaborations of the software services, modules and components comprising the system. This is the main work product documenting the functional aspect of the architecture of the "to-be" system. The Component Model provides the details necessary to construct several of the Systems and Services Views and elaborate the system structural and functional models.
- **EC07 and System Documentation** – these items were reviewed to suggest EC08 operational details (e.g., possible operational nodes and actors), probable C4ISR functionality, and likely systems components. In total, these were used to add detail to all the DoDAF products.

4 Development Methodology and Documentation

Our conceptual architecture specification methodology began with an investigation of technology elements known to be EC08-relevant. To this end we collected substantial information on DCGS, NCES, DCGS Integration Backbone (DIB), FMV collectors, and video formats. We also reviewed numerous EC07 findings and designs to paint a likely picture of the probable nature of the EC08 operational and system/service environment. We were also aware that EC08 might again address the complicated problem of ISR and targeting integration and thus conducted a high level functional decomposition of ISR support to targeting resulting in an extensive family of potential use cases. Assessing the time/space dynamics of EC07 and the context of a hypothetical air/space operations center (AOC) it was possible to suggest that the theater-level dynamic (time-sensitive) targeting functional space nicely crosses the activity spaces of the other known EC08 capability objectives. Figure 3 depicts this notion. This realization focused our efforts on elaborating use cases from that dynamic. Combining the resulting use cases, which reveal probable actors, scenarios, assumptions, and activities, with the EC08-relevant technologies provided us a way to speculate where known open geospatial technologies and standards would be directly relevant in the probable exercise context. The work products that resulted from these analyses were then used to assemble standard DoDAF products to codify and present key aspects of the EC08 ISR enterprise and concepts for the potential OGC pilot.

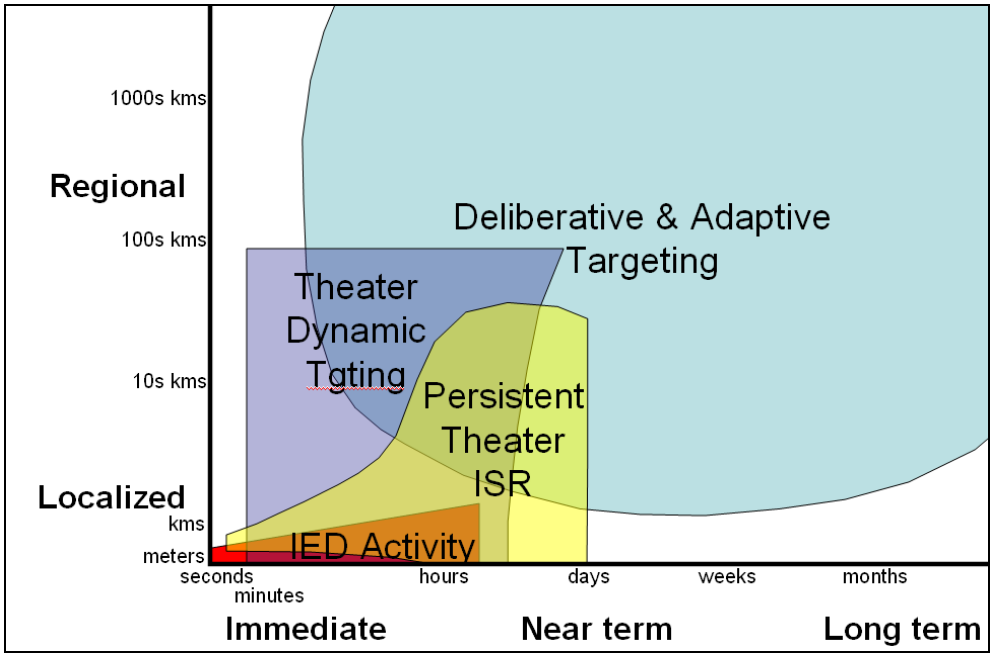


Figure 3 EC08 Expected Activity Space

The EC08 Initial Planning Conference suggested that EC08 activities be binned into several joint mission threads (JMTs) as diagrammed in Figure 4. The EC08 JMTs serve to administratively partition EC08 exercise planning and draw attention toward key capabilities that will play roles and thus be assessed in the course of the exercise. While appearing distinct, functionally the JMTs are parts of a larger operational cycle that includes persistent surveillance to maintain multi-domain awareness and that must scale to meet the more cyclical demands of joint targeting and NT-ISR (essentially time-sensitive strike). The balance between the needs of surveillance/awareness and targeting operations requires agile and dynamic ISR management.

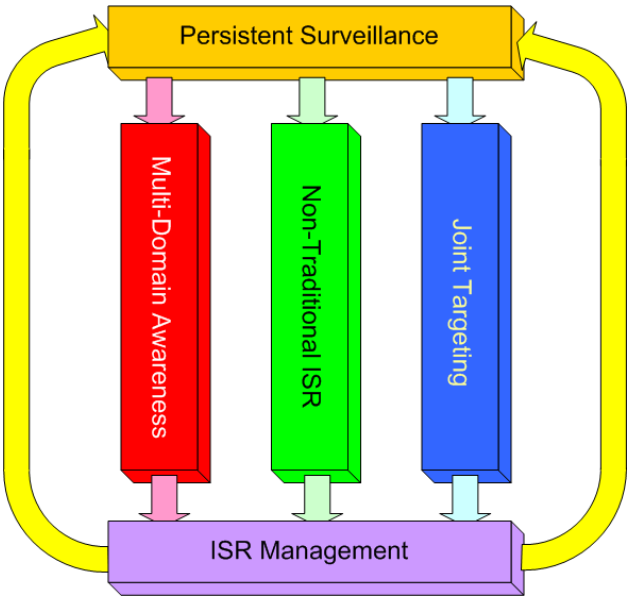


Figure 4 EC08 Joint Mission Threads

As the EC08 exercise and the proposed pilot become better defined, the work products and their DoDAF manifestations will approach the actual state of the exercise technology deployment and thus will serve to both explain them and document them in an acquisition-ready format. We also expect that several architectural products will be useful for developing EC08 test plans and conducting technology assessment activities.

In concert with and in addition to the activities described above our approach attempts to develop the following key issues that inform the architecting process and products:

4.1 Needs and Environment

- Data needs
  - Identify the types of data (e.g., spatial, non-spatial, pictures, metadata, etc) and data products that must be ingested or accessed by the system.
  - Identify the types of data and information products to be produced by the system.
  - Identify the data formats for storage and exchange that must be supported.
  - Identify how frequently data are updated and characterize the nature of the updates. What is the “granularity” of the data updates? Which datasets get updated?
  - Characterize the criticality of the data to the mission of the system’s users. Must access to the data be always available 24x7? What are the risks if they are not immediately available?
  - Identify the distribution constraints of the data. Characterize the level of Digital Rights Management (DRM) that must be supported.
  - Scope the data storage volume requirements of the system.
- Operational needs

  - Characterize the business model for operational use of the “to-be” system. Are services “outsourced” to external, coalition partners? How frequently?
  - Identify the business continuity, security and performance requirements of the system.
- Target computing environments
  - Identify the software, middleware, database, and network communications of the to-be SOA-based system.
  - How do these needs vary for the back-end, Web service, application development, and application client tiers?
- Data sharing and interoperability
  - Identify the technology and data standards required for the system.
  - Characterize the nature of connectivity to external systems. What types of services? How many? How frequent? How reliable? How much data must be transmitted?
  - Identify the needs for data sharing with stakeholders. Are the data to be accessed and shared changing dynamically or relatively static? Is access required to be online or is offline transmission (e.g., via DVD) acceptable?
  - Characterize the needs for dynamic discovery of relevant resources (data and services) among stakeholders. Must metadata be produced, published and updated for online discovery of these resources?

4.2 Relevant Available Technologies

- C4ISR Technology
  - Develop approaches for partitioning, clustering, parallelizing and distributing the core systems and processes of the existing C4ISR Enterprise. How can OWS technology best be integrated within the distributed computing environment of the to-be architecture?
  - Assess technology options for distributing, clustering and parallelizing the system.
  - Assess options for improving the robustness (reliability, recovery and security) of the system.
- Data handling technology
  - Understand how the data flows thru the system, as currently configured, and for the desired (to-be) data flows. Where is automation required to reduce costs and eliminate bottlenecks?
  - Characterize the technology options for automating data handling and workflows required of the system and recommend procedures and technologies.
- Application development technology
  - Characterize the state-of-the-art and best-practices for Web-based application development environments and tools.
  - Identify options for application development frameworks and tools and define profiles of commercial and open-source solutions for use within the to-be system.
  - Define and recommend application development technologies and preferred methodologies and practices for the “to-be” system.

- Web services technology
    - Characterize the state-of-the-art and best-practices for provisioning Web services and Service Oriented Architectures. What are the best available options from the commercial and open-source realms?
    - Identify the technology and standards profiles for provisioning an open standards based interoperability framework of Web services.

4.3 Modeling Activities

With the requirements gathered and validated and a framework of data, technology, and standards profiles identified, the key artifacts of the architecture specification are the modeling activities identifying the information and service models of the system. These activities are used to capture the essential data and service aspects of the system:

- Information Model
    - Represents the understanding of business information structures and rules, enabling communication of this understanding to all stakeholders.
    - Provides an implementation-free set of requirements for the physical database and data processing designs.
    - Clearly and uniquely identifies key business entities in the system.
- Component Model
    - Helps to manage the complexity of the overall solution.
    - Supports the organization of the project.
    - Establishes the linkage with the operational aspects of the business.
    - Establishes traceability between the architecture and the design level activities.
    - Establishes traceability between requirements (functional and non-functional) and the architecture.

5 Operational Views

5.1 Overview

The OV-1 depicted in Figure 1 draws attention to the net-centric, hyper-dynamic, multi-participant, compartmented and geographically distributed nature of the C4ISR Enterprise. These characteristics present challenges for maximizing resource utilization and data sharing in support of the mission.

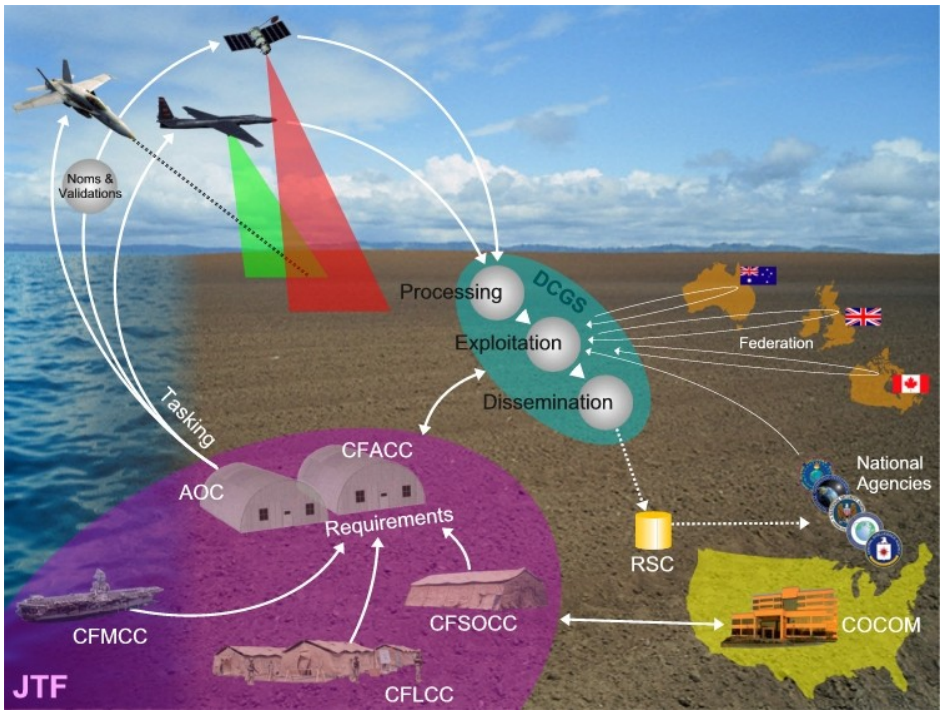


Figure 5. OV1- High Level Concept for EC08

Horizontal Intelligence [2] (HI) is the set of processes and capabilities to a***cquire, synchronize, correlate, and deliver*** C4ISR data with responsiveness to ensure success across all policy and operational missions.

Horizontally integrating warfighter intelligence data improves the consumers' production, analysis and dissemination capabilities. HI requires ***access*** (including ***discovery, search, retrieval, and display***) to intelligence data among the warfighters and other producers and consumers. These consumers include, but are not limited to, the COCOMs, Services, Defense agencies, and the Intelligence Community.

Goal:

To improve HI, the C4ISR activities within and supporting the joint force must implement ***data sharing*** among intelligence capabilities, services, processes, and personnel interconnected within shared spaces in accordance with the DoD Net-Centric directive and strategy.

5.1.1 DCGS "As-is"

The "as is" DCGS environment has been characterized by CJCSI 3340.02 in this way:

- Multiple sensors invoke one or more processes to store data in disparate repositories, most often within a single intelligence discipline

[2] "Horizontal Integration of Warfighter Intelligence," Chairman of the Joint Chiefs of Staff Instruction CJCSI 3340.02, 23 December 2005.

- Organizations accessing intelligence data invoke separate processes and often view data at differing points as it moves from repository to repository

- Some organizations must access data through other organizations.

- The minimal metadata tagging needed to make data discoverable and meaningful to the warfighter is not always applied at the earliest possible point.

- Sensors can use a combination of onboard, single ground station, and multiple ground station processing to move data to a repository…

    - Some data goes to Distributed Ground Systems (DGS), other data goes to local, regional, and functional repositories.

    - Tactical organizations invoke a different processing system to acquire data from each location.

    - Some external organizations can acquire data using the same processing systems as tactical organizations; others require a more accessible location, such as a national repository, to acquire the data

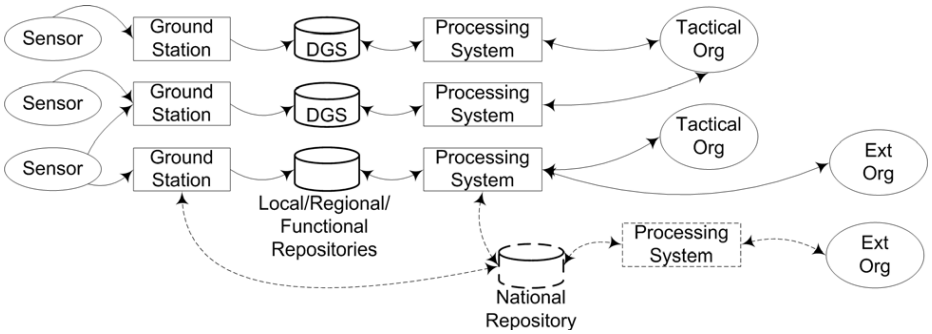


Figure 6. DCGS As-Is (OV-1)

In short, as Figure 6 shows, the DCGS is constructed from stove piped systems, with multiple and often incompatible ways to process and store data, where data is accessed at different repositories at different times by different systems and with minimal metadata, applied too late in data collection and processing workflows.

5.1.2 DCGS "To-be"

The CJCSI 3340.02 goes on to describe the desired "to-be" state of DCGS:

- All sensor data is posted to shared space using repeatable processes and composable, standards-based services, which includes tagging for discovery prior to posting.

- Organizations accessing intelligence data invoke the discovery processes to locate data and access the data in shared space.

- Organizations conduct processing, exploitation, analysis, and production activities using repeatable processes and composable, standards-based services in shared space.

- Sensors interface with DCGS through a composable and standards-based set of services in the DCGS Integration Backbone (DIB) and Net-Centric Enterprise Services (NCES).
- Tactical organizations access the shared space through the same set of services.
- NCES link the tactical shared space to more accessible shared spaces, such as those available on Intelink or stored in a DODIIS, RSC, NDC, or RSOC.
- External organizations unable to interface directly with DCGS gain access from another shared space via NCES

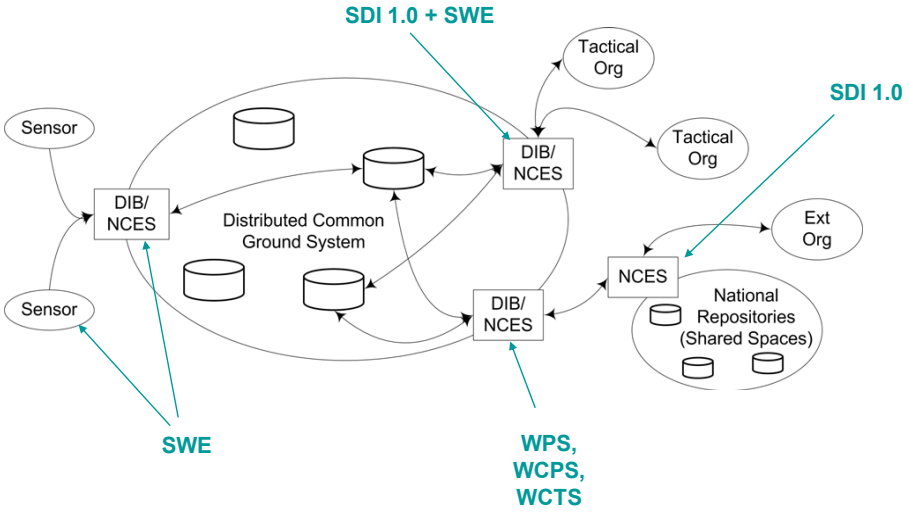


Figure 7. DCGS To-Be with OWS Services (OV-1)

In short, as Figure 7 shows, the objective state should exhibit these qualities:

- *Sensor data posted to shared space*
- *Common processes used to locate and access data*
- *Sensors interface to system via composable, standards-based services*
- *Processing, exploitation, analysis and production via composable, standards-based services*
- *Dynamically describe and discover sensor attributes and capabilities*
- *Data tagged with metadata at the source to enable federated discovery and exploitation*

Note in above figure that OGC Web Service (OWS) specifications for sensor handling, GEOINT data processing, discovery and exploitation are identified at key interoperability points in the to-be system.

5.2 Use Cases

We developed an extensive library of annotated UML use cases to support OV5 (Operational Activity Model) definition. These use cases were developed on the premise that EC08 will in part focus on the role that FMV resources will enable the targeting cycle in a distributed, multilevel, coalition environment. We stressed the full motion video (FMV) role as it is expected to figure prominently in the EC08 sensor architecture, supports (or is supported by) all five JMTs, and represents a dynamic that has not been fully 'bedded-down' and integrated with the greater C4ISR enterprise that is characterized by distributed, multinational and commercial players operating within enclaves of differing security levels. We chose this set of use cases as it leverages each of the JMTs in some way and represents a logical, sequential means to expose the core activities we expect to see performed during the EC08 evolution.

To determine candidate use cases, we 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. In particular, we focused on how and where FMV is used throughout these cycles. This approach was useful in that it flushed out relevant actors, assumptions, activities, and typical activity sequences.

The accompanying EC08 Use Case Exposition Report details the result of our use case investigation. It systematically walks through and describes the use cases that we felt most relevant to the EC08 exercise. As we mentioned in Section 4, we focused on FMV support to deliberate and time-sensitive targeting. In doing so, we exposed many of the activities that support the five JMTs. We also elaborated several resource posture change use cases and several architectural use cases that attempt to generalize commercializing, distributing, securing, and/or internationalizing nodes of the ISR enterprise.

The following three figures present the functional setting of the use case families derived from the initial phases of the deliberative joint targeting cycle, the time-sensitive (dynamic) targeting cycle, and the Combat Assessment stage of the deliberate cycle. Each family of use cases is numbered in the square boxes on the figures and is presented in that order.

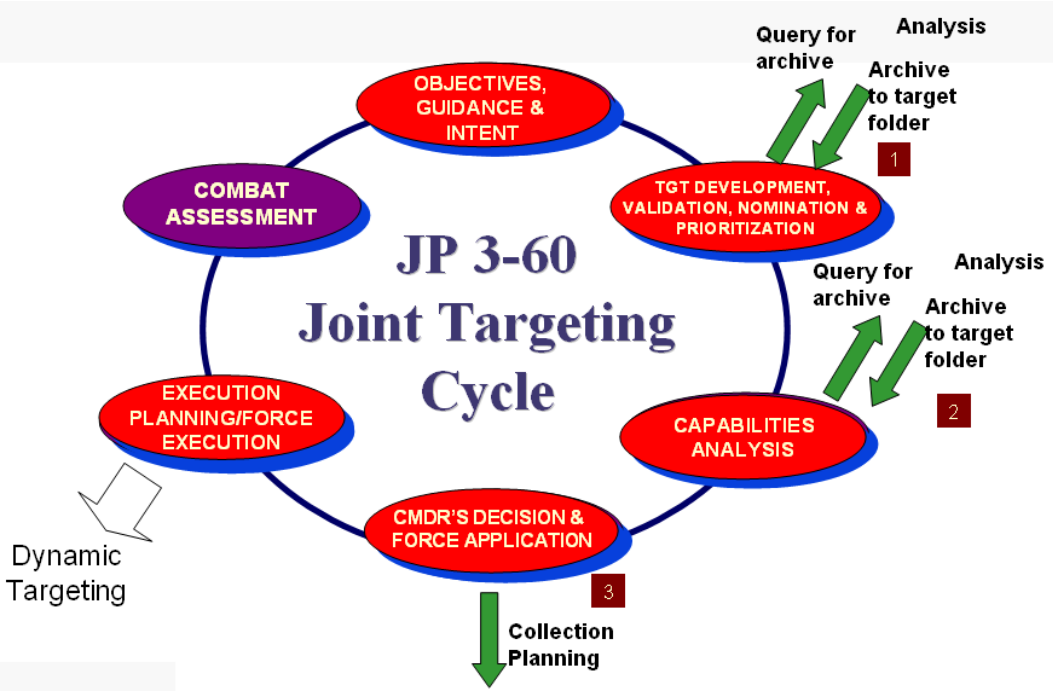


Figure 8 JP 3-60 Use Case Families

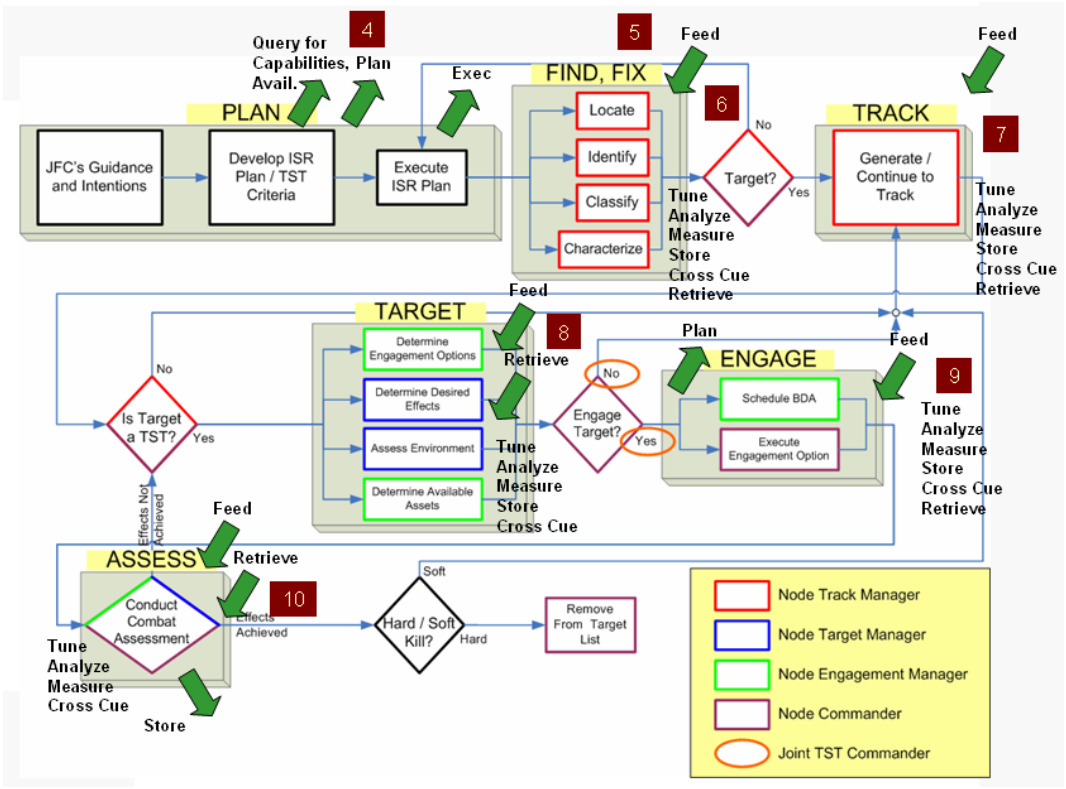


Figure 9 TST Use Case Families

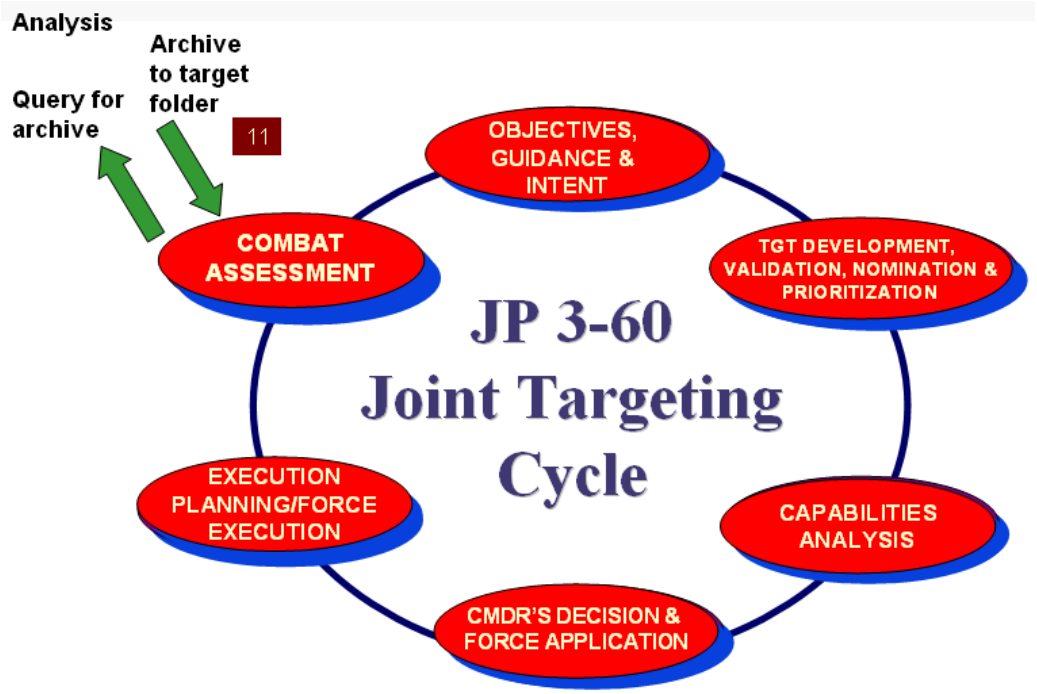


Figure 10 Combat Assessment Use Cases

The following figure provides a high level listing of actors and use cases developed during the functional decomposition process.

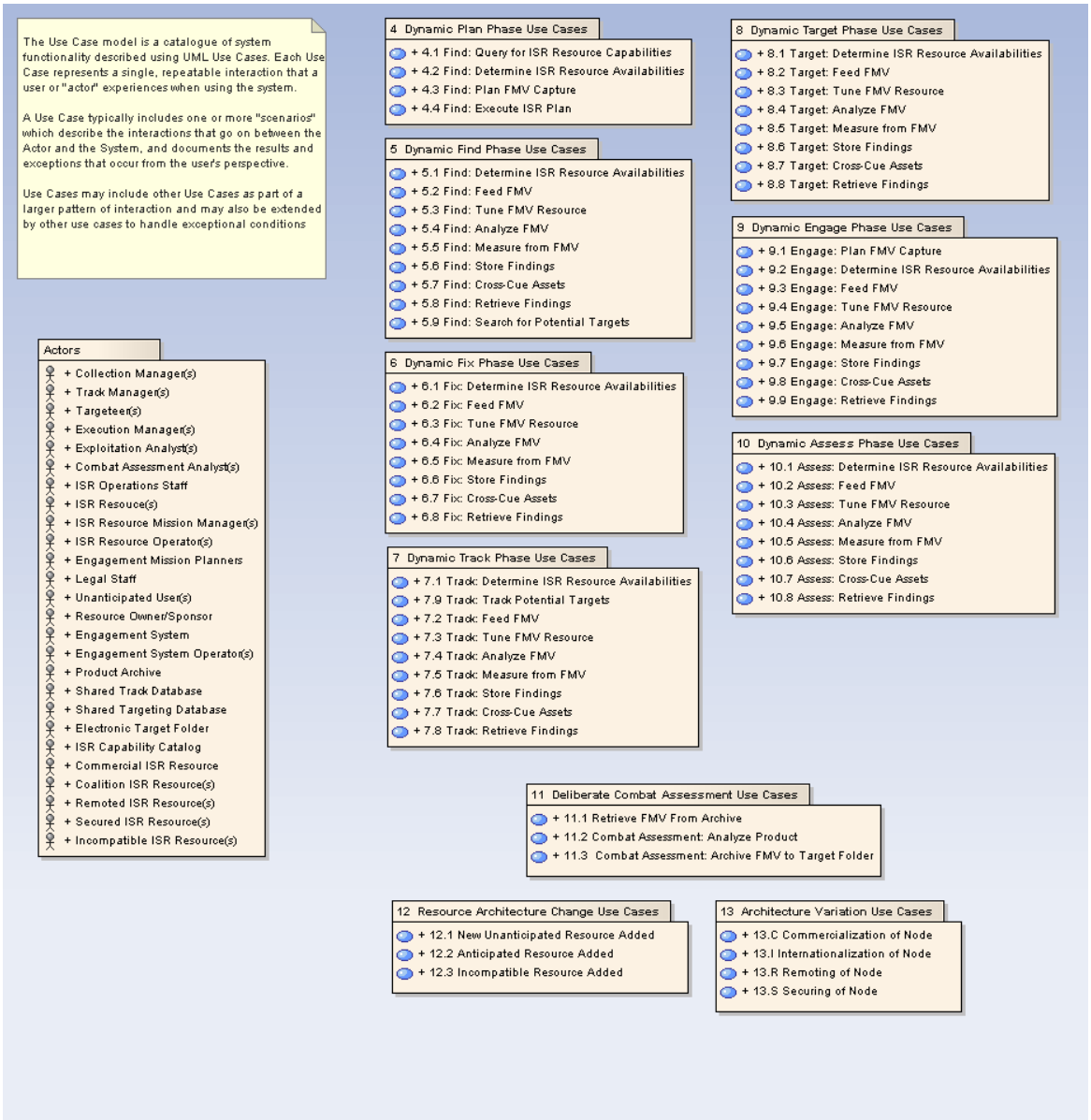


Figure 11 Use Case Model with Actors

The following figures provide additional explanation and exposition of these use case families. Cases in yellow highlight show particularly strong potential for open geospatial technology insertion. Additional detail can be found in the Use Case Exposition document.

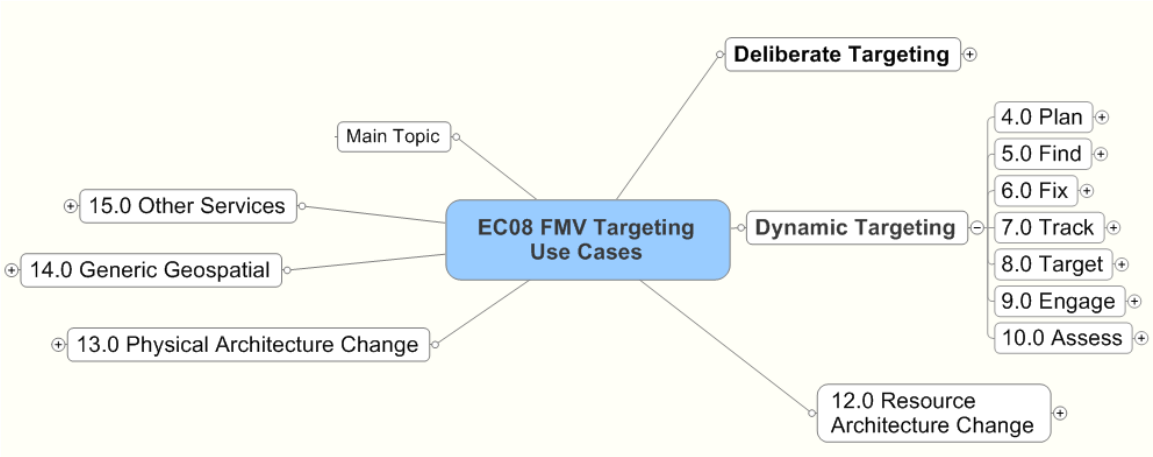


Figure 12 Top Level Use Case Structure

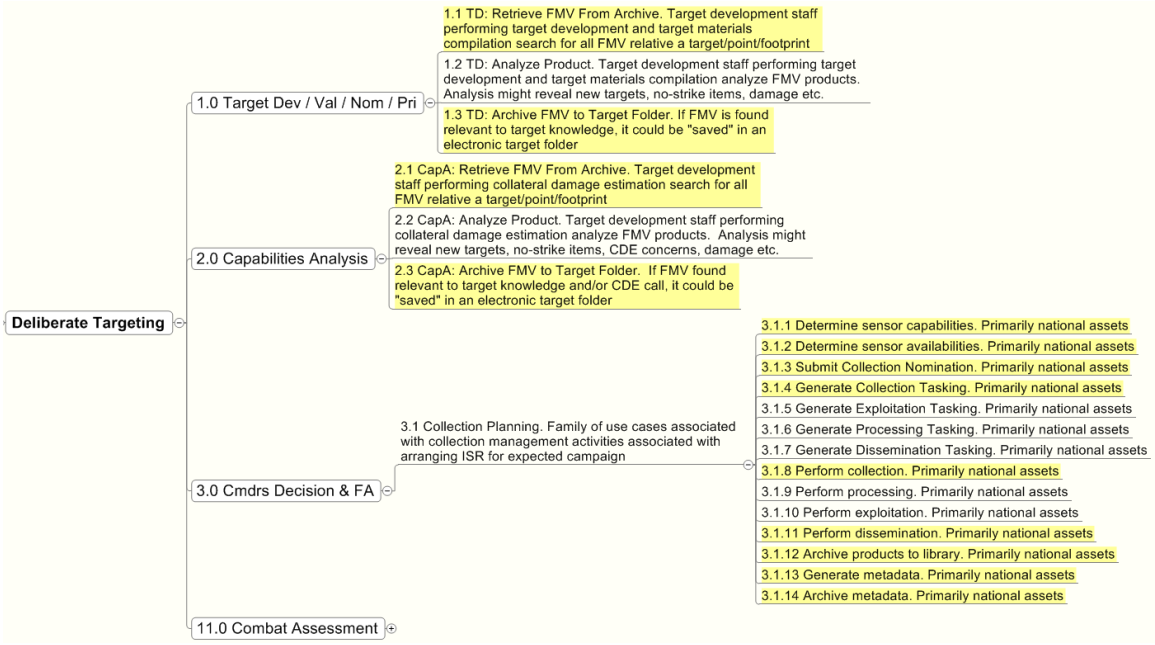


Figure 13 Detail: Use Case Families 1-3

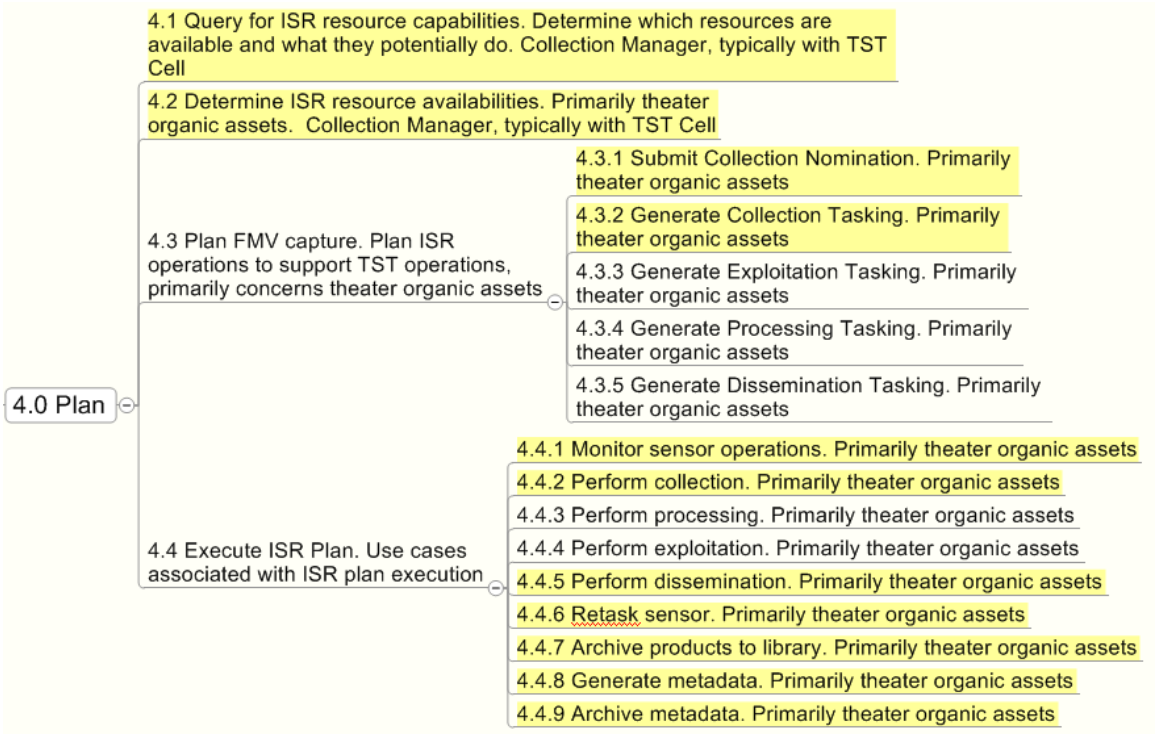


Figure 14. Detail: Plan Use Cases

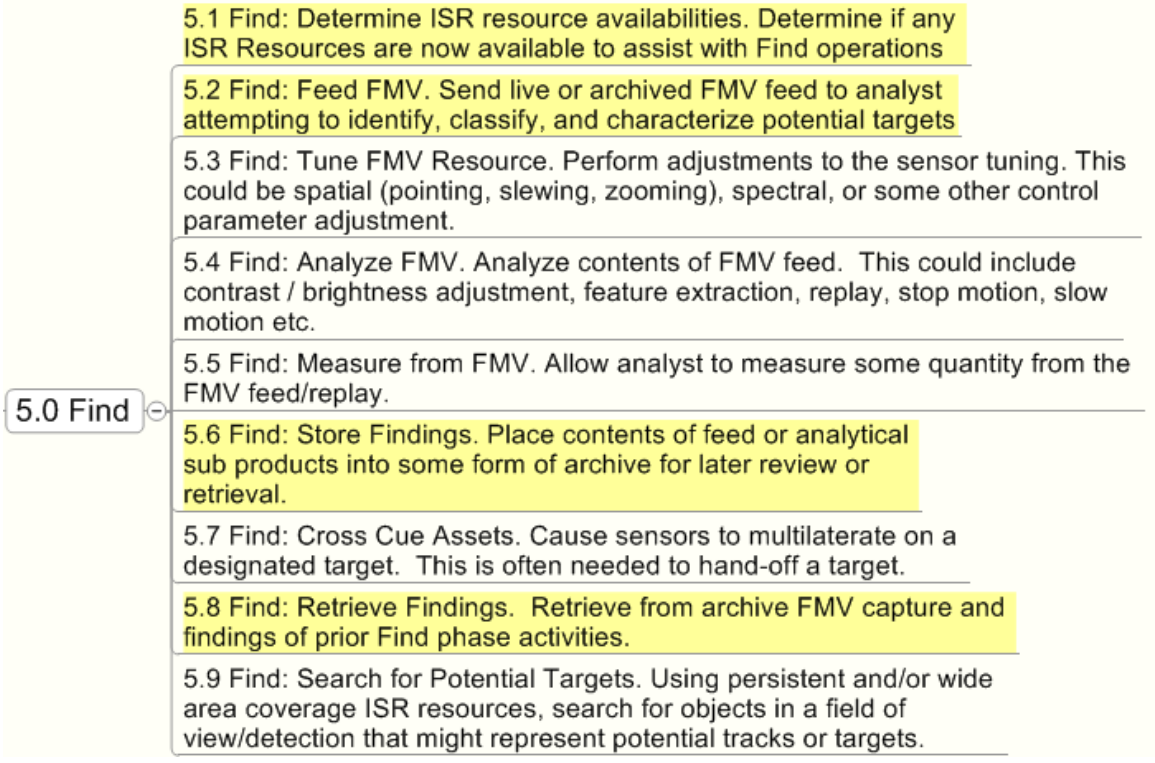


Figure 15 Detail: Find Use Cases

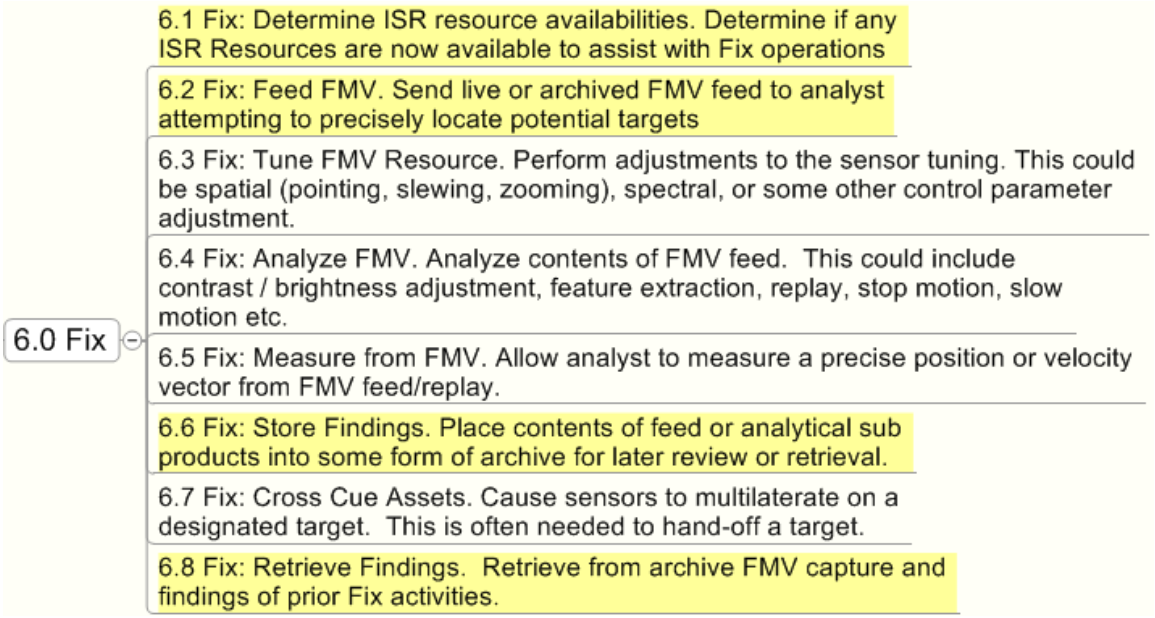


Figure 16 Detail: Fix Use Cases

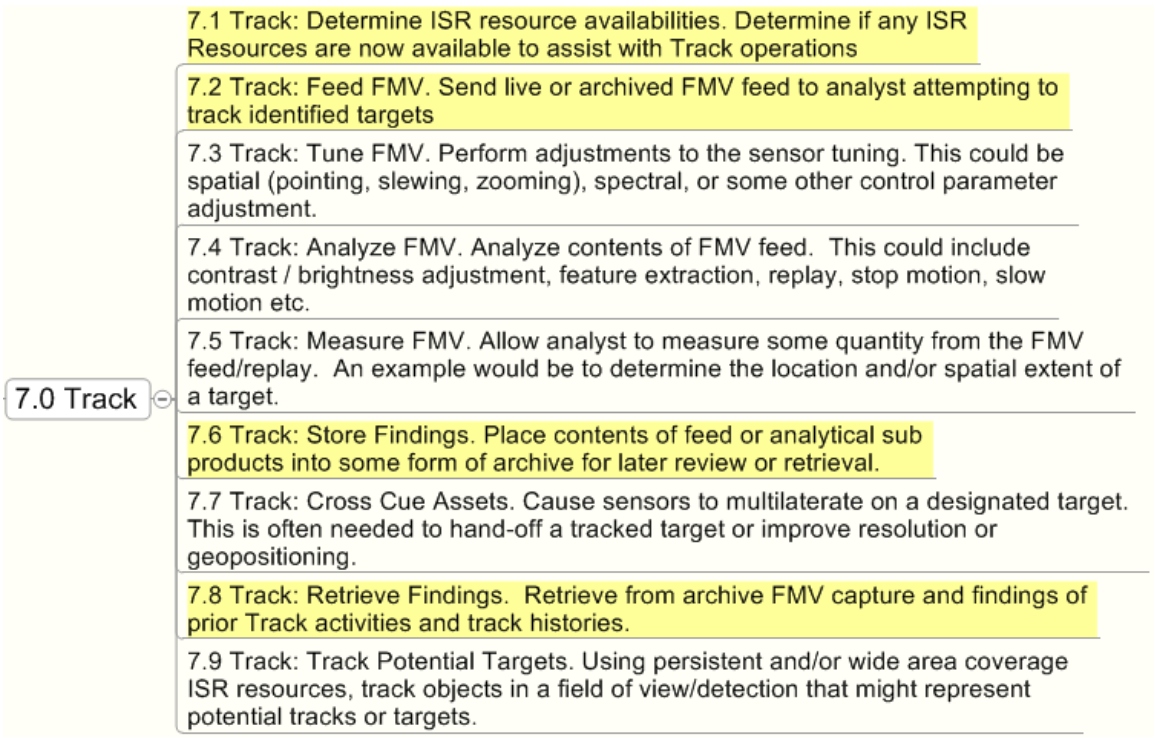


Figure 17 Detail: Track Use Cases

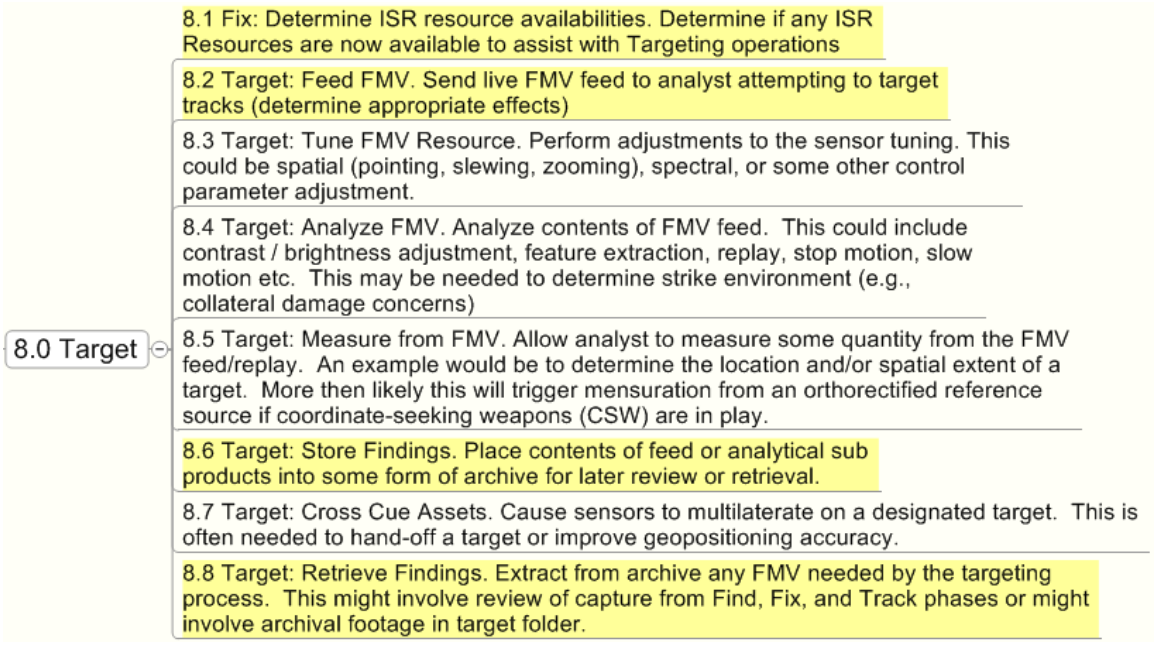


Figure 18 Detail: Target Use Cases

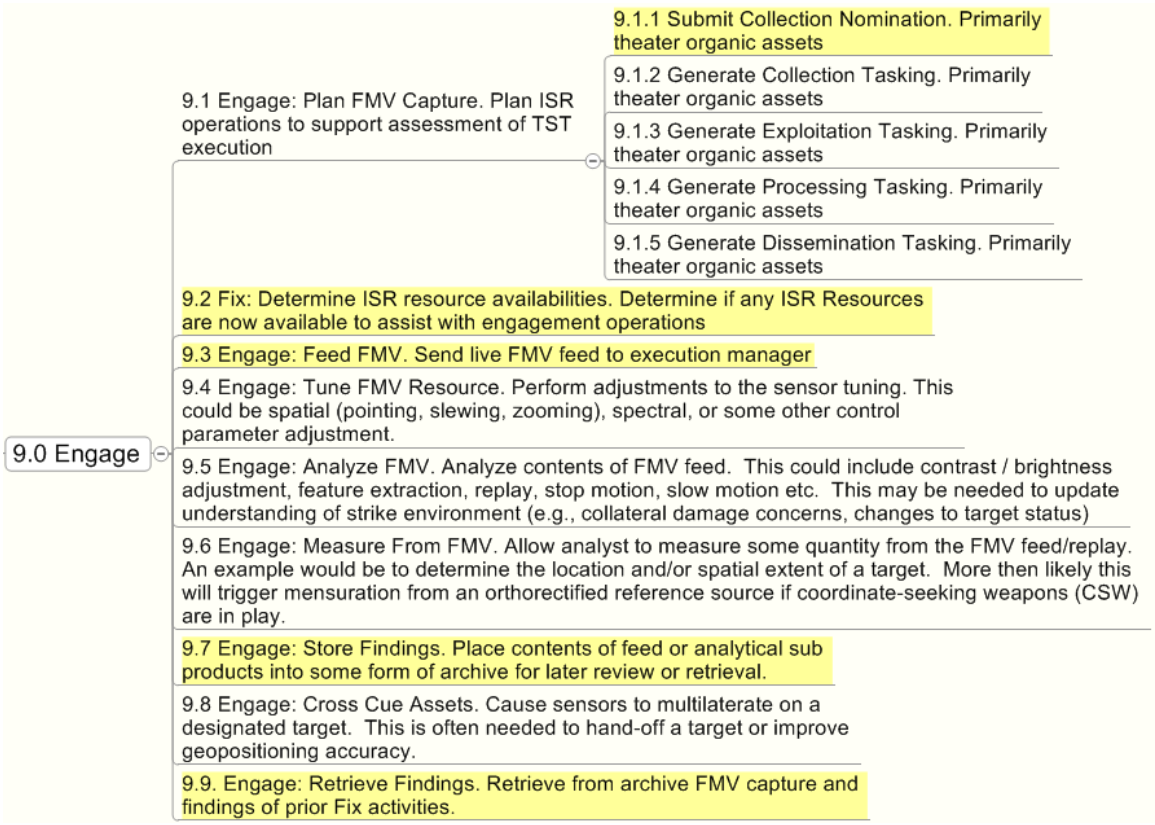


Figure 19 Detail: Engage Use Cases

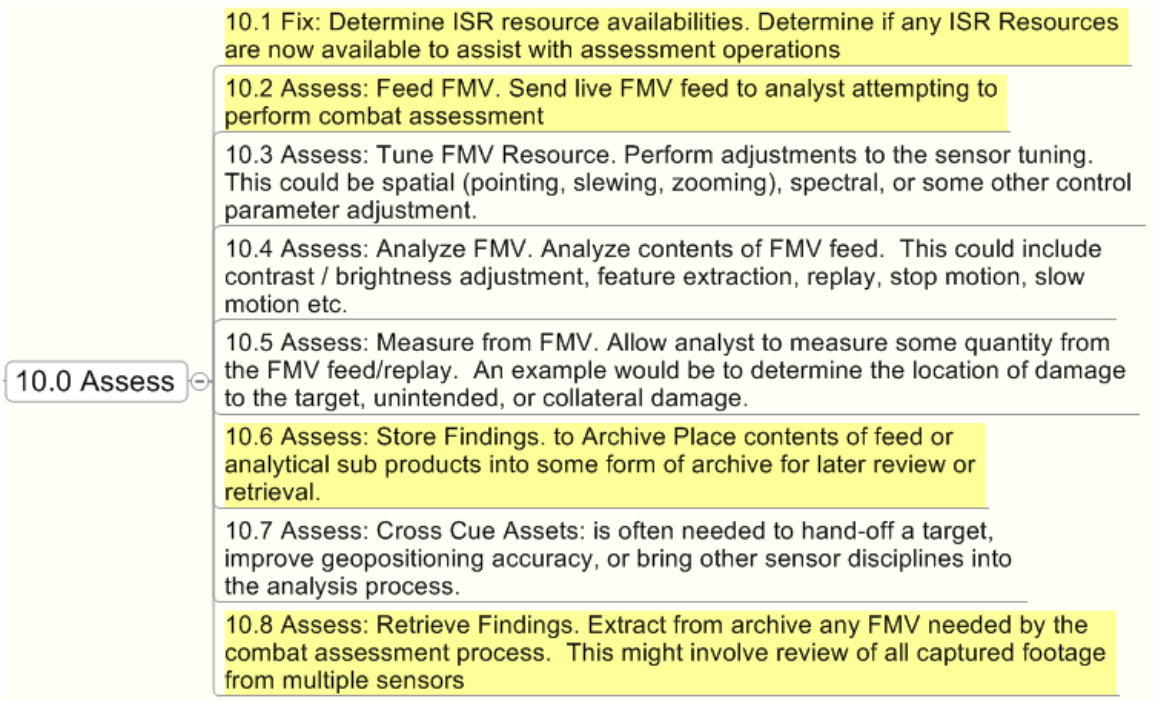


Figure 20 Detail: Assess Use Cases

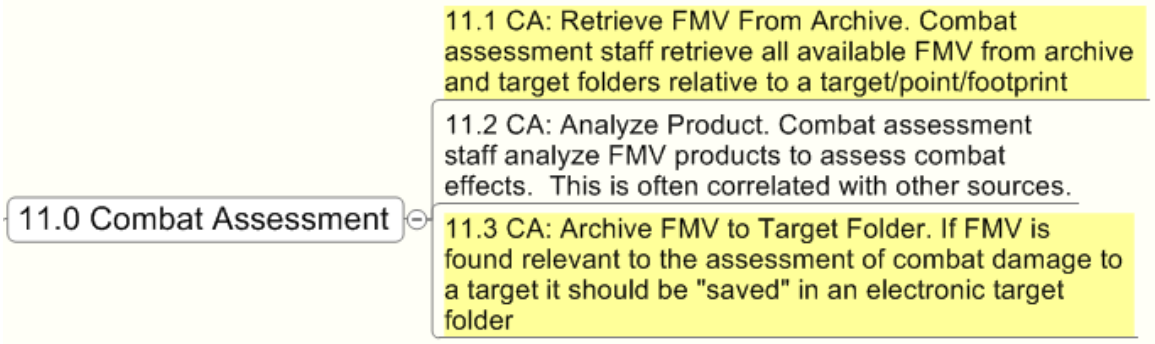


Figure 21 Detail: Combat Assessment Use Cases

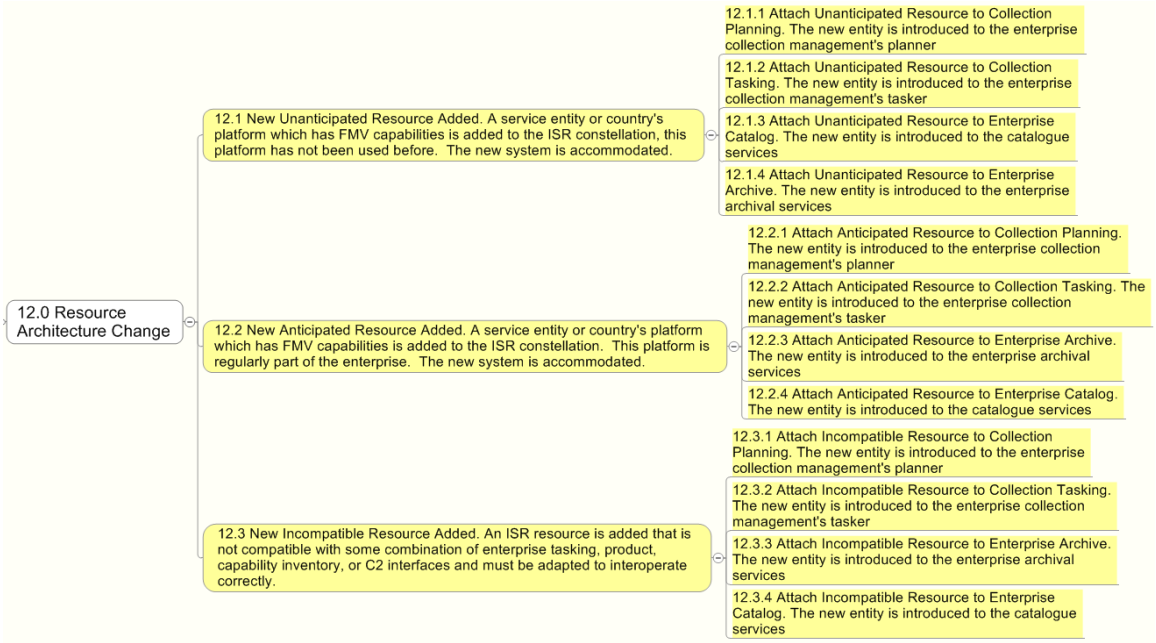


Figure 22 Detail: Resource Change Use Cases

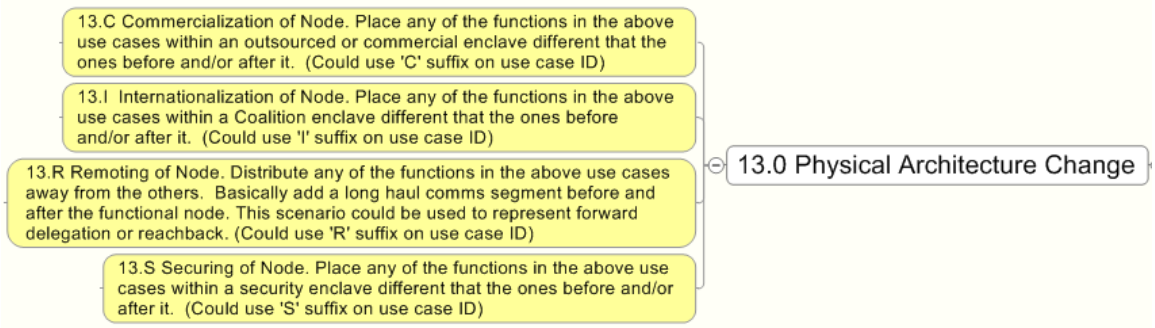


Figure 23 Detail: Architectural Use Cases

6 System Views

The System View (SV) describes systems and services and interconnections that support, in this context, the C4ISR business functions described in the Operational Views section above. This section focuses on SV-4a (Systems Functionality Description) products documenting system functional hierarchies and system functions of a conceptual SV model supporting the C4ISR enterprise.

6.1 Overview

Figure 24 presents a very high-level depiction of OWS components operating at conceptual DCGS nodes: an “Observation System Node” and an “Information Management System Node”. Within the “Observation System Node” element, the OWS service components provide common

services for nominating/tasking sensor resources and accessing the resulting ISR observations and 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).

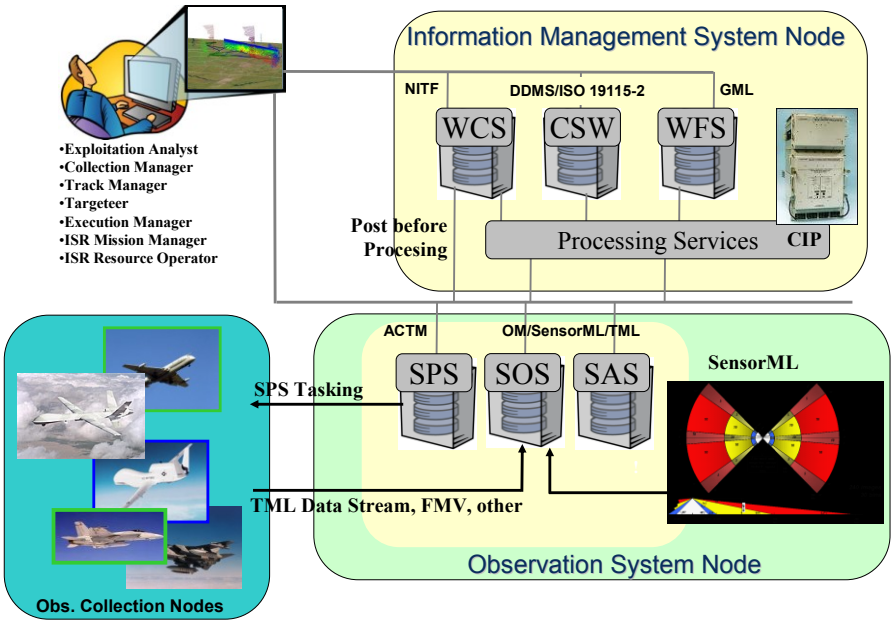


Figure 24. SV1 - OGC Web Service View

Resource managers, analysts and decision-makers, through the common behaviors exposed b 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 can, in turn, be stored, processed, shared and exploited.

6.2 System Functions

The System Functions identified here functionally decompose C4ISR functions into a hierarchy of "data transforms that support the automation of activities or information elements exchange." The functions listed were derived from the "DCGS SOA Service Portfolio (Notional)", also known as the "Chiclet Chart" among EC07/EC08 participants. In this work, the implied service components (chiclets) have been recast as common C4ISR "system functions" that are instantiated by DCGS systems.

6.2.1.1 Domain Functions

Domain Functions address specific functional domains of the C4ISR enterprise.

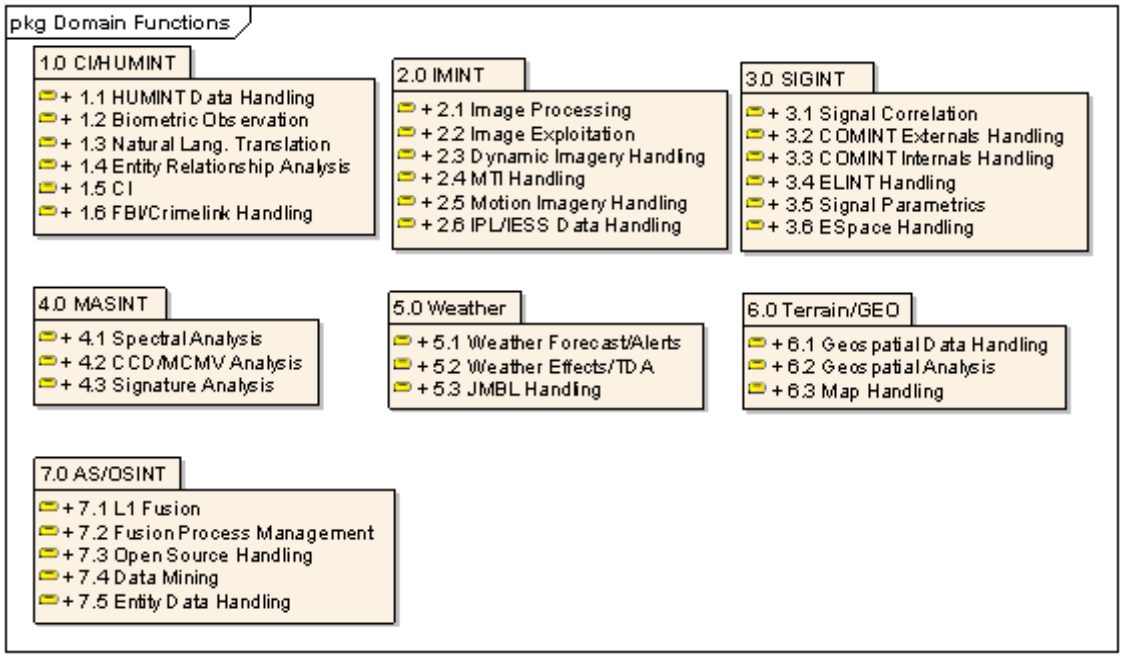


Figure 25. SV4a - DCGS Domain System Functions (functional decomposition)

DCGS Domain System Functions having particularly strong geospatial characteristics in which OGC specifications have high potential applicability are listed in Table 1:

Note: This analysis of potential applicability of OGC specifications in the tables that follow in this section is based primarily on recognition that most (and especially GEOINT) information has an explicit or otherwise implicit geospatial aspect to it and that data encodings can be enhanced if standard ways to model and represent geospatial information are leveraged. Similarly, standard ways to store, process, discover and access these data provide benefit within net-centric service oriented computing environments.

Table 1. OGC Specification support for DCGS Domain System Functions

DCGS System Function	OWS Services	OGC Encodings	Relevant OGC Specifications
1.1 HUMINT Data Handling	✓	✓	• WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
1.2 Biometric Observation	✓	✓	• WMS, WFS, WCS, SOS, WPS, SPS • GML, OM, SensorML, TML

1.6 FBI/Crimelink Handling	✓	✓	• WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
2.1 Image Processing	✓	✓	• WCS, SOS, WPS • GML, OM, SensorML, TML
2.2 Image Exploitation	✓	✓	• WMS, WCS, WPS • GML, SensorML, TML
2.3 Dynamic Image Handling	✓	✓	• WMS, WCS, SOS, WPS • GML, OM, SensorML, TML
2.4 MTI Handling	✓	✓	• SOS, WFS, SPS • GML, OM, SensorML, TML
2.5 Motion Imagery Handling	✓	✓	• SOS, SPS • GML, OM, SensorML, TML
3.7 COMINT Externals Handling	×	✓	• • GML, OM, SensorML, TML
3.7 COMINT Internals Handling	×	✓	• • GML, OM, SensorML, TML
3.7 Elint Handling	×	✓	• GML, OM, SensorML, TML
5.1 Weather Forecasts/Alerts	✓	✓	• WMS, WFS, WCS, SOS • GML, OM, SensorML, TML
5.2 Weather Effects /TDA	✓	✓	• WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
6.1 Geospatial Data Handling	✓	✓	• CSW, WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
6.2 Geospatial Analysis	✓	✓	• WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
6.3 Map Handling	✓	✓	• CSW, WMS • GML, SLD
7.1 L1 Fusion	✓	✓	• WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML

7.3 Open Source Handling	✓	✓	• CSW, WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML
7.4 Data Mining	✓	✓	• CSW, WMS, WFS, WCS, SOS, WPS • GML, OM, SensorML, TML

6.2.1.2 Core Functions

Core Functions provide support for multiple C4ISR Domain Functions via sets of common and reusable functions.

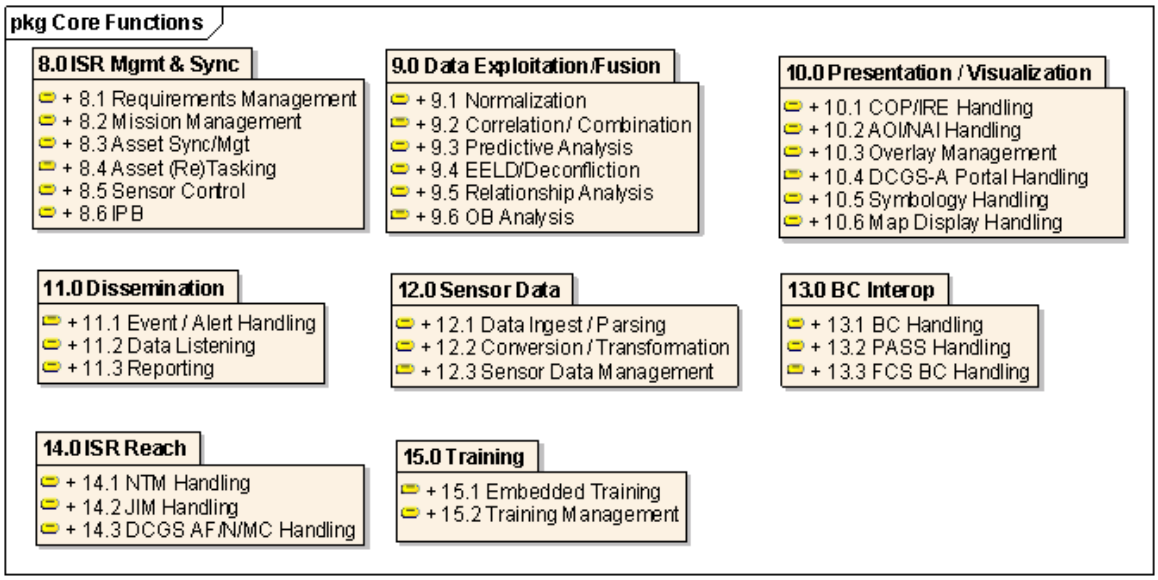


Figure 26. SV4a - DCGS Core System Functions (functional decomposition)

DCGS Core System Functions having particularly strong geospatial characteristics in which OGC specifications have high potential applicability listed in Table 2.

Table 2. OGC Specification support for DCGS Core System Functions

DCGS System Function	OWS Services	OGC Encodings	Relevant OGC Specifications
8.1 Requirements Management	✓	✓	• CSW, WMS, WFS, SPS • GML, SensorML, TML
8.2 Mission Management	✓	✓	• WMS, WFS, SPS

			• GML, OM, SensorML, TML
8.4 Asset (Re-)tasking	✓	✓	• SPS • GML, OM, SensorML, TML
8.5 Sensor Control	✓	✓	• SPS, SAS • GML, OM, SensorML, TML
9.1 Normalization	✓	✓	• WMS, WFS, WCS, SOS, CSW • GML, OM, SensorML, TML
10.1 COP/IRE Handling	✓	✓	• WMS, WFS, WCS, SOS, CSW, WNS, SAS • GML, OM, SensorML, TML, SLD
10.2 AOI/NAI Handling	✓	✓	• WMS, WFS, WCS, SOS, CSW, WNS, SAS • GML, OM, SensorML, TML, SLD
10.3 Overlay Management	✓	✓	• WMS, WFS, CSW • GML, SLD
10.5 Symbology Handling	✓	✓	• WMS, WFS, CSW • GML, SLD
10.6 Map Display Handling	✓	✓	• WMS, WFS, CSW • GML, SLD
11.1 Event/Alert Handling	✓	✓	• WMS, WFS, SOS, WNS, SAS • GML, OM
11.2 Data Listening	✓	✓	• WNS, SAS • GML, OM, SensorML, TML
11.3 Reporting	✓	✓	• WMS, WFS, WCS, SOS, CSW • GML, OM
12.1 Data Ingest Parsing	✓	✓	• CSW, WPS • GML
12.2 Conversion / Transformation	✓	✓	• WMS, WFS, WCS, SOS, CSW, WPS • GML, OM, SensorML, TML

12.3 Sensor Data Management	✓	✓	• CSW, SOS, WMS • GML, OM, SensorML, TML
14.3 DCGS AF/N/MC Handling	✓	✓	• WMS, WFS, WCS, SOS, CSW, WNS, SAS, WPS • GML, OM, SensorML, TML

6.2.1.3 Infrastructure Functions

Infrastructure Functions define an underpinning framework of services for handling and provisioning network, data and compute resources supporting the C4ISR Core and Domain System Functions.

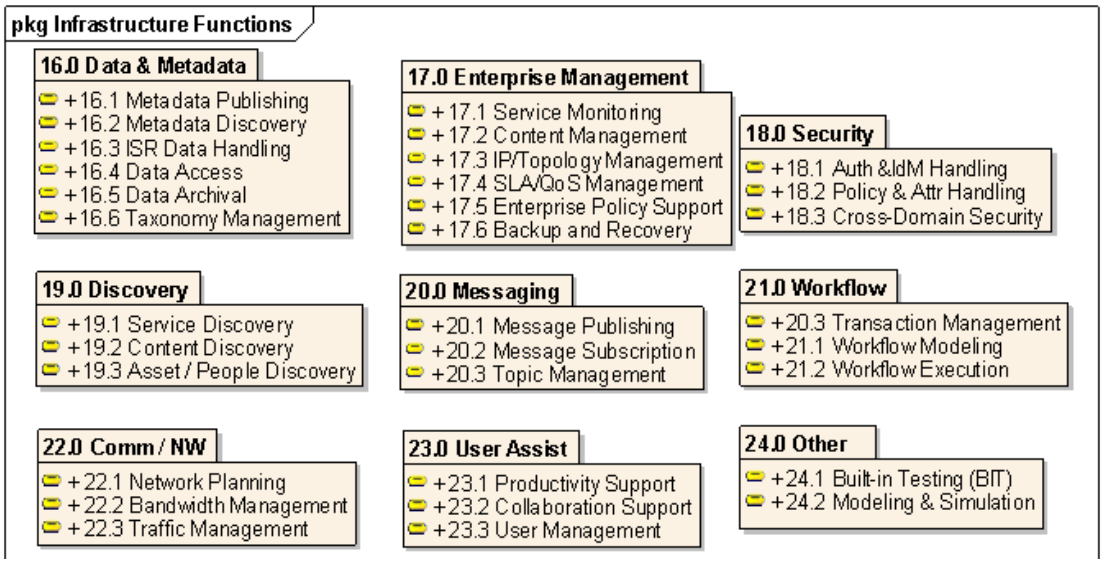


Figure 27. SV4a - DCGS Infrastructure System Functions (functional decomposition)

DCGS Infrastructure System Functions having particularly strong geospatial characteristics in which OGC specifications have high potential applicability are listed in Table 3.

Table 3. OGC Specification support for DCGS Infrastructure System Functions

DCGS System Function	OWS Services	OGC Encodings	Relevant OGC Specifications
16.1 Metadata Publishing	✓	✓	• CSW, WNS • GML, OM, SensorML, TML
16.2 Metadata Discovery	✓	✓	• CSW, WNS

			• GML, OM, SensorML, TML
16.3 ISR Data Handling	✓	✓	• CSW, WMS, WFS, WCS, SOS, WPS, WNS • GML, OM, SensorML, TML
16.4 Data Access Services	✓	✓	• CSW, WMS, WFS, WCS, SOS, WNS • GML, OM, SensorML, TML
16.5 Data Archival Services	✓	✓	• CSW, WFS-T, WCS-T, SOS-T, • GML, OM, SensorML, TML
16.6 Taxonomy Management	✓	✓	• CSW • GML, OM
19.1 Service Discovery	✓	✓	• CSW • GML, OM
19.2 Content Discovery	✓	✓	• CSW • GML, OM, SensorML, TML
19.3 Asset / People Discovery	✓	✓	• CSW • GML, OM, SensorML, TML
20.1 Message Publishing	✓	✓	• WNS, SAS • GML, OM, TML
20.2 Message Subscription	✓	✓	• WNS, SAS • GML, OM, SensorML, TML

6.3 Information Model

6.3.1 Key ISR Data Objects

Figure 28 catalogs the high-level business data objects of the C4ISR enterprise, specifically with respect to the FMV use cases. Existing and emerging technical standards for encoding representations of these business objects are listed.

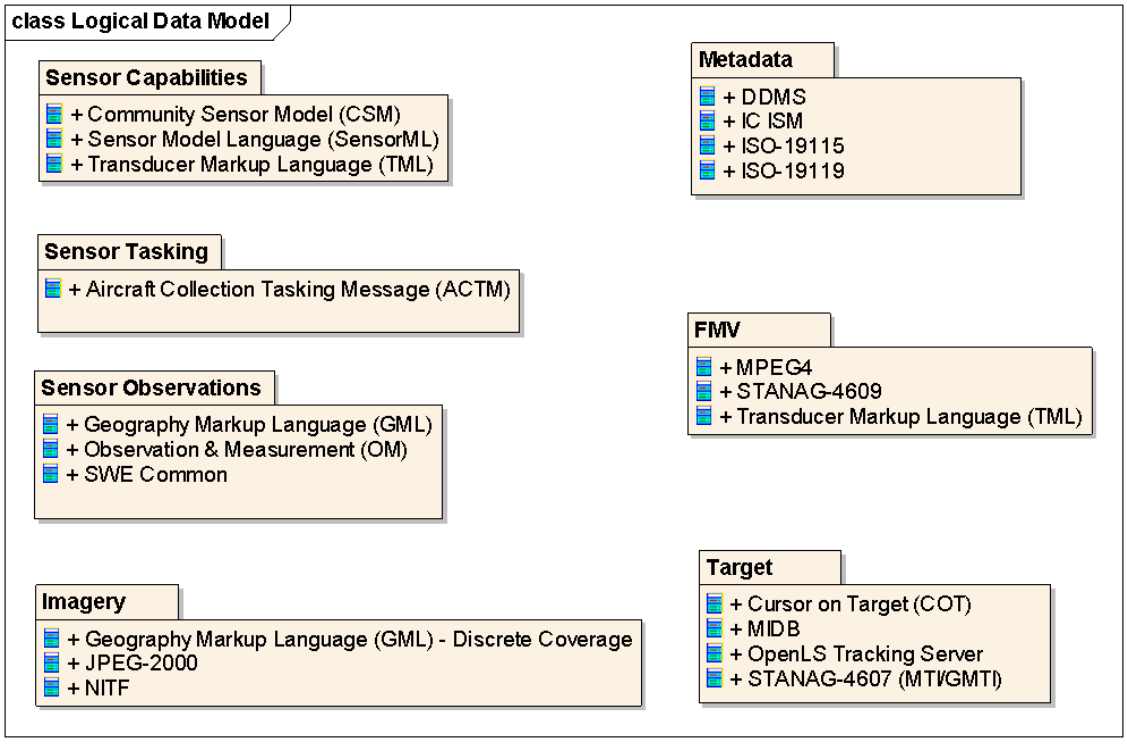


Figure 28. OV-7- Logical Data Model

6.3.2 Key OGC Data Objects

This section highlights key OGC information model elements that are considered most relevant to the C4ISR domain and the EC08 demonstration priorities. These information model elements are fully documented in their respective OGC implementation specification and the relevant topic volumes of the OGC Abstract Specification.

6.3.2.1 Geography Information Elements

Geography Markup Language (GML) is an XML grammar written in XML Schema for the modelling, transport, and storage of geographic information. The key concepts used by Geography Markup Language (GML) to model the world are drawn from the OpenGIS® Abstract Specification and the ISO 19100 series. GML provides a variety of kinds of objects for describing geography including features, coordinate reference systems, geometry, topology, time, units of measure and generalized values.

A geographic feature is "an abstraction of a real world phenomenon; it is a geographic feature if it is associated with a location relative to the Earth". So a digital representation of the real world can be thought of as a set of features. GML defines the various entities such as features, geometries, topologies etc. through a hierarchy of GML objects as shown in the UML diagram below.

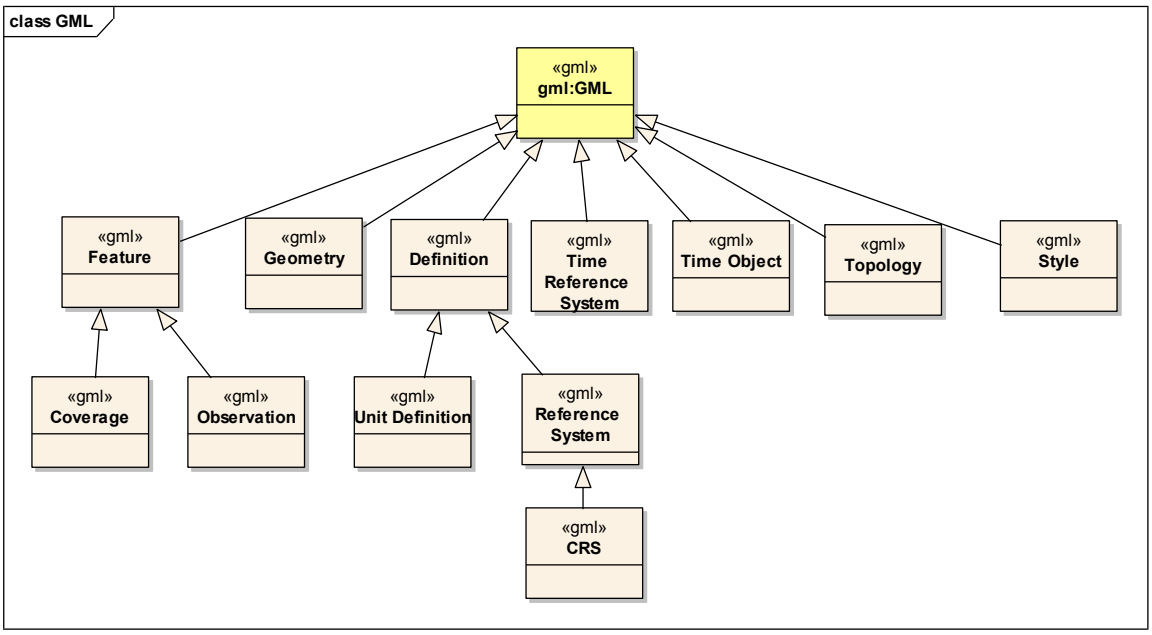


Figure 29. OV-7 - OGC GML (High-level Information Model)

Where the following classes are defined by GML:

- **Feature** – an abstraction of real world phenomena. [ISO 19101] A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant. [ISO 19136]
- **Coverage –** a feature that acts as a function to return values from its range for any direct position within its spatiotemporal domain [ISO 19123]
- **Geometry –** spatial object representing a geometric set (set of direct positions) [ISO 19107]
- **Unit Definition** – a general definition of a unit of measure [ISO 19136]
- **Reference system** –contains the metadata required to interpret data values unambiguously. [ISO 19136]
- **Time Reference System** – a reference system used to measure values in the time domain. Common types of time reference systems include calendars, ordinal temporal reference systems, and temporal coordinate systems (time elapsed since some epoch, e.g. UNIX time). [ISO 19136]
- **CRS –** Coordinate Reference System; a *coordinate system* that is related to the real world by a datum [ISO 19111]
- **Time Object –** a temporal primitive or temporal complex. [ISO 19136]
- **Topology** – A branch of geometry describing the properties of a figure that are unaffected by continuous distortion [Collins Concise Dictionary]. Topology is mostly concerned with identifying the connectivity of networks and the adjacency of surfaces. [ISO 19136]
- **Style** – used to to "attach" graphical styling information to GML data [ISO 19136]

6.3.2.2 Observation and Sensor Information Elements

An Observation is an act associated with a discrete time instant or period through which a number, term or other symbol is assigned to a phenomenon. Elements of the “Observations and Measurement” (OM) information model include the following classes:

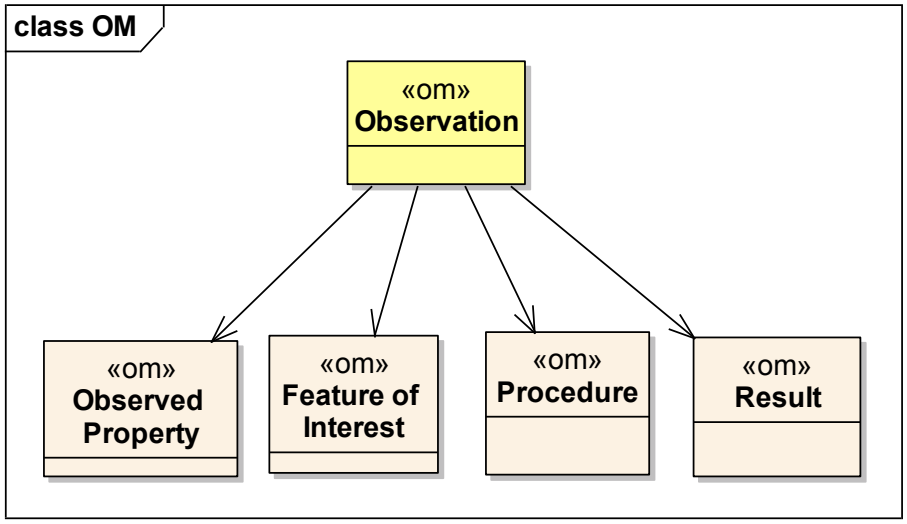


Figure 30. OV-7 - OGC Observations and Measurement Information Model

- **Observed Property –** identifies or describes the phenomenon for which the observation result provides an estimate of its value. It must be a property associated with the type of the feature of interest..
- **Feature of Interest –** a feature of any type (ISO 19109, ISO 19101), which is a representation of the observation target, being the real-world object regarding which the observation is made
- **Procedure** – description of a process used to generate the result. It must be suitable for the observed property.
- **Result** – contains the value generated by the procedure. The *type* of the observation result must be consistent with the observed property, and the scale or scope for the value must be consistent with the quantity or category type.

A Sensor Model is used is to define processes and processing components associated with the measurement and post-measurement transformation of observations. Elements of the "Sensor Model Language" (SensorML) information model include the following classes:

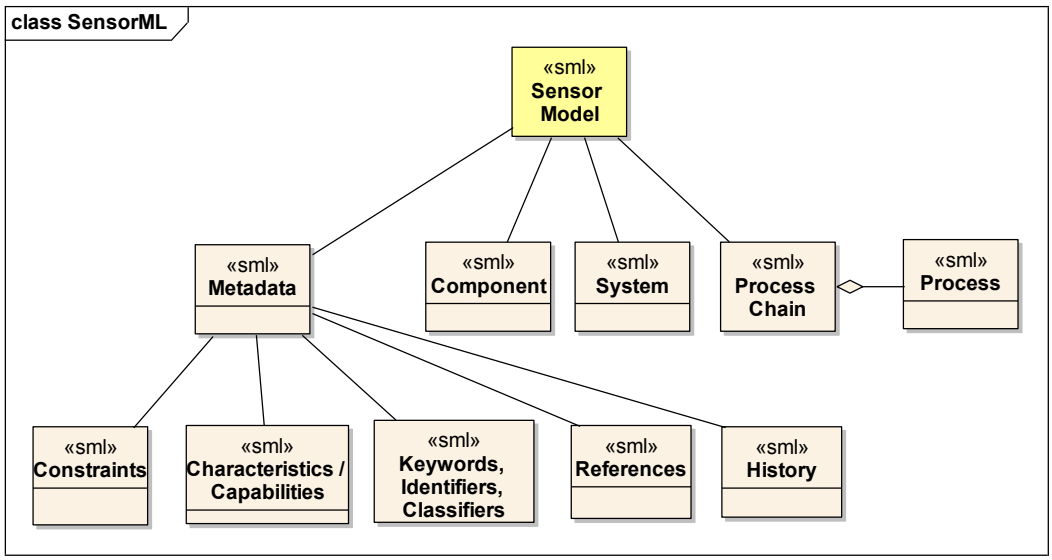


Figure 31. Sensor Model Language (SensorML) Information Model

- **Metadata** – primarily to support discovery of resources, qualification of process results, and assistance to humans. These metadata include identifiers, classifiers, constraints, capabilities, properties, contacts, documentation sources, and history.
- **Component** – an instance of a process model defining more or less atomic pure processes that are expected to be used within more complex process chains to model a physical process; includes all the location and interface properties of any physical process and adds a method property that can describe the basis of physical processing of the component.
- **System** – an instance of a process chain, defining a collection of processes that are executable in a sequential manner to obtain a desired result. Like all processes in SensorML, a system has inputs, outputs, and parameters properties. An airborne remote sensing system may include, for example, the radiometric scanner (itself perhaps modeled as a system), as well as a GPS sensor and Inertial Momentum Unit for reporting location and orientation of the platform.
- **ProcessChain** -- defines a collection of processes that are executable in a sequential manner to obtain a desired result. Like all processes in SensorML, ProcessChain itself has inputs, outputs, and parameters properties.
- **Process** – description of a process that that takes one or more inputs, and based on parameters and methodologies, generates one or more outputs.

A transducer system describes the transducer organization of data, the transducer response and geometry characteristics, the pre-processing between the data and the transducer, and the external logical relationships relating to understanding how multiple components (transducers and processes) within a system relate to one another. Transducer systems are a collection of transducers and processes working together to produce TML data or to utilize TML data to invoke desired phenomenon states. The Transducer System of the “Transducer Markup Language” (TML) information model includes the following classes:

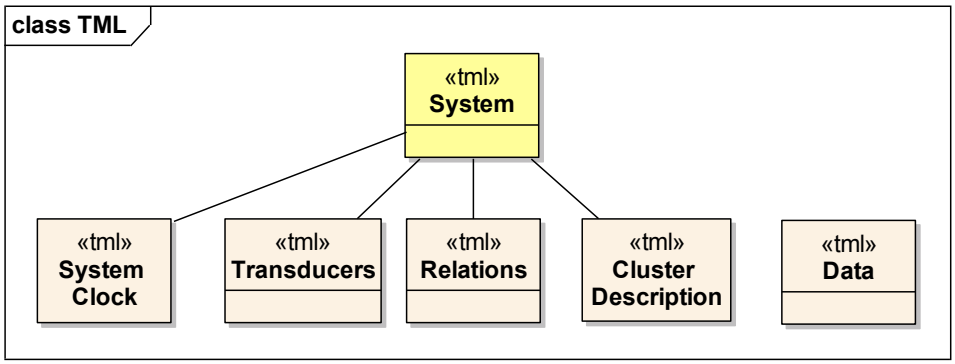


Figure 32. Transducer Markup Language (TML) Information Model

- **System Clock** – time tag transducer sampling events so that relative and absolute time relations can be maintained throughout the exchange and archive process.
- **Transducer** – The transducer is the interface between the data world of computers and the real world. All information and actions between the two domains go through a transducer. A transducer therefore transforms a real world phenomenon into data or vice-versa. TML representations contain adapters for transducers, processes, system clock, network, archive, and registry. The transducer node manages and maintains data description for the data it is handling, system clock and timing.
- **Relations** – describes relationships among the various parts in the system as well as to external references such as geographic datums.
- **ClusterDescription –** describes the explicit structure of raw data within a TML cluster, representing a mapping from the logical data model to actual data and provides the encoding/decoding information to enable the understanding of the transducer data. A Data Cluster Description describes and provides the implicit structure of the data message that is transmitted in a data cluster.
- **Data –** carries the data to or from transducer systems.

6.3.3 OWS Service Framework

The OWS Service Framework (OSF) identifies services, interfaces and exchange protocols that can be utilized by any application. OpenGIS Services are implementations of services that conform to OpenGIS Implementation Specifications. Compliant applications, called OpenGIS Applications, can then "plug into" the framework to join the operational environment. The OSF tiers are shown in Figure 33.

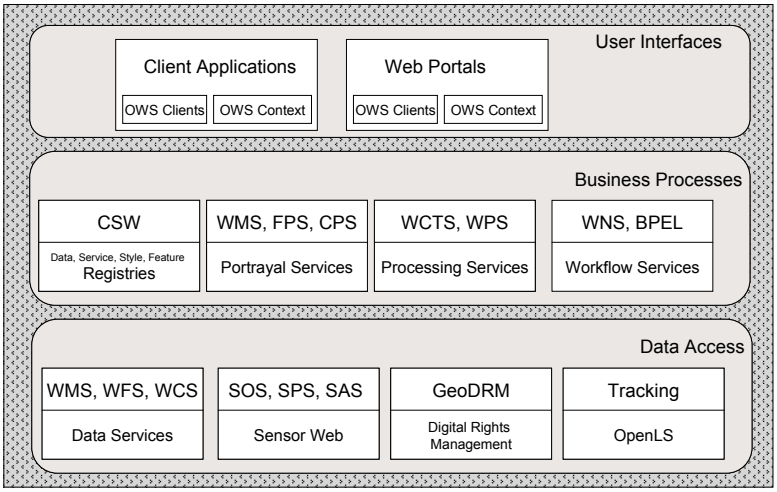


Figure 33. OWS Service Framework

By building applications to common interfaces, each application can be built without a-priori or build-time dependencies on other applications or services. Applications and services can be dynamically added, modified, or replaced without impacting other applications. In addition, operational workflows can be changed on-the-fly, allowing rapid response to time-critical situations. This loosely coupled, standards-based approach to development results in very agile systems—systems that can be flexibly adapted to changing requirements and technologies.

Of the OSF services, those that are most directly relevant to supporting activities of the C4ISR Enterprise can be grouped into two main categories: Spatial Data Infrastructure (SDI) and Sensor Web Enablement (SWE). Brief descriptions of the SDI and SWE services are found in this section below.

6.3.3.1 SDI Framework

The SDI group of specifications, adopted by NGA[3], represents a baseline of technology needed to implement a fully interoperable, end-to-end spatial data infrastructure. The SDI framework serves in NGA's mission within the NSG to:

- Firmly establish leadership in providing GEOINT through OGC Web Services
- Firmly establish leadership in providing browser-based GEOINT analysis and visualization
- Streamline development and deployment while reducing redundancy in data stores and web sites
- Maintain consistency in provisioning and coordination with customers

The SDI framework consists of the following OGC specifications:

[3] NGA adopts the OGC Spatial Data Infrastructure specification baseline (SDI 1.0): http://www.nga.mil/NGASiteContent/StaticFiles/OCR/nga0518.pdf

1. **Web Map Service (WMS)** – Produces maps of spatially referenced data dynamically from geographic information. This International Standard defines a "map" to be a portrayal of geographic information as a digital image file suitable for display on a computer screen. A map is not the data itself. WMS-produced maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats.
2. **Web Feature Service (WFS)** – Allows a client to retrieve and update 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.
3. **Web Coverage Service (WCS) –** Supports electronic retrieval of geospatial data as "coverages" – that is, digital geospatial information representing space-varying phenomena (e.g., imagery and elevation data). A WCS provides access to potentially detailed and rich sets of geospatial information, in forms that are useful for client-side rendering, multi-valued coverages, and input into scientific models and other clients.
4. **Catalog Service for the Web (CSW)** – Enables applications to perform discovery, browse and query operations against distributed and potentially heterogeneous catalog servers. The Catalog Interface specification uses metadata and spatial location to identify and select data sources of interest, and provides for interoperability in catalog update, maintenance, and other librarian functions.
5. **Styled Layer Descriptor (SLD) –** An encoding “language” (expressed in XML) that enables a human or machine client to define symbolization rules which can be used to portray the output of Web Map Servers, Web Feature Servers and Web Coverage Servers. SLD is an XML encoding of a map’s appearance.
6. **Web Map Context (WMC) –** An encoding “language” (expressed in XML) that states how a specific grouping of one or more maps from one or more map servers can be described in a portable, platform-independent format for storage in a repository or for transmission between clients.

6.3.3.2 SWE Framework

SWE provides a core information model comprised of a layered series of abstractions from Transducer, to Process, System and Observation (Figure 34). In addition to SWE Common, a collection of data types and constructs for describing and encoding sensor data that builds on and extends core GML data types. The SWE Information Model provides a normalized representation of these components of sensor systems. See 6.3.2.2 for description of these elements of the model.

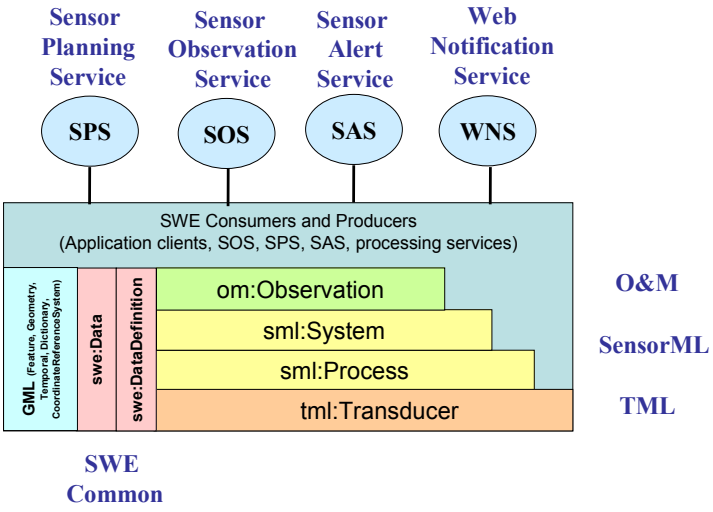


Figure 34. SWE Standards Framework

The SWE Information Model and Encoding specifications are:

1. **Observations & Measurements (O&M)** - The general models and XML encodings for representing observations and measurements made using sensors.
2. **Sensor Model Language (SensorML)** – The general models and XML Schema for describing the processes within sensor and observation processing systems; provides information needed for discovery, georeferencing, and processing of observations, as well as tasking sensors and simulations.
3. **Transducer Model Language (TML) –** The XML encoding for describing sensor system characteristics and supporting real-time streaming observations and tasking commands to and from sensor systems**.**

Layered on the SWE Information Model are the SWE Services (SPS, SOS, SAS and WNS), exposing standard behaviors for discovering, accessing and modeling sensor systems and their data. The SWE Web Service specifications are:

1. **Sensor Observation Service (SOS)** – An open interface for a service by which a client can obtain observations and sensor and platform descriptions from one or more sensors.
2. **Sensor Planning Service (SPS)** – An open interface for a service by which a client can 1) determine the feasibility of collecting data from one or more sensors or models and 2) submit collection requests to these sensors and configurable processes.
3. **Sensor Alert Service (SAS)** – An open interface for a web service for publishing of and subscribing to deliverable alerts from sensor or simulation systems.
4. **Web Notification Service (WNS)** – An open interface for a service by which a client may conduct asynchronous dialogues, or message interchanges, with one or more other services.

6.4 Component Model

The component model focuses on the mechanisms and functions required to support distributed interaction between objects in the system. The key concepts are *node*, *systems node, link* and *needline*. All components are derived from analysis of the TST use cases of Section 5.2 and the "Use Case Exposition" annex.

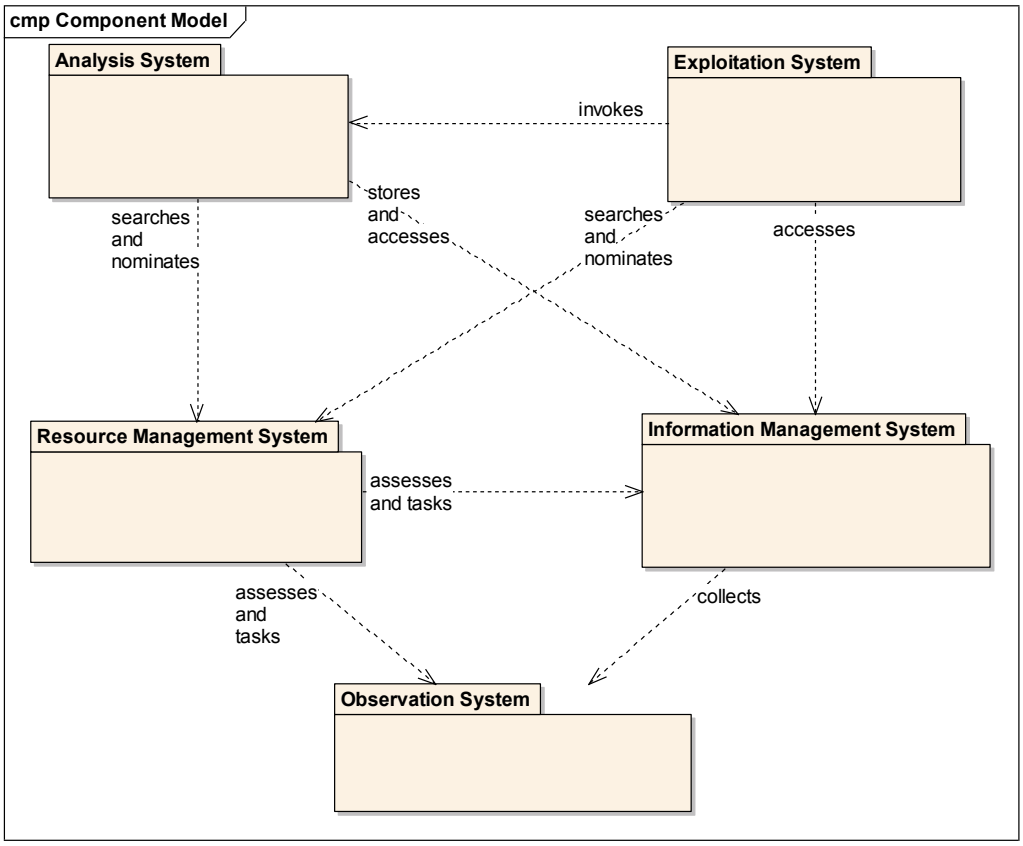


Figure 35. Conceptual C4ISR Systems Nodes (SV-1)

The conceptual component model (Figure 35) defines a distributed system for management and processing of ISR resources, comprised of six node types connected by a set of links. This view reflects the following behaviors (roles, responsibilities, capabilities and configurations) of the system:

- All nodes may be fixed or mobile, network-connected or disconnected and, depending on security domain constraints, accessible or inaccessible from other nodes. *(Note: these architecture "behaviors" are driven by use case families 12 and 13 of section 5.2: Unanticipated, Aniticipated, Incompatible, Remoted, Commercialized, Internationalized, Secured.)*

- Each system may appear in different nodes but offer different sets (subsets) of services. In other words, a system (e.g., Information Management System) might offer a set of services to the C4ISR environment from different locations, but each set is still part of the same "logical" (or "virtual") system.

- Sensors (i.e., ISR Resources) are attached to Observation System nodes.

- Observation System nodes "advertise" information about attached ISR Resources so that other system nodes can assess ISR Resource feasibility (availability, coverage, capability and capacity).

- Observation System nodes are attached to and receive tasking from a Resource Management System node.

- Observation System nodes may locally store received Observations for forwarding or subsequent discovery, sharing and collection by other system nodes (e.g., Information Management System nodes, other Observation System nodes).

- Observations from an Observation System node are posted to (or collected by) Information Management Systems for processing, archiving and broader community sharing and access.

- Information Management System nodes are attached to and receive tasking from a Resource Management System node.

- Information Management System nodes may be shared, replicated and federated (i.e., like all system nodes, more than one Information Management System node may exist within the C4ISR operating environment).

- Analysis System nodes may process data accessed from multiple Information Management System nodes.

- Analysis System nodes may locally store data for forwarding or subsequent discovery, sharing and collection by other system nodes (e.g., Information Management Nodes, other Analysis System nodes).

- Analysis System nodes store output data to the "shared space" of the Information Management System.

- Exploitation System nodes discover and access data in multiple Information Management System nodes.

- Resource Management System nodes have purview, allocation and tasking rights over attached Information Management System and Observation System resources to consolidate and coordinate their operation in support of C4ISR analysis and exploitation activities.

- Analysis System nodes delegate to a Resource Management System node to search and discover for needed ISR Resources (sensors, data or services).

- Analysis System nodes submit nominations for allocation and tasking of ISR Resources to a Resource Management System node.

- Exploitation System nodes delegate to a Resource Management System node to search and discover needed ISR Resources (sensors, data or services).

- Exploitation System nodes submit nominations for allocation and tasking of ISR Resources to a Resource Management System node.

6.4.1 Observation System

The systems, services and nodes comprising an Observation System are described below. Not all Observation Systems support all sub-systems and services. These system functions and services derive from and are intended to support the activities of the P-F2T2EA use cases identified in section 5.2 of this document. The system functions and services may be incomplete outside the context of these use cases.

Note: services listed that are followed by an acronym in parentheses indicate services that may be supported in whole or part by a published OGC service interface specification. The acronym identifies the service specification.

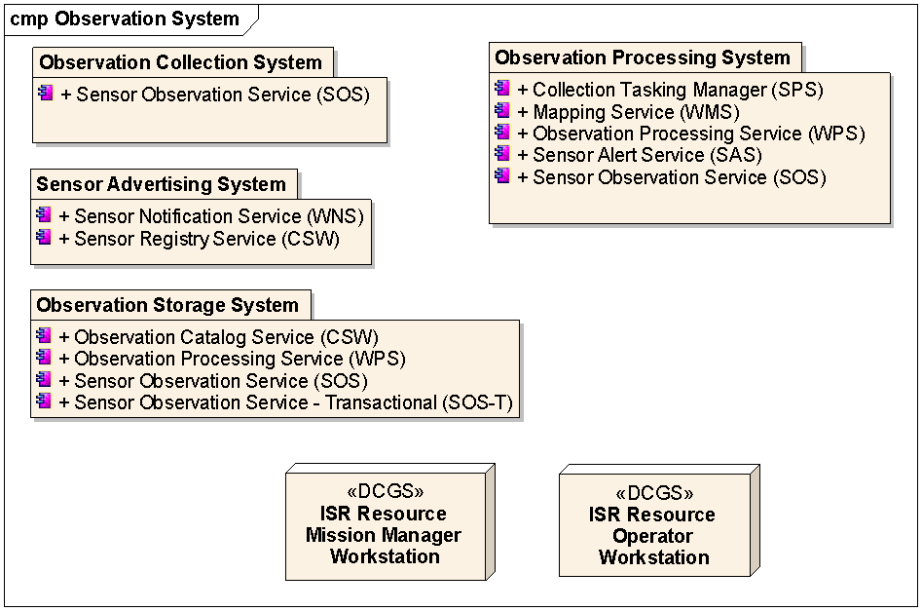


Figure 36. Sensor System Components (Conceptual)

Characteristic behaviors (roles, responsibilities, capabilities and configurations) of Observation Systems and their constituent functions and services include:

- Observation Collection System nodes collect observations on fixed or mobile, terrestrial, waterborne, airborne or satellite platforms.
- Observation Collection Systems may provide standard services for Observation Processing System nodes to receive or access Observations.
- Observation Processing System nodes provide command and control for one or more Observation Collection System nodes.
- Observation Processing System receives collection tasking from the Resource Management System.
- Observation Processing System nodes shall contain metadata about capabilities of attached Observation Collection System nodes (i.e., platforms and sensors) and the Observation objects that are received and processed.

- Observation Processing System nodes may directly forward or otherwise share Observations (data) received from Observation Collection Systems with external system nodes (e.g., other Observation System or Information Management System nodes).

- Observations (data) from an Observation Collection System node may be stored locally and subsequently processed, shared or distributed to external system nodes (e.g., other Observation System or Information Management System nodes).

- Observation Processing System nodes provision services for ISR Resource mission planning, tasking, and control.

- Observation Processing System monitors sensor state conditions and data thresholds and, as conditions warrant, alerts actors and systems.

- Observation Processing System supports generation of maps showing sensor location, coverage, state and their Observations to be obtained.

- The Sensor Advertising System publishes metadata about sensors and sensor platforms (sensor characteristics, capabilities, calibrations, protocols, procedures, etc) for discovery by external system nodes

6.4.2 Information Management System

The system functions, services and nodes comprising an Information Management System are described below. Not all Information Management Systems support all the functions and services shown here. These system functions and services derive from and are intended to support the activities of the P-F2T2EA use cases identified in section 5.2 of this document. The system functions and services may be incomplete outside the context of these use cases.

Note: services listed that are followed by an acronym in parentheses indicate services that may be supported in whole or part by a published OGC service interface specification. The acronym identifies the service specification.

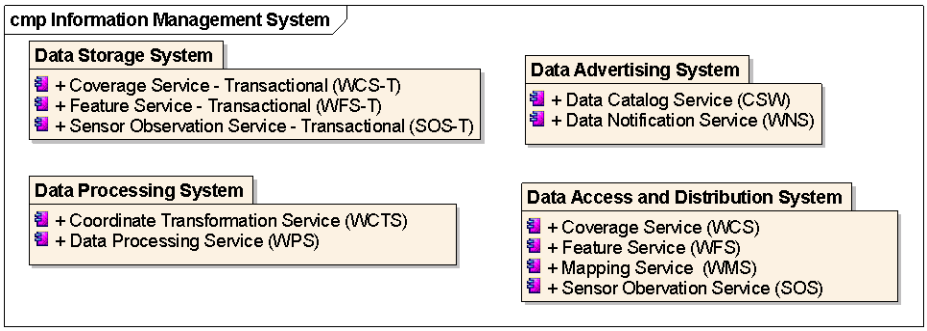


Figure 37. Information Management System Components (Conceptual)

Characteristic behaviors (roles, responsibilities, capabilities and configurations) of Information Management Systems and their constituent functions and services include:

- Data Storage System nodes preserve ISR information datasets for access and use by a designated community or within a network security domain.

- Data Processing System nodes enable transformation and other specific processing of ISR data artifacts (e.g., Observation, Imagery, Features, other).

- The Data Advertising System nodes publish metadata about stored datasets for discovery by external system nodes (e.g., Resource Management System, Analysis System, etc).

- Data Access and Distribution System nodes 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.

6.4.3 Resource Management System

The systems, services and nodes comprising a Resource Management System are described below. Not all Resource Management Systems support all sub-systems and services. These system functions and services derive from and are intended to support the activities of the P-F2T2EA use cases identified in section 5.2 of this document. The system functions and services may be incomplete outside the context of these use cases.

Note: services listed that are followed by an acronym in parentheses indicate services that may be supported in whole or part by a published OGC service interface specification. The acronym identifies the service specification.

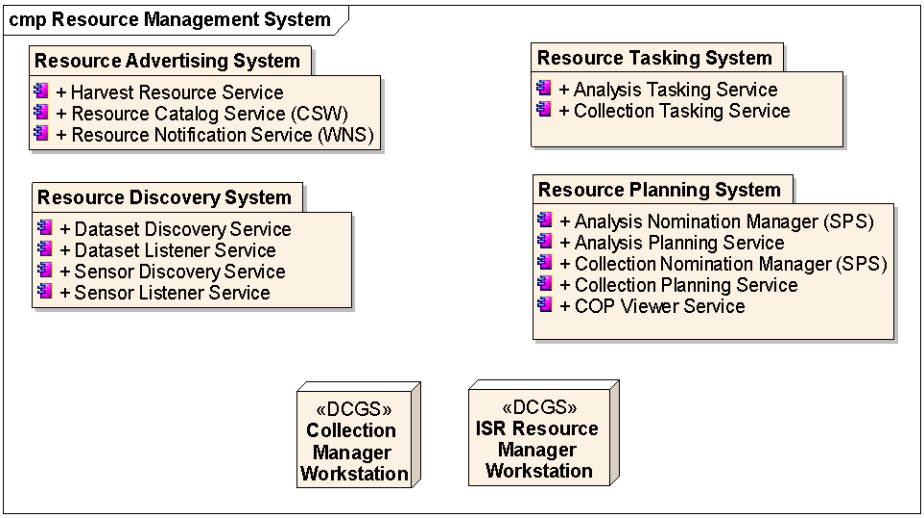


Figure 38. Resource Management System Components (Conceptual)

Characteristic behaviors (roles, responsibilities, capabilities and configurations) of Resource Management Systems and their constituent functions and services include:

- Resource Advertising System nodes advertise to external systems and users the existence, availability, capabilities and other characteristics of ISR Resources (sensors and data).

- Resource Advertising System nodes may notify "subscribers" (external systems and users) of the existence of newly available ISR Resources.

- Resource Advertising System nodes may also “harvest” (replicate locally) metadata descriptions of ISR Resources from other system nodes (e.g., Observation System or Information Management System nodes).

- Resource Tasking System nodes invoke tasking of ISR activities such as ISR Collection and ISR Analysis under the pervue of the Resource Tasking System.

- Resource Planning System nodes receive and manage nomination requests for Collection and Analysis tasking from external systems and users (e.g., Analysis System or Exploitation System nodes).

- Resource Planning System nodes enable 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.

- Resource Discovery System nodes enable subscription to and notification by external system nodes (e.g., Observation System node) when ISR Resources become available or unavailable.

- Resource Discovery System nodes 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.

6.4.4 Analysis System

The systems, services and nodes comprising an Analysis System are described below. Not all Analysis Systems support all sub-systems and services. These system functions and services derive from and are intended to support the activities of the P-F2T2EA use cases identified in section 5.2 of this document. The system functions and services may be incomplete outside the context of these use cases.

Note: services listed in figure below that are followed by an acronym in parentheses indicate services that may be supported in whole or part by a published OGC service interface specification. The acronym identifies the service specification.

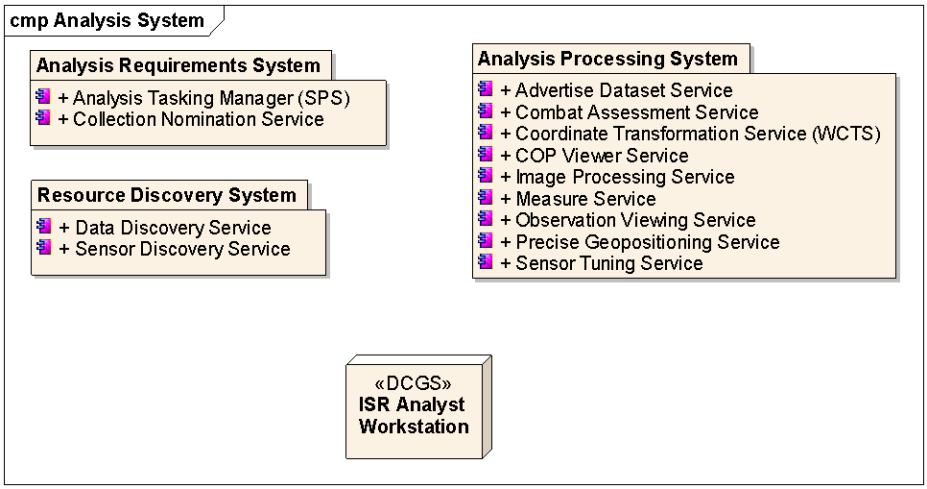


Figure 39. Analysis System Components (Conceptual)

Characteristic behaviors (roles, responsibilities, capabilities and configurations) of Analysis Systems and their constituent functions and services include:

- Analysis Requirements System receive, from an attached Resource Management System node, tasking for analysis activities to commence.
- Analysis Requirements System nodes nominate collection activities to the Resource Management System.
- Analysis Processing System nodes 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 activites such as precise geopositioning, measurement, image processing; viewing the COP and observations (e.g., live or archived video streams).
- Resource Discovery System nodes support search/discovery of ISR Resources (datasets and sensors) known to an attached Resource Management System node.
- Storage, advertising and access of datasets produced locally as output from Analysis activities is delegated to a (possibly co-located) Information Management System node.

6.4.5 Exploitation System

The systems, services and nodes comprising an Exploitation System are described below. Not all Exploitation Systems support all sub-systems and services. These system functions and services derive from and are intended to support the activities of the P-F2T2EA use cases identified in section 5.2 of this document. The system functions and services may be incomplete outside the context of these use cases.

Note: services listed in figure below that are followed by an acronym in parentheses indicate services that may be supported in whole or part by a published OGC service interface specification. The acronym identifies the service specification.

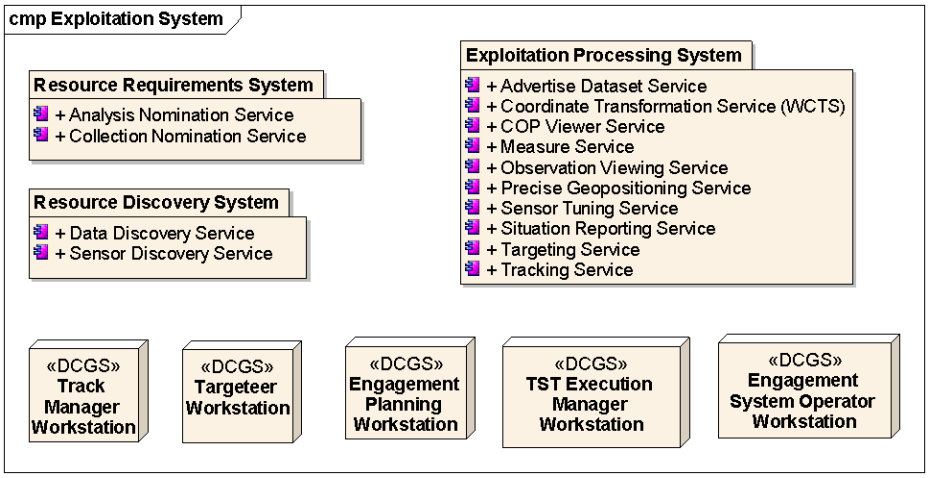


Figure 40. Exploitation System Components (Notional)

Characteristic behaviors (roles, responsibilities, capabilities and configurations) of Exploitation Systems and their constituent functions and services include:

- Resource Requirements System nodes nominate activities for collection and analysis to the Resource Management System.
- Exploitation Processing System nodes 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.
- Resource Discovery System nodes support search/discovery of ISR Resources (datasets and sensors) known to an attached Resource Management System node.
- Storage, advertising and access of datasets produced locally as output from Exploitation activities is delegated to a (possibly co-located) Information Management System node.

7 Implementation Scenarios

This section focuses on SV-1 (Systems/Services Interface Description) products depicting systems nodes and the systems and services resident at these nodes, conceptually linking the organizations, actors and activities represented in the Operation View of section 5 with the functions and information models described in the System View of section 6.

7.1.1 Overview

The scenarios that follow illustrate possible representative deployment scenarios of OWS technologies. These scenarios are intended to be conceptual and informative, not exhaustive or definitive. In most cases, because of the complexity and dynamism of C4ISR operations, there are many possible different deployments of operational nodes with changing roles and

responsibilities of system actors and interactions among them. The scenarios below are intended to be informative with respect to the role and value of OWS for enabling SSOA-based, net-centric systems that are more agile, extensible and flexibly constructed and deployed.

It is important to note, as section 5.1.3 of volume 2 of the DoDAF 1.5 specification does, that SV-1 diagrams illustrate "that the same system may appear in different nodes, but offer different sets of service functional groupings," highlighting that a "system might offer a set of services to the NCE from different locations, but each set is still to be considered part of the same system." This is critical to understanding how the "pluggable system node" concept (Figure 41) and the system views illustrated in this section specifically address the capabilities and effects identified in use cases 12 ("Resource Architecture Change") and 13 ("Physical Architecture Change") as detailed in section 5.2 of this document.

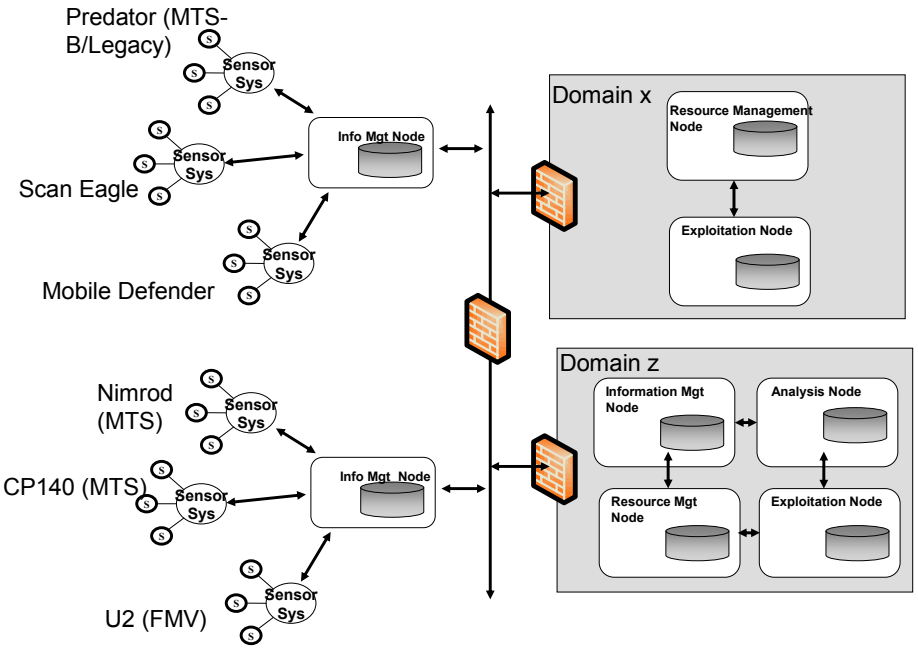


Figure 41. Pluggable System Nodes

The scenarios that follow place OWS technologies into a system context supporting the identified F2T2EA use cases for FMV (section 5.2). The figures provide an SV-1 System Interface Description product using the UML 2.0 Composite Structure diagram notation. The purpose is to relate OWS specifications and their implementation to operational activities, nodes, services, interfaces, interactions and data flows.

7.1.2 Sensor System Scenarios

7.1.2.1 Sensor Advertising

Sensor "advertising" is about making a resource known to other nodes of the system and is a necessary step prior to searching for ISR resources and determining their capabilities, tasking and accessing observed results. The most relevant use cases for which this scenario is a necessary prerequisite or an immediate result, include those listed in the table below:

UC 4.1 Find: Query for ISR Resource Capabilities	UC 4.2 Find: Determine ISR Resource Availabilities
UC 4.4 Find: Execute ISR Plan. • 4.4.1 Monitor sensor operations • 4.4.8 Generate metadata. • 4.4.9 Archive metadata.	UC 5.1 Find: Determine ISR Resource Availabilities.
UC 5.7: Find: Cross-Cue Assets	UC 6.1 Fix: Determine ISR Resource Availabilities.
UC 6.7 Fix: Cross-Cue Assets	UC 7.1 Track: Determine ISR Resource Availabilities.
UC 7.7 Track: Cross-Cue Assets	UC 8.1 Target: Determine ISR Resource Availabilities.
UC 8.7 Target: Cross-Cue Assets	UC 9.2 Engage: Determine ISR Resource Availabilities.
UC 9.8 Engage: Cross-Cue Assets	UC 10.1 Assess: Determine ISR Resource Availabilities
UC 10.7 Assess: Cross-Cue Assets	UC 12.1: New Unanticipated Resource Added
UC 12.2: Anticipated Resource Added	UC 13.C/I/R/S: Commercialization / Internationalization / Remoting of Node

Figure 42 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities identified in the above referenced use cases.

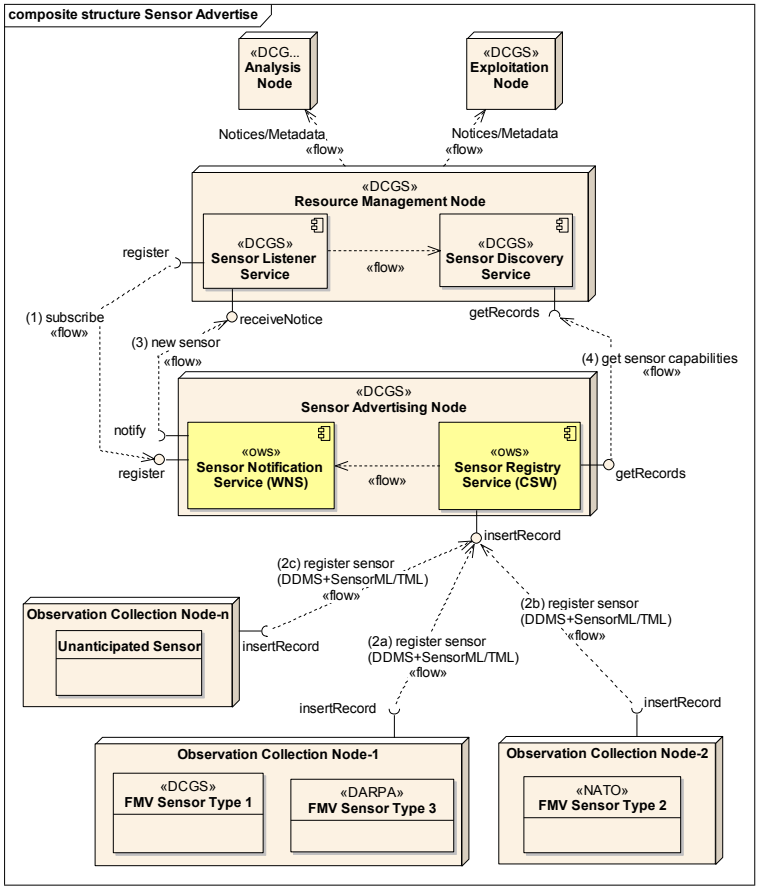


Figure 42. Advertise new sensor availability (SV-1)

This system view exhibits the following characteristics:

- The Resource Management Node is a physical deployment of services of a Resource Management System (Section 6.4.3). Zero or more Observation System Nodes may be "attached" to a Resource Management Node. It is possible that the number of attached Observation System Nodes will change over the course of operations.

- A Sensor Advertising Node represents a physical deployment of Sensor Advertising System services of an Observation System (Section 6.4.1).

- Observation Collection Nodes (i.e., a sensor) are physical deployments of Observation Collection System services of an Observation System. It is possible that the number of Observation Collection Nodes attached to a given Observation System Node will change over the course of operations.

- Observation Collection Nodes have zero or more sensors "attached" (assigned) to them and this number may vary dynamically over the course of operations.

- The Sensor Listener Service subscribes to one or more Sensor Notification Services to "listen" for "announcements" of new sensors becoming available or for other notifications about the changing state of attached sensors during the course of operations. This interaction is shown in flow-line 1.

- When Observation Collection Nodes become network-attached to an Observation System Node (and its Observation Advertising Node), metadata about the sensor and its capabilities are (automatically or manually) registered to the Sensor Registry Service. Consider the situation shown when a new "unanticipated" sensor becomes available to the Observation System. This interaction is shown in flow-lines 2a, 2b and 2c.

- Sensor metadata (characteristics, capabilities, status, calibration parameters, etc) are published to the Sensor Registry Service in the form of DDMS envelopes with, depending on the sensor, SensorML or TML descriptions. The Sensor Registry Service is an implementation of the OGC CSW specification.

- As the availability or state of a sensor (one of many, even thousands, of possible sensors attached to an Observation System Node) changes, the Sensor Notification Service notifies all subscribed listeners. Business rules determine if and when a notice is triggered and the content of the notice. The Sensor Notification Service is an implementation of the OGC's WNS service interface. This interaction is shown in flow-line 3.

- In this scenario, the Sensor Listener Service triggers the Sensor Discovery Service to "harvest" metadata about the sensor from the Sensor Registry Service of the Observation System node to which the new sensor is attached.

- The Resource Management System Node a) notifies (according to business rules) the attached Analysis Nodes and Exploitation Nodes of relevant changes to sensor system availability and b) enables stakeholders to get specific information (e.g., SensorML) about sensor capabilities.

7.1.2.2 Sensor Capability Discovery

To determine sensor capabilities and availability, system actors (e.g., TST Planners, Collection Manager, etc) operating at Analysis, Exploitation and Resource Management Nodes, query ISR assets cataloged by the Resource Catalog Service of the Resource Advertising System operating at the Resource Management Node (6.4.3). This activity is captured in the 7.1.2.1 and 7.1.4.1 system views and corresponding use cases.

7.1.2.3 Collection Nomination and Tasking

Given the availability and capabilities of a resource are known, collection nomination begins the process of consolidating sensor platform operations for acquiring ISR products for analysis and exploitation. Once under ISR management the sensor may be tasked and tuned, depending on platform capabilities and security, locally or remotely by an ISR Resource Operator. Use cases exposing these activities include those listed in the table below:

UC 3.1 Deliberate Collection Planning • 3.1.3 Submit Collection Nomination. • 3.1.4 Generate Collection Tasking	UC 4.3 Plan: Plan FMV capture. • 4.3.1 Submit Collection Nomination. • 4.3.2 Generate Collection Tasking

UC 5.3 Find: Tune FMV Resource.	UC 6.3 Fix: Tune FMV Resource.
UC 7.3 Track: Tune FMV Resource.	UC 8.3 Target: Tune FMV Resource.
UC 9.1 Engage: Plan FMV capture. • 9.1.1 Submit Collection Nomination. • 9.1.2 Generate Collection Tasking	UC 9.4 Engage: Tune FMV Resource.
UC 10.3 Assess: Tune FMV Resource.	UC 13.C/I/R/S: Commercialization / Internationalization / Remoting of Node

Figure 43 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities identified in the above referenced use cases.

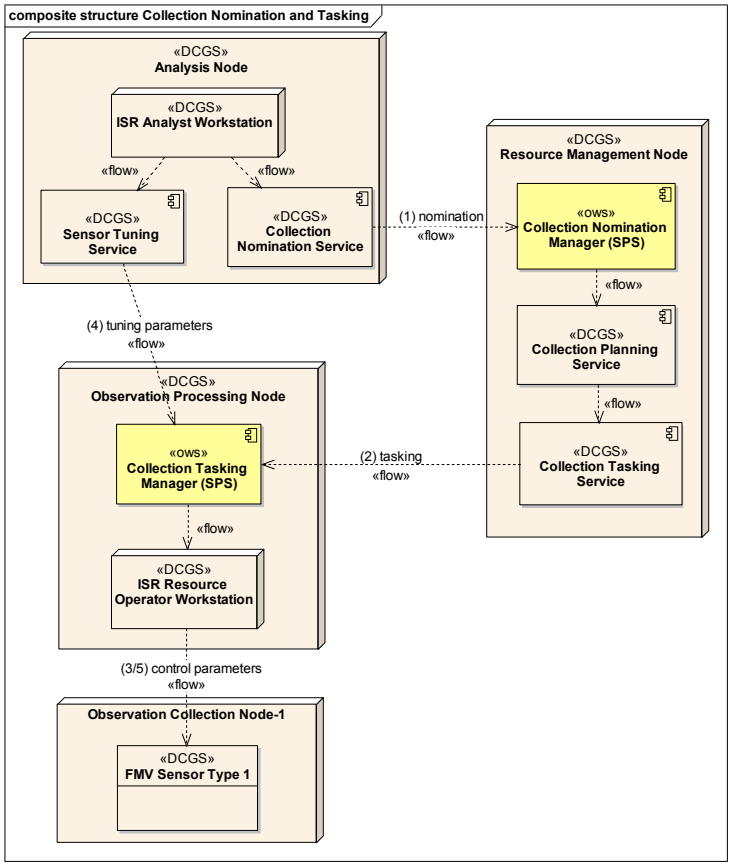


Figure 43. Collection Nomination and Tasking

This system view exhibits the following characteristics:

- Observation Processing Nodes, a component of the Observation System (Section 6.4.1), have zero or more Observation Collection Nodes “attached” (assigned) to them.

- Observation Processing Nodes control attached Observation Collection Nodes (sensors) and receive (and optionally store and process) data from them.

- Resource Management Nodes and components of the Resource Planning System and Resource Tasking System receive collection nominations, plan and allocate system resources and generate collection tasking for ISR Resources. These activities are shown in flow-lines 1 and 2.

- Observation Nodes and their Observation Processing Systems receive tasking and tuning which are communicated to the ISR Resource Operator working at a workstation node. The physical location of the ISR Resource Operator workstation may be local or remote with respect to the Observation Node. Receipt of tasking and tuning messages are shown in flow-lines 1 and 2.

- The ISR Resource Operator, depending on the sensor system, directly or indirectly controls the operation of the sensor. These activities are shown in flow-lines 3 and 5.

7.1.2.3.1 Collection Tasking Detail

Figure 44 depicts detailed interactions between services supporting activities for tasking ISR Resources. This system view expands on flow-line 2 of Figure 43 above, showing the interactions between the Collection Tasking Service of a Resource Management Node and the Collection Tasking Manager, ISR Resource Operator Workstation and Observation Collection Nodes of the Observation System.

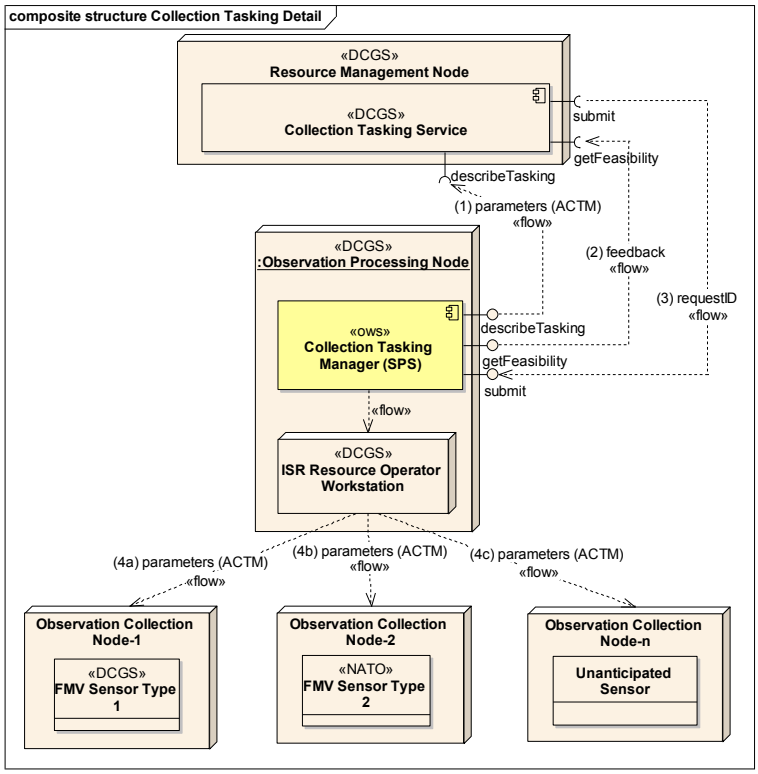


Figure 44. Collection Tasking Detail (SV-1)

This system view exhibits the following characteristics:

- The Collection Tasking Manager (CTM) is a service component of the Observation Processing System responsible for receiving and processing ISR Resource tasking messages. The Collection Tasking Manager is an implementation of the OGC Sensor Planning Service (SPS) interface.

- The collection tasking dialog between the Resource Manager System and the Observation System nodes begins when the Collection Tasking Service (CTS) must determine, for a given Observation System (and attached ISR Resources), the tasking parameters that must be specified to constitute a valid and complete tasking request. The describeTasking operation is invoked and the required tasking parameters are returned as, for example, Aircraft Collection Tasking Message (ACTM) elements. This interaction is shown in flow-line 1.

- The CTS must determine the feasibility of issuing a tasking request (e.g., will the ISR Resource be available, suitably configured and in the vicinity of the target at the time the

collection is requested to occur?). The CTM responds to getFeasibility requests by the CTS with an answer or suggested alternatives that are feasible. This interaction is shown in flow-line 2.

- The CTS finally sends a tasking message to the CTM via the submit request. This interaction is shown in flow-line 3.

- Finally, one or more Observation Collection Nodes (ISR Resources) receive tasking from an ISR Resource Operator, part of the Observation Processing Node. Depending on the sensor system, control parameters may be expressed using ACTM. These interactions are shown in flow-line 4a, 4b and 4c.

7.1.2.4 Sensor Data Collection, Alert and Forward

This scenario concerns the receipt of full-motion video (FMV) from one or more Observation Collection Nodes and forwarding of real-time and archived video feeds to actors such as ISR Operations Staff, Exploitation Analysts,Track Managers, Targeteers, Collection Managers and Execution Managers. This scenario specifically depicts the “feed”, “analyze,” “store,” and “retrieve” activities within each phase of the F2T2EA process. Use cases exposing these activities and driving the system component interactions described below include:

UC 1.1 Deliberate Targeting/Target Development: Retrieve FMV from Archive.	UC 2.1 Deliberate Targeting/Capabilities Analysis: Retrieve FMV from Archive.
UC 3.1 Deliberate Targing Cmdrs Decision & FA/Collection Planning: • 3.1.8 Perform collection • 3.1.9 Perform processing • 3.1.10 Perform exploitation • 3.1.11 Perform dissemination • 3.1.12 Archive products to library.	UC 4.4 Plan: Execute ISR Plan. • 4.4.1 Monitor sensor operations • 4.4.2 Perform collection • 4.4.3 Perform processing • 4.4.4 Perform exploitation • 4.4.5 Perform dissemination • 4.4.7 Archive products to library. • 4.4.8 Generate metadata. • 4.4.9 Archive metadata.
UC 5.2 Find: Feed FMV.	UC 5.4.Find : Analyze FMV
UC 5.6 Find: Store Findings.	UC 5.8.Find : Retrieve Findings
UC 6.2 Fix: Feed FMV.	UC 6.4.Fix : Analyze FMV
UC 6.6 Fix: Store Findings.	UC 6.8.Fix : Retrieve Findings
UC 7.2 Track: Feed FMV.	UC 7.4.Track : Analyze FMV
UC 7.6 Track: Store Findings.	UC 7.8.Track : Retrieve Findings
UC 8.2 Target: Feed FMV.	UC 8.4.Target : Analyze FMV

UC 8.6 Target: Store Findings.	UC 8.8.Target : Retrieve Findings
UC 9.3 Engage: Feed FMV.	UC 9.5. Engage: Analyze FMV
UC 9.7 Engage: Store Findings.	UC 9.9. Engage: Retrieve Findings
UC 10.2 Assess: Feed FMV.	UC 10.4. Assess : Analyze FMV
UC 10.6 Assess: Store Findings.	UC 10.8. Assess : Retrieve Findings
UC 11.1 Combat Assessment: Retrieve FMV from Archive.	UC 12.0. Resource Architecture Change : • 12.1 New unanticipated resource added • 12.2 New anticipated resource added
UC 13.0 Physical Architecture Change • 13.C Commercialization of node • 13.I Internationalization of node • 13.R Remoting of node • 13.S Securing of node	

Figure 45 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities identified in the above referenced use cases.

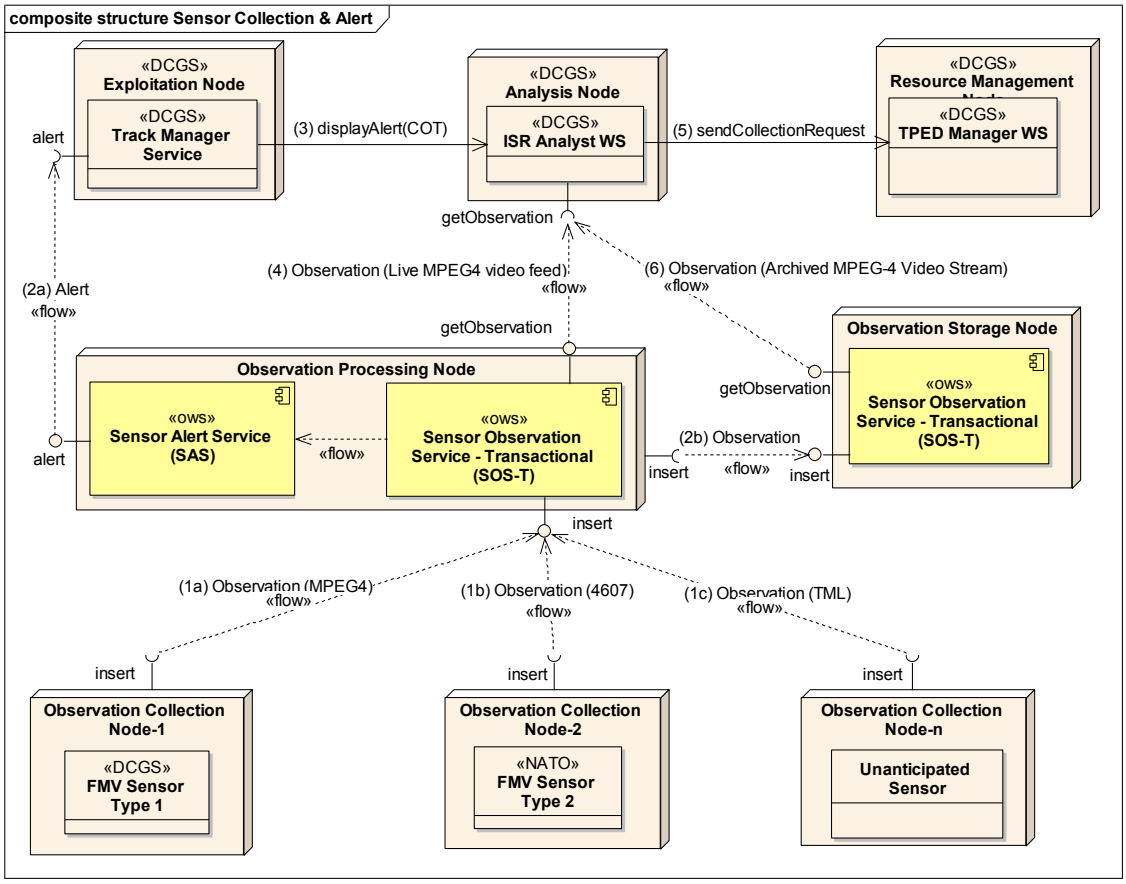


Figure 45. Sensor Data Collection, Alert, Access and Store (SV-1)

This system view exhibits the following characteristics:

- Multiple Observation Collection Nodes, each equiped with full-motion video (FMV) capable sensors. Each sensor or sensor/platform may be a different “make and model” and have different capabilities. For example, one produce and transmit MPEG4 encoded video, others transmit STANAG-4607, and others transmit video streams using the OGC Transducer Markup Language (TML) encoding.

- The data from each Observation Collection Node are “normalized”, regardless of sensor type or the encoding format of the observation “results” (i.e., the video data), as OGC Observation data objects.

- Observations from the Observation Collection Nodes are transmitted or otherwise provided to their attached Observation Processing Node via the provided “insert”

operation of the OGC Sensor Observation Service – Transactional (SOS-T). These interactions are shown in flow-line 1a, 1b and 1c.

- Through business logic within the Observation Processing Node, alerts indicating that new sensor data is now available are generated and "advertized" via the OGC Sensor Alert Service (SAS).

- Subscribers to SAS (note: the interactions required to subscribe to SAS are not shown in the figure) are alerted of the availability and the channel to the FMV observation data. In this case, the Track Manager Service at an Exploitation Node receives the alert. This interaction is shown in flow-line 2a.

- Through business logic within the Observation Processing Node, the FMV data stream may also be stored for subsequent processing and access. In this case, the SOS-T component of the Observation Processing Node forwards the video Observations it has received to the SOS-T component of an Observation Storage Node. This interaction is shown in flow-line 2b.

- The ISR Analyst Workstation component of an Analysis Node receives a "displayAlert" message with a Cursor On Target (CoT) "event" object indicating a target and the availability of FMV. This interaction is shown in flow-line 3.

- ISR Analyst Workstation components (or other components) establishes live connections to the video feed via "getObservation" requests to the SOS component of the Observation Processing Node. This interaction is shown in flow-line 4.

- In this scenario, the ISR Analyst actor generates a new collection nomination or sensor tuning request to Collection Manager or Exploitation Manager actors at the Resource Manager Node. This interaction is shown in flow-line 5.

- The archived video may be subsequently retrieved via "getObservation" requests to the SOS component of the Observation Storage Node. This interaction is shown in flow-line 6.

7.1.3 Information Management System

It is the responsibility of the Information Management System (as described in section 6.4.2) to provision services for controlled and efficient data sharing capabilities. These scenarios concern the storage of full-motion video (FMV) and other ISR data products from one or more system nodes (Observation Collection Nodes, Analysis Node, Exploitation Node, Resource Management Node) for subsequent sharing (store, discover and access) among stakeholder actors such as ISR Operations Staff, Exploitation Analysts,Track Managers, Targeteers, Collection Managers and Execution Managers. The scenarios in this section specifically depict the "store," "process," "discover" and "retrieve" activities within each phase of the F2T2EA process.

7.1.3.1 Store and Process

Use cases exposing "store" (including, "archive") and "process" activities driving the system component interactions described below include:

UC 1.1 Deliberate Targeting/Target Development: Archive FMV to Target Folder.	UC 2.1 Deliberate Targeting/Capabilities Analysis: Archive FMV to Target Folder.

UC 3.1 Deliberate Targing Cmdrs Decision & FA/Collection Planning: • 3.1.9 Perform processing • 3.1.11 Perform dissemination • 3.1.12 Archive products to library. • 3.1.13 Generate metadata. • 3.1.14 Archive metadata.	UC 4.4 Plan: Execute ISR Plan. • 4.4.3 Perform processing • 4.4.5 Perform dissemination • 4.4.7 Archive products to library. • 4.4.8 Generate metadata. • 4.4.9 Archive metadata.
UC 5.6 Find: Store Findings.	UC 6.6 Fix: Store Findings.
UC 7.6 Track: Store Findings	UC 8.6 Target: Store Findings.
UC 9.7 Engage: Store Findings.	UC 10.6 Assess: Store Findings.
UC 11.3 Combat Assessment: Archive FMV to Target Folder.	UC 12.0. Resource Architecture Change : • 12.1 New unanticipated resource added • 12.2 New anticipated resource added
UC 13.0 Physical Architecture Change • 13.C Commercialization of node • 13.I Internationalization of node • 13.R Remoting of node • 13.S Securing of node	

Figure 46 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities identified in the above referenced use cases.

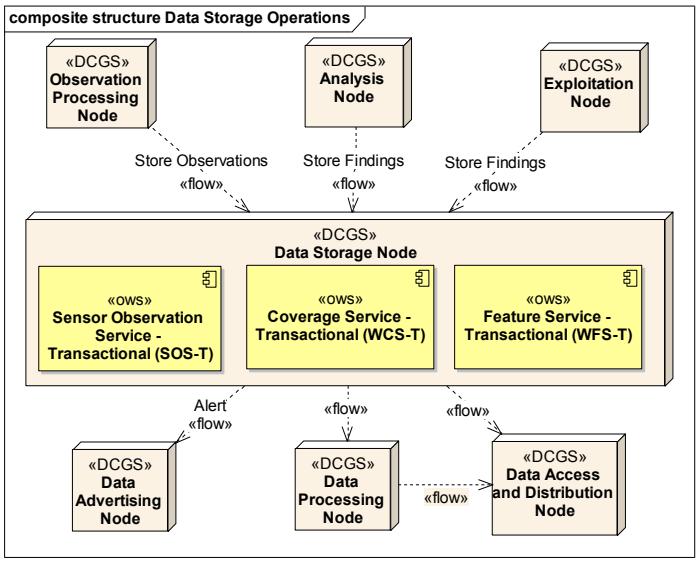


Figure 46. Data Storage Services (SV-1)

This system view exhibits the following characteristics:

- A Data Storage Node (an implementation of the Data Storage System component of the Information Management System) may have one or more data-producing nodes attached: Observation Processing Node, Analysis Node and Exploitation Node.

- The Data Storage Node provisions Sensor Observation Service – Transactional, Coverage Service – Transactional and Feature Service – Transactional services to enable ingestion for storage, processing and dissemination of "normalized" data representing ISR observations (products of ISR Resources) and "findings" (products of Analysis and Exploitation business activities).

    - The "Sensor Observation Service – Transactional" component handles normalized representations of observation data produced by ISR Resources and provided by Observation Processing Nodes and is an implementation of the OGC SOS-T service interface specification.

    - The "Coverage Service – Transactional" component handles normalized representations of processed imagery data produced by ISR Resources and/or Analysis and Exploitation system components and is an implementation of the OGC WCS-T service interface specification.

    - The "Feature Service – Transactional" component handles normalized representations of feature-level data produced by ISR Resources and/or Analysis and Exploitation system components and is an implementation of the OGC WFS-T service interface specification.

- The Data Storage Node generates and stores metadata about received data to be stored.

- The Data Storage Node may generate alerts based on data-driven business rules that are forwarded to the Data Advertising Node of the Information Management System.

- Based on business rules and received processing tasking, the Data Storage Node may delegate data processing activities to services of a Data Processing Node. Processing of received data may occur before or after storage. Results of data processing may be stored or made immediately available for access and distribution. Metadata about the processed data (and the processing lineage and pedigree) are generated and stored.

- Based on business rules and received dissemination tasking, the Data Access and Distribution node makes data from the Data Storage Node available for access and distribution to authorized system actors.

7.1.3.2 Retrieve: Access and Distribute

Use cases exposing “”access and distribute” activities driving the system component interactions described below include:

UC 1.1 Deliberate Targeting/Target Development: Retrieve FMV from Archive.	UC 2.1 Deliberate Targeting/Capabilities Analysis: Retrieve FMV from Archive.
UC 3.1 Deliberate Targing Cmdrs Decision & FA/Collection Planning: • 3.1.7 Generate Dissemination Tasking • 3.1.11 Perform dissemination	UC 4.3 Plan FMV capture. • 4.3.5 Generate Dissemination Tasking
UC 4.4 Plan: Execute ISR Plan. • 4.4.5 Perform dissemination	UC 5.8.Find : Retrieve Findings
UC 6.8.Fix : Retrieve Findings	UC 7.8.Track : Retrieve Findings
UC 8.8.Target : Retrieve Findings	UC 9.1 Engage: Plan FMV Capture. • 9.1.5 Generate Dissemination Tasking
UC 9.9. Engage: Retrieve Findings	UC 10.8. Assess : Retrieve Findings
UC 11.1 Combat Assessment: Retrieve FMV from Archive.	UC 12.0. Resource Architecture Change : • 12.1 New unanticipated resource added • 12.2 New anticipated resource added
UC 13.0 Physical Architecture Change • 13.C Commercialization of node • 13.I Internationalization of node • 13.R Remoting of node • 13.S Securing of node	

Figure 47 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities for data “advertising”.

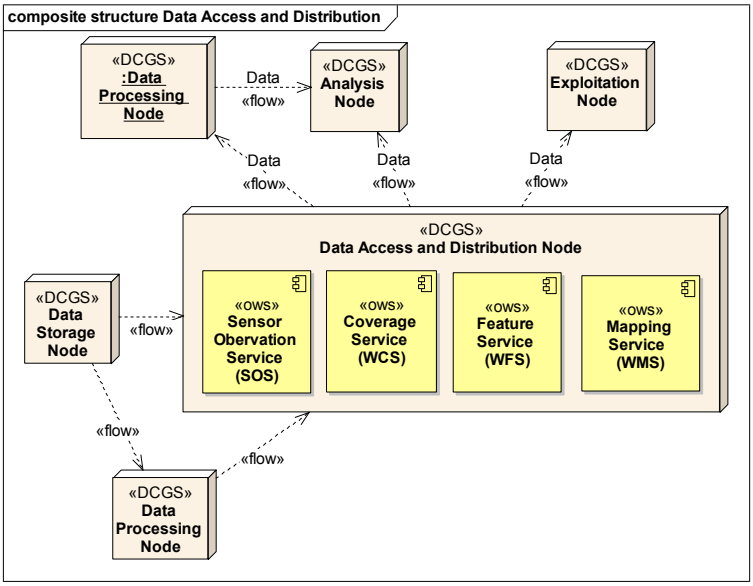


Figure 47. Data Access and Distribution Services (SV-1)

This system view exhibits the following characteristics:

- A Data Access and Distribution Node (an implementation of the Data Access and Distribution System component of the Information Management System) may have one or more data-consuming nodes attached: Analysis Node, Exploitation Node and Resource Management Node (not shown).

- The Data Access and Distribution Node receives notification from a Data Storage Node, based on business rules or dissemination tasking, that data are available for authorized access and distributed.

- Data processing workflows may be defined, based on business rules or dissemination tasking, that process the data from the Data Storage Node prior to their access and dissemination by data consumer nodes.

- The Data Access and Distribution Node provisions Sensor Observation, Coverage Service, Feature Service and Mapping Service components for access and dissemination of “normalized” data representing ISR observations (products of ISR Resources) and “findings” (products of Analysis and Exploitation business activities).

    - The Sensor Observation Service component, an implementation of the OGC SOS service interface specification, enables discovery, filtering and access of unprocessed or processed observation data. The SOS is the most direct way to

request and access stored FMV streams for a given area of interest, time and subject of interest.

- The Coverage Service component, an implementation of the OGC WCS service interface specification, enables query and filtering of unprocessed or processed coverage data (e.g., hyper-spectral/multi-spectral/visible EO, RADAR, LIDAR, processed imagery and terrain, etc).

- The Feature Service component, an implementation of the OGC WFS service interface specification, enables query and filtering of geospatial features encoded using GML.

- The Mapping Service component, an implementation of the OGC WMS service interface specificaiton, enables generation of entire symbolized maps or individual map layers from stored geodata represented as common MIME image types (PNG, GIF, JPG, etc).

7.1.3.3 Advertise: Notify and Catalog

Use cases exposing “notify and catalog” activities are details of the “retrieve” (access and distribute) use cases. Notification and discovery activities are often (but not always) a necessary prerequisite for data retrieval: stakeholders must know that relevant information is available and where and how to get it. For example, stakeholders may wish to be notified by the Information Management System when relevant data become available for access. Similarly, stakeholders may need to actively search the Information Management System holdings for relevant, available and archived data. The business activities for “notify and catalog” are not explicitly identified in the F2T2EA use cases but are instead “derived” from the use cases driving the “access and distribute” system view above.

Figure 48 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities for data “advertising”.

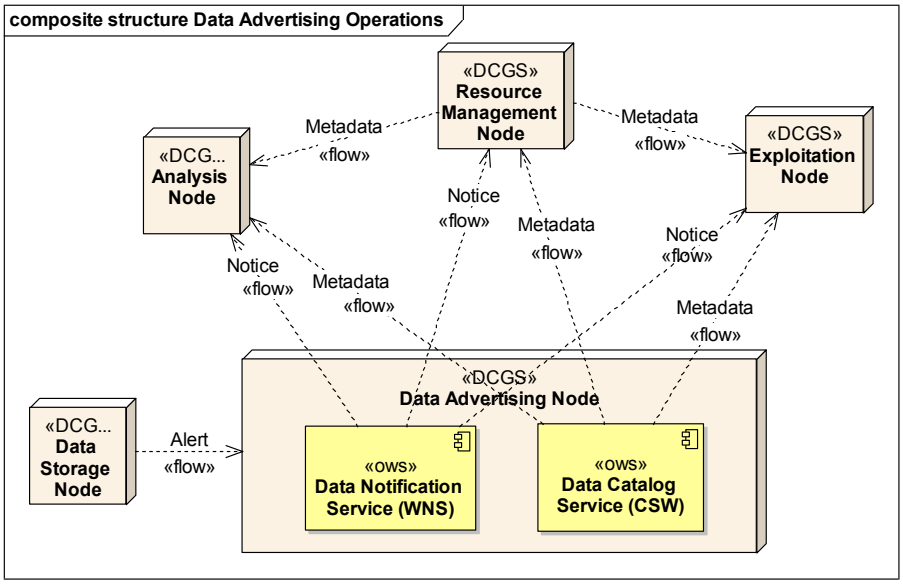


Figure 48. Data Advertising Services (SV-1)

This system view exhibits the following characteristics:

- A Data Advertising Node (an implementation of the Data Advertising System component of the Information Management System) may have one or more data-consuming nodes attached: Observation Processing Node, Analysis Node, Exploitation Node and Resource Management Node.

- The Data Advertising Node receives alerts, based on data-driven business rules, from Data Storage Nodes of the Information Management System.

- The Data Advertising Node provisions Data Notification Service and Data Catalog Service components to enable notification, discovery and dissemination of “normalized” data representing ISR observations (products of ISR Resources) and “findings” (products of Analysis and Exploitation business activities) and their metadata.

    - The Data Notification Service is an implementation of the OGC Web Notification Service (WNS) interface specification. The WNS sends notification messages to subscribers (e.g., Analysis Nodes, Resource Management Nodes and Exploitation Nodes) about the availability of new datasets.

    - The Data Catalog Service is an implementation of the OGC Catalog Service for the Web (CSW) interface specification. The CSW is used by consumer nodes (e.g., Analysis Nodes, Resource Management Nodes and Exploitation Nodes) to search metadata about available datasets and their characteristics (e.g., type of data, time of observation, method of processing, processing parameters, etc).

7.1.4 Analysis System

It is the responsibility of the Analysis System (as described in section 6.4.2) to provision services for enabling rapid and effective analysis of ISR observation data through synthesis of multiple types of information from multiple sources, precision measurement and visualization. These scenarios concern the analysis of full-motion video (FMV) and other ISR data products from one or more system nodes (Observation Collection Node, Analysis Node, Exploitation Node, Resource Management Node, Information Management Node) and the sharing (store, discover and access) of resulting analytical findings among stakeholder actors such as ISR Operations Staff, Exploitation Analysts, Track Managers, Targeteers, Collection Managers and Execution Managers. The scenarios in this section specifically depict the “discover”, “retrieve”, “view”, “process”, “measure”, and “store” activities within each phase of the F2T2EA process.

7.1.4.1 Discover Resources (Sensors and Data)

The business activities for “discover resources” are not explicitly identified in the F2T2EA use cases but are instead derived from the “query”, “plan”, “determine”, and “retrieve” use cases identified previously in sections 7.1.2.1, 7.1.2.2 and 7.1.3.3. These activities drive the component interactions described in the system view below.

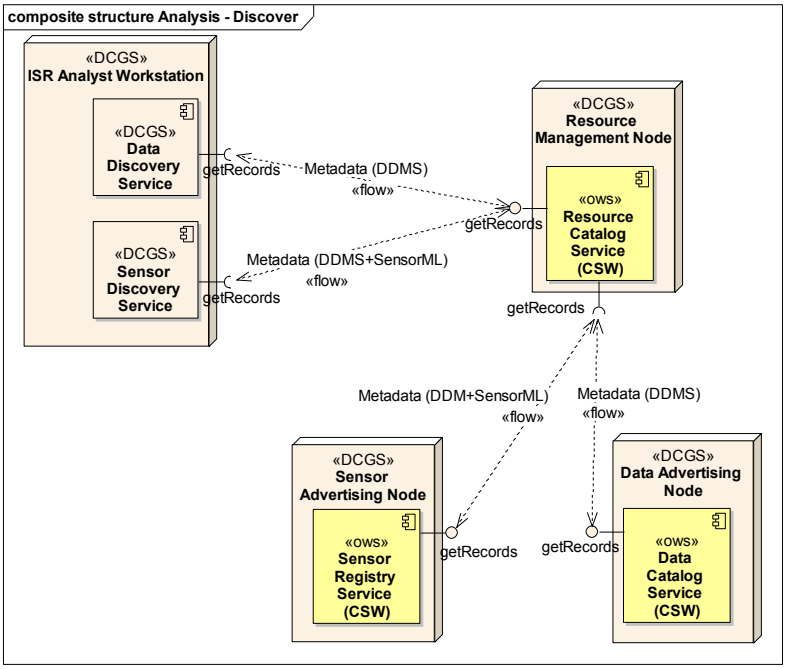


Figure 49. Discover Resources for Analysis (SV-1)

This system view exhibits the following characteristics:

- A Resource Management Node may have one or more data-consuming nodes (e.g., ISR Analyst Workstations) attached.

- Resource Management Nodes provision a Resource Catalog Service component, providing a one-stop “clearinghouse” service that enables stakeholders to find available resources (e.g., ISR Resources (sensors), processed or unprocessed data, and other services) under the purview of the Resource Management Node.

- The Resource Catalog Service is an implementation of the OGC Catalog Service for the Web (CSW) interface specification. This scenario highlights the "distributed search" capability of the CSW interface, allowing multiple network-distributed catalogs to be managed independently but federated for scalable resource discovery.

- The ISR Analyst Workstation Node delegates to the Resource Catalog Service component to find needed resources that may be managed by or attached to other system nodes, wherever and whenever they may be available.

- Metadata about system resources are encoded using DDMS but may have additional, resource-specific metadata (e.g., ISR Resources may have associated SensorML metadata about the sensor characteristics and processes).

7.1.4.2 Open Channel for Live Video

This activity is described in 7.1.2.4.

7.1.4.3 Tune ISR Resource

This activity is described in 7.1.2.3 and 7.1.2.3.1.

7.1.4.4 View, Measure and Analyse ISR Observations

Use cases exposing "view", "measure" and "analyze" activities driving the system component interactions described in the system view below include:

UC 1.1 Deliberate Targeting/Target Development: Retrieve FMV from Archive.	UC 1.2 Deliberate Targeting/Target Development: Analyze Product
UC 1.3 Deliberate Targeting/Target Development: Archive FMV to Target Folder	UC 2.1 Deliberate Targeting/Capabilities Analysis: Retrieve FMV from Archive
UC 2.2 Deliberate Targeting/Capabilities Analysis: Analyze Product	UC 2.3 Deliberate Targeting/Capabilities Analysis: Arrchive FMV to Target Folder
UC 3.1 Deliberate Targing Cmdrs Decision & FA/Collection Planning: • 3.1.9 Perform processing • 3.1.10 Perform exploitation • 3.1.12 Archive products to library.	UC 4.4 Plan: Execute ISR Plan. • 4.4.3 Perform processing • 4.4.4 Perform exploitation • 4.4.7 Archive products to library.
UC 5.4.Find : Analyze FMV	UC 5.5 Find : Measure from FMV
UC 5.6 Find: Store Findings.	UC 6.4.Fix : Analyze FMV
UC 6.5 Fix: Measure from FMV	UC 6.6 Fix: Store Findings.
UC 7.4.Track : Analyze FMV	UC 7.5 Track: Measure from FMV

UC 7.6 Track: Store Findings.	UC 8.4.Target : Analyze FMV
UC 8.5 Target: Measure from FMV	UC 8.6 Target: Store Findings.
UC 9.5. Engage: Analyze FMV	UC 9.6 Engage: Measure from FMV.
UC 9.7 Engage: Store Findings.	UC 10.4. Assess : Analyze FMV
UC 10.5 Assess: Measure from FMV	UC 10.6 Assess: Store Findings.
UC 11.1 Combat Assessment: Retrrieve FMV from Archive	UC 11.2 Combat Assessment: Analyze Product
UC 11.3 Combat Assessment: Archive FMV to Target Folder	UC 12.0. Resource Architecture Change : • 12.1 New unanticipated resource added • 12.2 New anticipated resource added
UC 13.0 Physical Architecture Change • 13.C Commercialization of node • 13.I Internationalization of node • 13.R Remoting of node • 13.S Securing of node	

Figure 50 depicts interactions between elements of the conceptual Component Model described in Section 6.4. This system view captures the key components and interactions supporting the operational activities for “view, measure and analyze”:

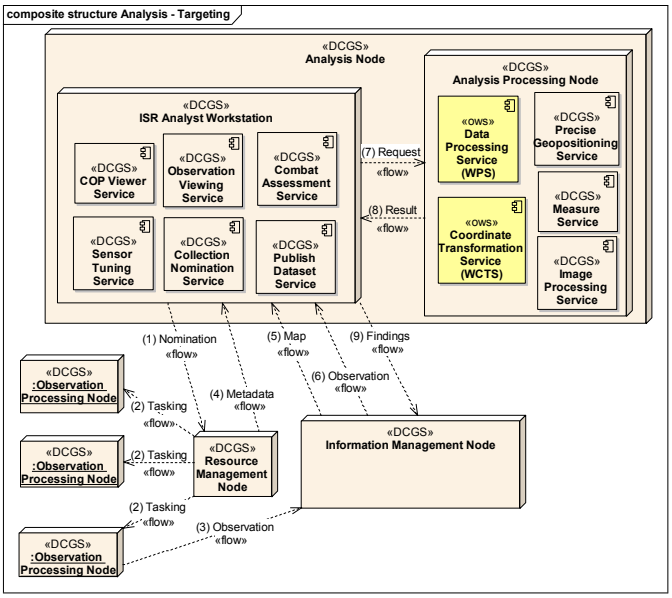


Figure 50. View, Measure, Analyze (SV-1)

This system view exhibits the following characteristics:

- An Analysis Node may have one or more data-consuming nodes (e.g., ISR Analyst Workstations) attached.

- An Analysis Node may have one or more data-producing nodes (e.g., ISR Analyst Workstations) attached and one or more data processing nodes (i.e., Analysis Processing Nodes).

- The Analysis Node may nominate ISR collection to the Resource Management Node using, for example, the Collection Nomination Service of the ISR Analyst Workstation node. This interaction is shown in flow-line 1. The Resource Management Node in turn tasks one or more ISR Resources for collection missions. This interaction is shown in flow-lines 2. These nomination and tasking interactions are more fully described in the system views of sections 7.1.2.3 and 7.1.2.4.

- One or more Observation Processing Nodes store ISR data collected and make them available to one or more system nodes via attached Information Management Node(s). This interaction is shown in flow-line 3 and more fully described in the system views of section 7.1.3.1.

- The Resource Management Node publishes metadata about recently collected datasets and the ISR Analyst Workstation searches, discovers relevant ISR data. This interaction is shown in flow-line 4 and more fully described in the system views of section 7.1.3.3.

- The ISR Analyst Workstation provisions applications, tools and services for viewing the Common Operating Picture (COP) and ISR observations, and performing video and

image processing, mensuration and other processing, generation of data product "findings" and storing findings for use by others. Visualization of COP and ISR are supported by requests to the Web Mapping Service (WMS) of the Information Management Node. Access to ISR observation data is via SOS, WCS, and WFS services of the Information Management Node. These interactions are shown in flow-lines 5 and 6 and more fully described in section 7.1.3.2 and elsewhere.

- The Analysis Processing Node provisions analytical and data processing services, including Coordinate Transformation Service and Data Processing Service components which are, respectively, implementations of OGC Web Coordinate Transformation Service (WCTS) and Web Processing Service (WPS) specifications.

- The ISR Analyst Workstation issues requests to these processing services which, in turn, return results. It is important to note that these services may be provisioned on a single server or multiple servers and may be co-located or remote to the ISR Analyst Workstation Node. This interaction is shown in flow-lines 7 and 8.

- The ISR Analyst Workstation stores resulting analytical data products (findings) to the Information Management Node for subsequent advertising, discovery and access by other nodes and stakeholders of the system. This interaction is shown in flow-line 9.

7.1.4.5 Store Findings

This activity is described in 7.1.3.1.

7.1.4.6 Cross-cue Assets

This activity is described in 7.1.2.3 and 7.1.2.3.1.

7.1.4.7 Retrieve Findings

7.1.5 Exploitation System

Exploitation system activities supporting F2T2EA involve much of the same activities, components, services and interactions as the Analysis System described in the system views above. This draws attention to architectural patterns that emerge from analysis of the operational activities in the OV. The SV draws attention to these patterns, which indicate opportunities for reuse and refactoring of services to support common operations for:

- Discovery of dynamically updated data and sensor assets

- Access to live and archived data

- Sensor tasking and tuning

- Observation viewing, measurement and analysis.

- Storage of analytical and exploited results

- Sensor asset cueing and tasking.

- Data sharing and discovery.

8 Technical Views

8.1 Technical Standards Profile (TV-1)

- STANAG
  - STANAG 7023 – NATO Primary Imagery Format
  - STANAG 7085 – Interoperable Data Link for Imagery
  - STANAG 4607 – NATO GMTI Format
  - STANAG 4609 – Motion Imagery
  - STANAG 4545 – NATO Secondary Imagery Format (NSIF)
  - STANAG 3277 – Aircraft Collection Tasking Message
  - STANAG 4633 – NATO Common Emitter Reporting Format
  - STANAG 4575 – NATO Advanced Data Storage (NADS)
  - STANAG 4559 – NATO Standard Imagery Library Interface
  - STANAG 7024 – Air Recce Tape Recorder Standard
- International Organizations for Standardization (ISO)
  - ISO 19115:2003 *Geospatial Metadata*
  - ISO 19115-2 *Extensions for Imagery and Gridded Data*
  - ISO 19139 *XML Schema Implementation of ISO 19115:2003*
  - ISO 19130 *Sensor and Data Models for Imagery and Gridded Data*
- OGC SDI 1.0
  - Web Map Service (WMS): OpenGIS® Web Map Service (WMS) Implementation Specification; 1.1; 06-042
  - Styled Layer Descriptor (SLD): OpenGIS® Styled Layer Descriptor Profile of the Web Map Service Implementation Specification ; 1.1.0; 05-078r4
  - Web Feature Service (WFS): OpenGIS® Web Feature Service (WFS) Implementation Specification; 1.1; 04-094

  - Catalogue Services (CS-Web): OpenGIS® Catalogue Service Implementation Specification; 2.0.2; 07-006r1

  - Geography Markup Language (GML): OpenGIS® Geography Markup Language (GML) Encoding Specification; 3.1.1; 03-105r1

  - Filter Encoding Specification (FE): OpenGIS® Filter Encoding Implementation Specification; 1.1; 04-095

8.2 Emerging Standards Profile (TV-2)

- OGC SWE Approved Implementation Specifications

  - SPS: OpenGIS Sensor Planning Service Implementation Specification; 1.0; 07-014r3

  - SensorML: OpenGIS® Sensor Model Language (SensorML); 1.0; 07-000

  - TML: OpenGIS® Transducer Markup Language (TML) Implementation Specification; 1.0; 06-010r6

- OGC SWE Pending Specifications

  - OM: Observations and Measurements - Part 1 - Observation schema; 0.0; 07-022r1

  - OM: Observations and Measurements - Part 2 - Sampling Features; 0.0; 07-002r3

  - SOS: Sensor Observation Service; 0.0; 06-009r5

  - SAS: Sensor Alert Service RFC Package; 0.0; 07-072

  - WNS: Web Notification Service RFC Package;0.0; 07-071

- Other OGC Implementation Specifications

  - GML: OpenGIS® GML in JPEG 2000 for Geographic Imagery Encoding Specification; 1.0; 05-047r3

Appendix A Glossary (AV-2)

Activity – see Operational Activity.

Architecture Data Element - One of the data elements that make up the Framework products. Also referred to as architecture data type. (DoDAF)

Attribute - A quantitative or qualitative characteristic of an element or its actions. (CJCSI 3170.01E, 11 MAY 2005)

Capability - The ability to achieve a desired effect under specified standards and conditions through combinations of means and ways to perform a set of tasks. It is defined by an operational user and expressed in broad operational terms in the format of a joint or initial capabilities document or a joint doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) change recommendation. In the case of materiel proposals, the definition will progressively evolve to DOTMLPF performance attributes identified in the capability development document and the capability production document. (CJCSI 3170.01E, 11 MAY 2005)

Data - A representation of individual facts, concepts, or instructions in a manner suitable for communication, interpretation, or processing by humans or by automatic means. (IEEE 610.12)

Data Model - A representation of the data elements pertinent to an architecture, often including the relationships among the elements and their attributes or characteristics. (DoDAF)

Data-Entity - The representation of a set of people, objects, places, events or ideas that share the same characteristic relationships. (DDDS 4362 (A))

Function - A characteristic task, action, or activity that must be performed to achieve a desired outcome. For a product, it is a desired system behavior. (INCOSE) Also see *System Function*.

Information Element - Information that is passed from one operational node to another. Associated with an information element are such performance attributes as timeliness, quality, and quantity values. (DoDAF)

Information Exchange - The collection of information elements and their performance attributes such as timeliness, quality, and quantity values. (DoDAF)

Link - A representation of the physical realization of connectivity between systems nodes.

Needline - A requirement that is the logical expression of the need to transfer information among nodes.

Node - A representation of an element of architecture that produces, consumes, or processes data.

OGC – Open Geospatial Consortium, a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services.

Operational Activity - An activity is an action performed in conducting the business of an enterprise. It is a general term that does not imply a placement in a hierarchy (e.g., it could be a process or a task as defined in other documents and it could be at any level of the hierarchy of the OV-5). It is used to portray operational actions not hardware/software system functions. (DoDAF)

Operational Node - A node that performs a role or mission. (DoDAF)

OWS – OpenGIS® Web Services, a family of interoperability specifications for geospatial Web services, produced by the Open Geospatial Consortium (OGC).

Service – A distinct part of the functionality that is provided by a system on one side of an interface to a system on the other side of an interface to include those capabilities to execute a business or mission process or exchange information among both machine and human users via standard interfaces and specifications. (Derived from IEEE 1003.0)

System - Any organized assembly of resources and procedures united and regulated by interaction or interdependence to accomplish a set of specific functions. (DoDAF)

System Data Element - A basic unit of data having a meaning and distinct units and values. (Derived from 8320.1) The architecture data element or type that stores data from the architecture domain (i.e., it has a value) that is produced or consumed by a system function and that has system data exchange attributes as specified in the Systems Data Exchange Matrix. (DoDAF)

System Data Exchange - The collection of System Data Elements and their performance attributes such as timeliness, quality, and quantity values. (DoDAF)

System Function - A data transform that supports the automation of activities or information elements exchange. (DoDAF)

Systems Node - A node with the identification and allocation of resources (e.g., platforms,units, facilities, and locations) required to implement specific roles and missions. (DoDAF)