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Live-Virtual-Constructive Architecture Roadmap Implementation, Common Capabilities - Common Data Storage Formats Implementation Plan

Technical Report

May 2010

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

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EXECUTIVE SUMMARY

The Live-Virtual-Constructive Architecture Roadmap (LVCAR) report recommended actions to promote the sharing of tools, data, and information across the Enterprise and to foster common formats and policy goals to promote interoperability and the use of common Modeling and Simulation (M&S) capabilities. One of the recommended actions was to examine different data storage formats used across the various architectures to determine the feasibility of creating a set of architecture-independent formats. Such formats would be used for storage of classes of data in order to mitigate the cost and schedule impacts of database conversion, minimize conversion errors, and improve consistency across Live-Virtual-Constructive (LVC) architectures. The focus of this effort is limited to data interchange formats and applicable standards where the data is persistent, e.g., in stored datasets.

The study team identified nine (9) categories of data storage formats, based on expertise and feedback received at the LVC Common Capabilities Workshop at The Johns Hopkins University Applied Physics Laboratory (JHU/APL) in November 2009 and questionnaires administered in person at the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2009 and online. This stakeholder feedback was used to assess the priority for rationalization of data storage formats for each category. The team examined the contents of eight (8) metadata standards registries, catalogs and repositories for each category identified. These sources included the Department of Defense (DoD) Metadata Registry, DoD Information Technology Standards and Profile Registry (DISR), the North Atlantic Treaty Organization (NATO) and DoD M&S Standards Profile, and the Acquisition Streamlining and Standardization Information System (ASSIST) database, in addition to privately maintained source materials. For each of the nine (9) format categories, a list of applicable formats was compiled and characterized in terms of currency, openness, maturity, and applicability as a source (producer), interchange (mediation) and executable (consumer) data format. This information was used to assess the difficulty of rationalizing formats within each category.

In addition, the team developed a strategy for each of the nine categories by evaluating the feasibility of moving to a state of greater reuse via a combination of: (1) reduction in the number of formats used in each category; (2) standardization of formats in each category if no standards exist; (3) increased adoption of mediation formats to reduce translation errors; and (4) creation or engagement with category-specific communities of interest (COIs).

Using this prioritization approach, the standardized formats should be pursued in the following order:

Priority 1

- Manmade features
- Event results

Priority 2

- Geospatial

Priority 3

- Unit Order of Battle (UOB)
- Plans/scenarios

Priority 4

- Platform/Weapons performance
- Behavior

Priority 5

- Electronic Order of Battle (EOB)/network
- Logistics

The team identified the following list of general engagement strategies for improving the state of any category:

- Engage with ongoing efforts to ensure they include LVC-specific requirements,
- Establish forum/process for mediating between dissenting communities,
- Initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists,
- Accelerate promising, but slow, ongoing efforts,
- Enable management/cooperation changes, and
- Monitor until sufficient meaningful direction emerges.

Table ES-1 consolidates the recommendations, feasibility, and priority with these general strategies to provide specific strategies and timelines for each category.

Table ES-1: Implementation Plans

Category	Strategy	Timeline
Manmade features (Priority 1)	Engage with ongoing efforts to ensure they include LVC-specific requirements: • Determine M&S-specific set of requirements for three dimensional (3D) manmade features representation. • Work with existing standards bodies to ensure requirements not yet met by their specifications are incorporated in the next iteration (Khronos Group - COLLADA[1], Open Geospatial Consortium (OGC) – CityGML, Web3D - X3D).	Start: Fall 2010 Simulation Interoperability Workshop (SIW) Duration: 2 years

[1] A COLLAborative Design Activity for establishing an open standard Digital Asset schema for interactive 3D applications – a standard of the Khronos Group.

Category	Strategy	Timeline
Event results (Priority 1)	Monitor until sufficient meaningful direction emerges: • Observe ongoing development in the Joint Digital Collection, Analysis, and Review System (JDCARS) and One Semi-Automated Forces (OneSAF) logging/After Action Report (AAR) efforts with the goal of discovering commonalities in the development event results data models. • Coordinate with subject matter experts (SMEs) who regularly utilize event results data to generate AAR reports to gather their input requirements.	Start: 1 year Duration: 2 years
Geospatial (Priority 2)	Establish forum/process for mediating between dissenting communities; management/cooperation changes: • M&S Technical Working Group (TWG) petitions for voting status in the GWG. • Establishment of an M&S Geospatial Task Force. This task force would be tasked with coordinating with the Command and Control (C2) community to establish broad format requirements. • Development of a standards strategy, including the potential for convergence on a common set of mediation formats and identification of the Standards Development Organizations (SDOs) responsible for managing and extending those formats.	Start: Immediately Duration: 5 years • Geospatial Intelligence Standards Working Group (GWG) voting status – 6 months • M&S Geospatial Task Force – 6 months • Standards strategy – 2 – 5 years
UOB/force structure (Priority 3)	Engage with ongoing efforts to ensure they include LVC-specific requirements: • Ensure that government-owned proprietary standards are exposed to the commercial community in the form of recognized open standards. • Deconflict Coalition Battle Management Language (C-BML) with related standards. • Utilize Joint Land Component Constructive Training Capability (JLCCTC) as a reference implementation for wider LVCAR applicability.	Start: Fall 2010 SIW Duration; 2-5 years

Category	Strategy	Timeline
Plans/ scenarios (Priority 3)	Engage with ongoing efforts to ensure they include LVC-specific requirements; initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Move towards standardization and rationalization of data storage formats by delineating the relationship, scope and fundamental limitations of Joint Consultation, Command, and Control Information Exchange Model (J3CIEDM), Military Scenario Definition Language (MSDL) and C-BML. • Ensure that semantic as well as syntactic issues are addressed as exising mediation formats for plans and scenarios evolve. • Explore the reconciliation of plans and scenario representations in multi-resolution federations.	Start: Immediately Duration: 2 years
Platform /weapons performance (Priority 4)	Initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Determine the Air Force and Navy's desire/need to establish authoritative data sources and formats analogous to those produced by Army Materiel Systems Analysis Activity (AMSAA).	Start: 6 months Duration: 6 months
Behavior (Priority 4)	Monitor until sufficient meaningful direction emerges: • SISO has established a Human, Social, Cultural, Behavioral (HSCB) study group to determine if any standards are feasible in this area. Participate in this activity. • The Office of the Secretary of Defense (OSD) / Office of Naval Research (ONR) HSCB program funds several key model developers, but they are indifferent or antagonistic to standards at this point. Continue to engage with this effort and attempt to improve understanding and acceptance of common data storage formats.	Start: N/A Duration: revisit feasibility in 1.5 – 2 years

Category	Strategy	Timeline
EOB/ network (Priority 5)	Engage with ongoing efforts to ensure they include LVC-specific requirements; initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Extend recognized government standards (JC3IEDM, C-BML, MSDL) into a published open standard that is also reflected in the DISR baseline. • Establish an appropriately focused Simulation Interoperability Standards Organization (SISO) study group consisting of the relevant stakeholders from government and private industry. • Explore a pilot project aligning Commercial-Off-The-Shelf (COTS) and Government Off-the-Shelf (GOTS) tools with an updated Lightweight Directory Access Protocol (LDAP) Interchange Format (LDIF).	Start: Fall 2010 SIW Duration: 2-3 years
Logistics (Priority 5)	Accelerate promising, but slow, ongoing efforts: • Explore a pilot project that extends JC3IEDM to enable the direct interchange of logistics data into JLCTCC Entity Resolution Federation components • Extend initial JLCTCC pilot effort to support aggregate level constructive simulations and interaction with live systems through Logistics C2 systems.	Start: January 2011 Duration: 2 years

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1 INTRODUCTION

1.1 GOALS AND OBJECTIVES

The Live-Virtual-ConstructiveArchitecture Roadmap (LVCAR) included an expert tip on common data storage formats: The Department of Defense (DoD) should lead efforts to standardize or automate translations of data/scenario inputs to simulations and data capture formats. This makes it easier to prepare common data for use in different simulations. It will also help to limit errors due to data mismatches and makes it easier to test and compare results of different federations. It also makes it easier and cheaper to build new simulations since there will be ready data sources available.

This means that proliferation of data storage formats contributes to the cost, schedule, and risk of Live-Virtual-Constructive (LVC) events. The goal of this task is to reduce these impacts by reducing the number of formats in the identified categories with the following objectives:

- Reduce the cost and time to produce and/or transform input formats;
- Reduce the risk of errors caused by format conversion failures;
- Support the reuse of development tools by enabling the tools to produce and consume accepted common data storage formats; and
- Provide the basis for consistent database reuse where practicable.

1.2 BACKGROUND

1.2.1 History of DoD Data Standardization

Because of the breadth of the Defense Enterprise and the resulting interoperability challenges, data standardization has long been an issue. Initial data standardization efforts began in the early 1990s with the issuance of the DoD 8320-series of documents [Reference (a)][2]. The approach at that time centered on standardizing individual data elements (attributes), e.g., PERSON-Name. The intent was that all DoD information systems would implement those data standards internally and, thus, would be inherently interoperable. Along with the list of standardized data elements would be one DoD Enterprise Data Model to establish the relationship among the data elements. The data element definitions resided in the DoD Data Dictionary System. This centralized approach, directed by Office of the Assistant Secretary of Defense (OASD) Command, Control, Communications, and Intelligence (C3I) and implemented by the Defense Information Systems Agency (DISA), ultimately failed. Major reasons for this failure included the huge cost of modifying legacy systems to implement the approved data

[2] References may be found in Appendix A.

elements and the notion that one data model context could apply to all data across the department[3]. As will be described later, this "one size fits all" issue is a key challenge for M&S.

In 2003, the DoD Chief Information Officer (CIO) established a new direction for data in the Department—the Net-Centric Data Strategy (NCDS) [Reference (b)]. This memorandum and subsequent guidance [Reference (c)], called for the posting of data to shared spaces to support intended and unintended users, and to facilitate the use of that data, the development of common data formats [typically Extensible Markup Language (XML) schemas]. The strategy and guidance called for Communities of Interest (COIs) to establish those data formats and the mechanisms for data sharing.

The major differences between the initial data strategy and this new data strategy relative to standards were 1) the focus on establishing standards for data interchange (vice internal implementation) and 2) the decentralized approach to establishing standards. This second factor meant that some (but not all) of the "one size fits" all problems of the previous strategy were ameliorated. Some of the initial COIs were broadly scoped, and the Modeling & Simulation (M&S) COI is one such example; the Training COI is another. For broadly scoped COIs, challenges in reaching consensus on a single way of representing a data area still are likely to arise. Some of the later-established, more tightly focused COIs have been held up by the Assistant Secretary of Defense for Networks and Information Integration (ASD NII) as successful examples. A commonly cited example is the Maritime Domain Awareness COI, which focused on the sharing of maritime situational awareness data. To date, over 80 COIs have been established. Problems can arise when multiple COIs define conflicting data formats, and COI members have the need to interoperate with members of several COIs. This is an especially important point for the M&S COI, and will be further elaborated later. Apparent solutions to this are:

- Cross-COI collaborations - In the worst possible case becomes an N*(N-1)/2 problem where N is the number of COIs. For 80 COIs, that means 3160 possible collaborations, although practically the number is smaller but not insignificant.
- Adjudication by a higher body where conflicts arise – There is no current DoD organization tasked with this responsibility, which, as can be seen from the above, is a daunting task.
- Establishment of core elements – This strategy is evident in the establishment of the Universal Core (UCore) [Reference (c)] set of schema elements. UCore defines common concepts (who, where, etc.) that are intended for use in all COIs, eliminating many interoperability problems. The C2Core [Reference (d)] effort takes this same approach for a specific domain, spanning multiple, but not all, COIs.

[3] As a result, DoD cancelled DoD Directive 8320.1, replacing it with DoD Directive 8320.02.

1.2.2 M&S Data Standardization Challenge – Multiple Representations

The "one size fits all" issue was raised earlier as an issue across COIs. This issue exists to a great extent within the M&S Community. M&S is the art and science of abstracting away the unnecessary detail of a problem so that focus can be given to the essential elements. What those essential elements are varies depending on the application that M&S is supporting, thus the appropriate abstraction differs. For example, the information about an aircraft necessary to model its aerodynamic performance and the information necessary to model the logistical sustainment of an aircraft are largely two completely separate sets of attributes. The same need for varying representation in data becomes evident when models and simulations of differing resolutions exist. For example, when considering multiple simulations that model aircraft detectability, where one simulation models the aircraft as a single value for radar cross-section, and where another model takes into account the orientation and geometry of the aircraft, the data sufficient for one model is not suitable for use in the other. The result is a need for related, but separate, data interchange formats to describe aircraft. In some cases, data formats can be constructed that support multiple levels of resolution, but this is not always possible.

1.2.3 Standards Stewardship and the M&S Community

Standards stewardship addresses who has the ultimate responsibility for establishing and maintaining data standards. The first reaction of most communities is to establish standards sufficient for their own use, without regard to the representational needs from other communities. This approach works as long as applications stay within the boundaries of that community, but rapidly becomes a problem when applications work across community boundaries, or applications from multiple communities must interoperate. The M&S Community arguably encounters this problem more than any other community. The problem arises when virtual and constructive M&S must be integrated with operational live systems. In general, the data necessary to simulate a process or entity exceeds what is necessary for humans to reason about the same processes or entities. For example, a soldier can navigate using a raster image representation of terrain. However, for a semi-automated force constructive simulation to perform that same task, it must have information about the topology and characteristics of the simulated terrain.

Very few data standards are M&S-specific, e.g., standards for the interchange of Verification, Validation, and Accreditation (VV&A) results or run-time data exchange models. For standards to drive operational systems, the operational community is assigned stewardship for standardization, either by consensus or in some cases by DoD policy or United States (US) Code. That is not to say that related standards to support M&S applications should not exist, but where they do and differ in the overlapping representations with the operational standards, the potential for interoperability problems exist. Thus, forethought and cross-collaboration between M&S and operational users in the establishment and maintenance of standards is critical.

1.2.4 Common Patterns for Solving Data Interoperability Problems with Standards

To address the landscape of standards and data formats that are used to solve data interoperability problems, it is helpful to understand that several possible patterns exist to address standardization issues. To address these patterns, it is helpful to draw a distinction between data producers and data consumers. The terms "producer" and "consumer" should be considered "roles," not as categories of organizations or systems. In reality, a series of transactions often occur between the initial capture of data, and the final use or employment of the data. Intermediary organizations and systems in the chain of transactions take on roles as both producers and consumers of data. Based on these roles, three primary states of standardization can exist.

1.2.5 Base State: Multiple Producer and Consumer Formats, without Mediation

Without active standardization, the state of affairs for most data domains resembles what is shown in Figure 1-1. This state is characterized by a variety of producer and consumer formats, where some data producers (but not all) may use the same formats, and likewise some consumers (but not all) use the same formats. Historically, the producer formats are driven by the needs and capabilities of authoritative data producers, and consumer formats are driven by the efficient formatting of data for use in M&S or operational systems. This is not to say that data is stored inside the data production or using systems in exactly the corresponding formats. Often internal data storage is highly optimized. But in both cases--internal data storage and external data interchange formats--there is some documented schema describing the structure of data, and optimally, a well defined data dictionary the captures data semantics.

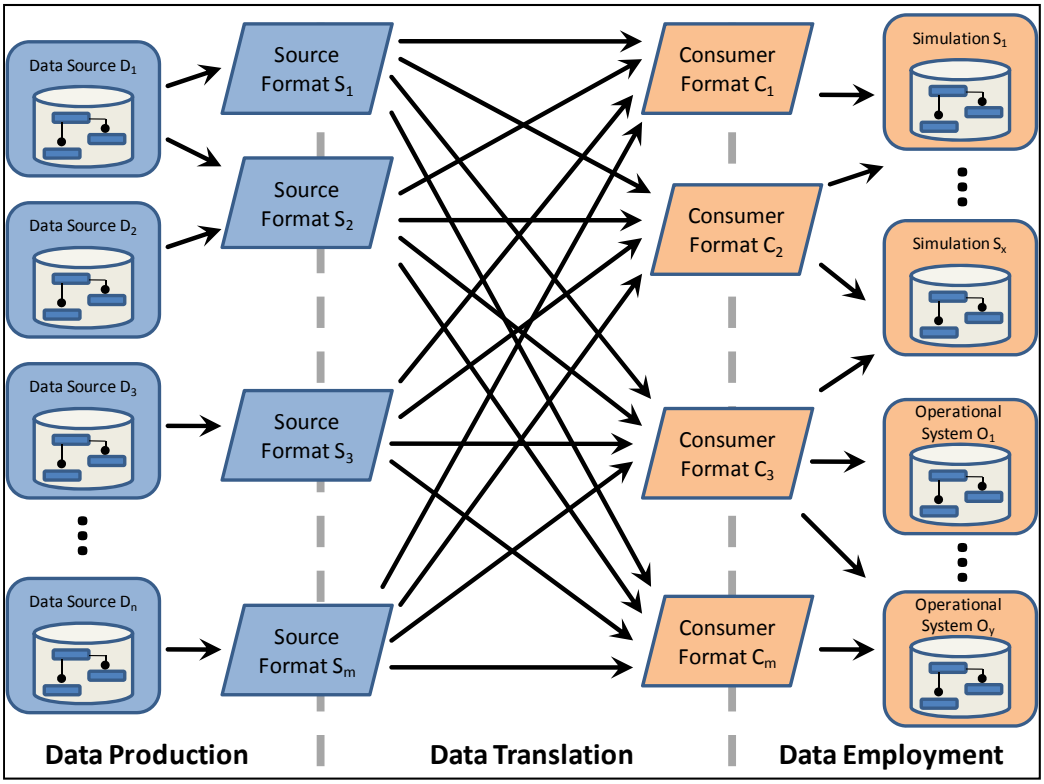

Figure 1-1: Base State: Multiple Producer and Consumer Formats, without Mediation

As can be seen in Figure 1-1, multiple PxC data translations can potentially exist, where P is the number of producer formats and C is the number of data consumer formats. Practically, a subset of these translations is often built, since not all consumers use data from all producers. With large numbers of producers and consumers, this state becomes problematic, requiring multiple changes in translation software when either producer or consumer formats change. Additionally, this doesn't scale as more producer and consumer formats are defined.

1.2.6 Fully Converged: Single Data Format

In an ideal world, one data format would include any and all data concepts, properties, and relationships. This state is represented in Figure 1-2. For the reasons stated above regarding "one size fits all," this state has not occurred for any of the data categories addressed in this report. To reach this state, strong central control would need to exist. Where legacy systems exist, significant costs would be incurred to modify the legacy systems to produce and consume data in a mandated format.

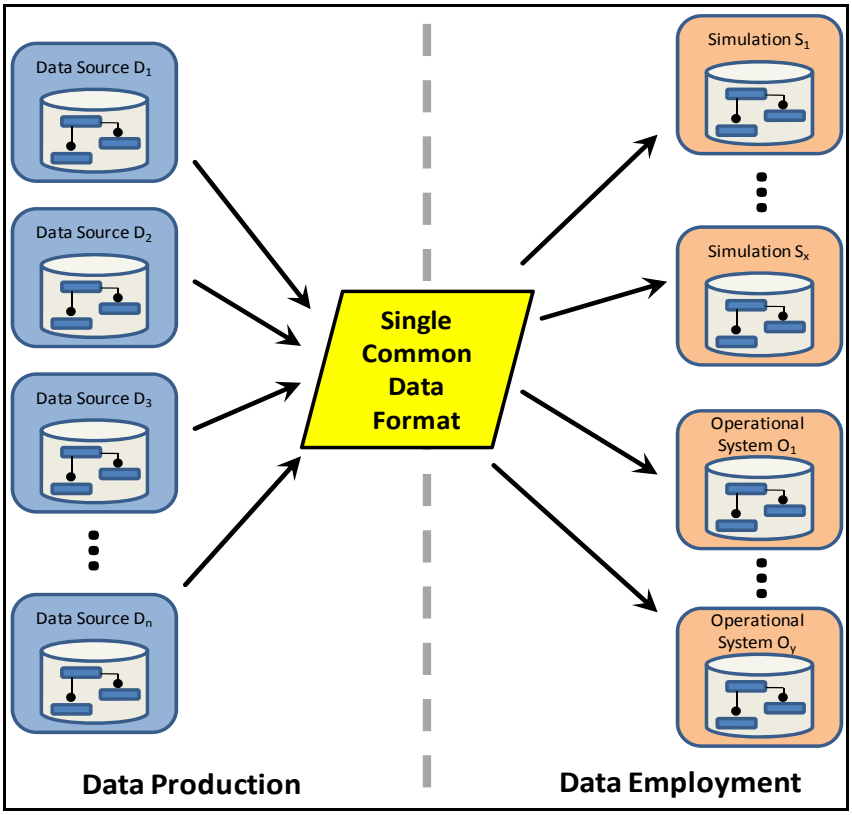

Figure 1-2: Fully Converged: Single Data Format

1.2.7 Partially Converged: Mediation Format(s) Exist

Where multiple producer and consumer formats exist, one or more mediation formats often emerge as is seen in Figure 1-3. These formats integrate representation capabilities from multiple producers and consumer formats. In the case of a single mediation format existing for a data category, the number of data translations that must be maintained is reduced from a complexity of PxC to P+C, where P is the number of producer formats and C is the number of consumer formats. Multiple mediation formats often exist where either 1) the data category has clearly identifiable subcategories and/or 2) consensus on a mediation format has been reached among a subset of data producers and consumers that have an interest in the data category. The achievement of an agreement among a group of stakeholders is what categorizes a successful COI in the DoD Net-centric Data Strategy.

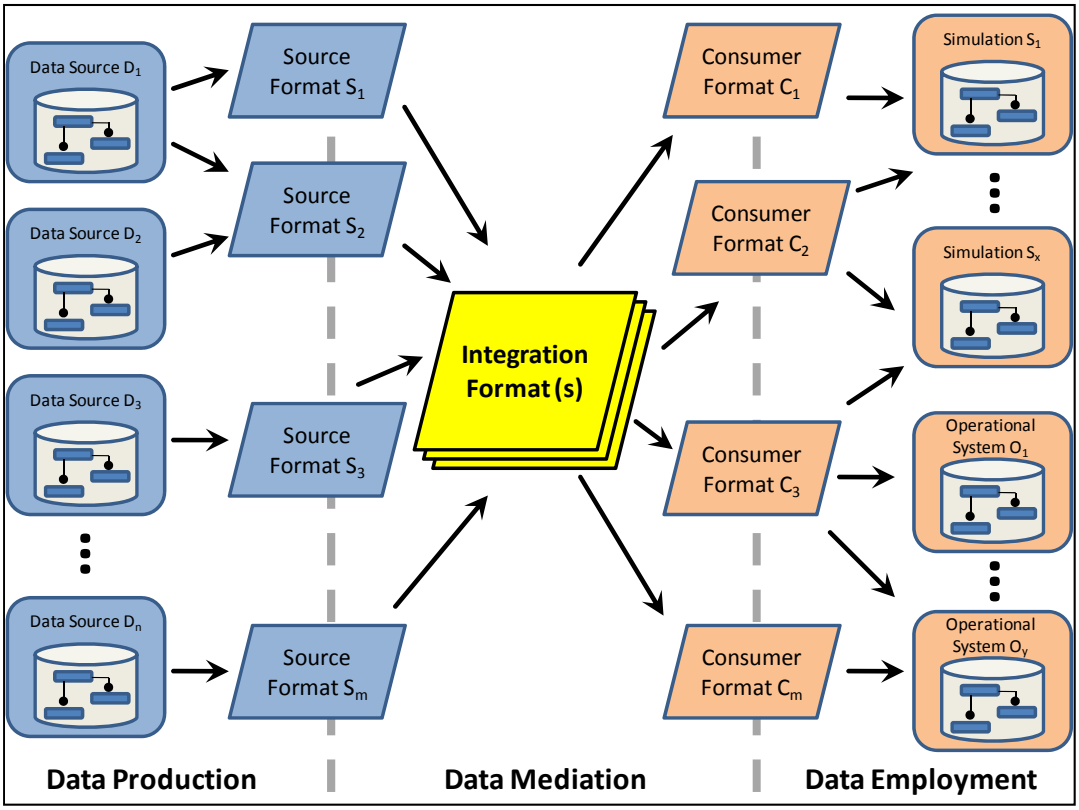

Figure 1-3: Partially Converged: Mediation Format(s) Exist

1.3 SCOPE

Although the term "standards" has been used in the previous section, the scope of this report is not just standards that are maintained by an open, consensus standards body. The broader definition of the term was used, and this report will address both formal standards and storage formats that are maintained either within the government or by industry (with or without collaborative means).

The scope of this report is limited to data formats used for the interchange of data. Consistent with the movement from the prior DoD data standardization direction to the Net-centric Data Strategy, no consideration is given to how data is represented internally in models or simulations. Further refining the scope, this report is concerned with data interchange formats and standards where the data has some persistence, e.g., in stored datasets.

This report does not address the temporal exchange of data among simulations or among simulations with other LVC systems. Data dictionaries that contain enumerated values that are used to constrain the contents of datasets consistent with the data formats are within the scope of this report. This report does not address the standardization of service oriented architecture (SOA) interfaces, nor does it address the standardization of logical data models where no physical data model in the form of a data format has been established.

The scope of this report focuses on the data classifications and corresponding formats as defined in the taxonomy found in Section 1.4, and does not address the interchange of data artifacts that describe the process of conducting M&S, e.g., conceptual models, federation agreements, VV&A documentation, etc.

1.4 METHODOLOGY

The team began by identifying categories of data storage formats from the team's event experience. This list was briefed at a workshop at JHU/APL in November 2009 where Joint Rapid Scenario Generation (JRSG) was proposed as a key input. The Authoritative Data Source (ADS) classes as defined by the prior Defense Modeling and Simulation Office (DMSO) and Services ADS initiatives were also submitted as an input. The resulting list is a rationalized mix of JRSG and ADS:

1. Geospatial data [including Meteorological and Oceanographic (METOC) and air/space]
2. Manmade environmental features, e.g., 3D models
3. Unit order of battle/force structure (including manning and readiness)
4. Electronic order of battle/network
5. Platform/weapons performance and/or characteristics
6. Plans/scenarios [including Time-Phased Force Deployment Data (TPFDD)]
7. Behavior (including organizational and individual)
8. Logistics
9. Event (testing, training, analysis, etc.) results

The team solicited inputs on categories and instances of data storage formats from the community via the November workshop, an online questionnaire[4], and a workshop in conjunction with the 2010 Spring Simulation Interoperability Workshop (SIW). In addition, the team searched the following recognized sources of data formats:

- Acquisition Streamlining and Standardization Information System (ASSIST) [Reference (e)]
- DoD Information Technology Standards and Profile Registry (DISR) [Reference (f)]
- M&S Standards Profile[5] [Reference (g)]
- Formats used by the tools in the Reusable Tools Implementation Plan [Reference (h)]
- NATO M&S Standards Profile

[4] The Current State Research can be found in Appendix B, and the original online questionnaire and responses are in Appendix C.

[5] Provided in draft format by AEgis Technologies on behalf of the Modeling and Simulation Coordination Office (M&S CO).

- Simulation input formats identified in the federation agreements acquired for the Federation Agreements Template task
- Simulation Interoperability Standards Organization (SISO) web site
- DoD Metadata Registry [Reference (k)]

The instances of formats in each category were researched to determine the state of the "market" for the category to support determination of the difficulty of reducing the number of formats as detailed at the beginning of the next section. The priorities for improving the "market" for each category were determined from the online questionnaire and feedback at the November 2009 workshop. The recommendations in Section 1 are based on the correlation of difficulty and priority.

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2 CURRENT STATE AND FEASIBILITY ASSESSMENT

In this section, the team describes the current state of formats in each of the identified categories and assesses the difficulty of achieving a reduced number of formats as described in Section 1.2.4. The detailed data upon which the assessment is based can be found in Appendix B. Criteria for assessing difficulty include:

1. Number of formats in the area.
2. How complex the format is: size, number of classes and attributes.
3. Multiple organizations working on standardized formats.
4. Political conflict in the domain. For the purpose of this study, "political conflict" is defined as "the actual or perceived opposition of needs, values, and interests" [Reference (i)].
5. Maturity (from M&S Standards Management Plan) [Reference (g)]
    a. Concept – The technology is conceptually feasible, but has not been implemented.
    b. Proof-of-concept – The technology has been demonstrated, but a prototype may require work arounds or expert support.
    c. Reference implementation(s) – The technology has at least one implementation that is sufficiently stable not to require expert support, but does not necessarily have the support tools, materials, and services that accompany a mature product.
    d. Experimentation – Proof-of-concept or reference implementation(s) are being evaluated by multiple users under multiple use cases.
    e. Productized/mature market – The technology is stable; at least one mature product is available with appropriate support tools, materials, and services.
6. Existence of one or more mediation standards in the category

In addition to current state, the team evaluated the feasibility of moving to a state of greater reuse via:

1. Reduction in the number of formats used in each category;
2. Standardization of formats in each category if no standards exist;
3. Increased adoption of mediation formats to reduce translation errors; and
4. Creation or engagement with category-specific communities of interest.

COIs would be focused on the format category, tasked with:

1. Determining a core set of required capabilities, likely determined by operational needs;
2. Determining a set of M&S extensions based on identified use cases; and
3. Coordinating among existing COIs [e.g., Geospatial Intelligence (GEOINT), M&S, etc.] and non-governmental stakeholders.

A listing, description, and cross-reference of all Global Information Grid (GIG) COIs to this effort is provided in Appendix D.

2.1 GEOSPATIAL DATA

The geospatial data category is here defined as encompassing all data storage formats for the representation of synthetic natural environments. This includes elevation models, two-dimensional (2D) and three-dimensional (3D) terrain, vector maps, geo-referenced raster imagery, Geographic Information System (GIS) databases, METOC data, and air and space data. This category covers all natural features and phenomena that are defined by a specific geographical location.

The team has identified 93 currently used data storage formats for geospatial data, 80 of which are actively maintained. Thirteen of those formats are not, strictly speaking, data storage formats, but are included as they are data dictionaries or conceptual models without which several important storage formats cannot be implemented. Of the remaining entries on the list, four are GIS extensions to major relational databases, 71 are unique storage formats, and five are Service- or Department-specific "universal" geospatial databases. Ten of the storage formats and 10 of the conceptual models have been identified as mediation formats.

The geospatial data category is characterized by a plethora of formats, standards bodies working on comprehensive solutions, and vendors producing data in proprietary formats. Attempts at comprehensive solutions to the explosion of formats have been made and are currently underway [e.g., Synthetic Environment Data Representation and Interchange Specification (SEDRIS), Open Geospatial Consortium (OGC) Geography Markup Language (GML), National Imagery Transmission Format Standard (NITFS), etc.] and each of the Army, Air Force, Navy, United States Special Operations Command (USSOCOM), and the Department of Homeland Security (DHS) all have their own "universal" geospatial data production plans ongoing, all of which are developing independently. A variety of factors have resulted in the number and diversity of data formats in this area:

- First, the area of geospatial data is very broad, encompassing data from sub-surface to space. For each subcategory of data there are a variety of data producers where many have established their own format.
- A commercial geospatial data market exists at a scope unlike other data categories addressed in this report. For other categories, the DoD tends to be the primary data producer, controlling the formats for data production. In the geospatial area, this is not the case; a large number of non-DoD data producers, including commercial data producers, are well established.
- Most geospatial data users, especially those using geospatial data in M&S, must integrate data from multiple sources to produce a coherent representation of the

environment. This process is a service industry unto itself and has resulted in multiple mediation efforts, e.g., Sythetic Environment Core (SE Core) and standards, e.g., SEDRIS, being established.

- The end-use application of geospatial data in M&S varies. Traditionally, geospatial data was driven by the need to produce paper maps and charts. With the emergence of automated decision support systems and M&S, geospatial data is used to drive applications from visualization to terrain reasoning to electromagnetic propagation calculation. Each of these applications has distinct data representation needs; thus, different formats have emerged.

All of these reasons have resulted in a trade-space of formats that resembles the model described in Figure 1-3 above. However, the mediation formats and standards are not aligned. One reason for the divergence in formats, especially mediation formats, has been the lack of cross-coordination between the operational community and the community of M&S users. M&S users have typically presumed that the operational geospatial community would not take action to satisfy their needs, and thus, have independently developed solutions including establishing formats and standards.

A recent example of these issues arising has been the conflict between the SEDRIS and National System for Geospatial Intelligence (NSG) standards, specifically the Environmental Data Coding Specification and the NSG Feature Data Dictionary (NFDD). Although many of the overlapping concepts in SEDRIS and NFDD derived from a common baseline, they have been named and defined differently in the two standards. The effort just to identify where the overlaps and conflicts exist has taken over three staff years to date. Additional effort will be required to either develop data translation solutions to mediate data between systems using these standards or to revise the standards and the applications that rely on them.

Addressing the divergence in the geospatial data category is very much like addressing the divergence in LVC architectures, and the same conclusions can be drawn. The geospatial data market is well established, with producers and consumers having made significant investments that preclude radical shifts in direction. It is unreasonable to expect that a single format for all geospatial data will emerge that will satisfy the needs of all geospatial data producers, integrators, and consumers. The results would be “yet another format.” Much as the LVCAR roadmap recognized that establishing a new LVC architecture would result in “yet another format,” a more reasonable expections is that the number of mediation formats can be reduced (achieve convergence). A first reasonable step is to reduce the divergence across the set of formats.

The following actions are recommended to drive towards convergence in the geospatial data category and are summarized in Table 2-1:

- The Community of M&S geospatial data users must engage with the operational geospatial community. In the past, M&S has been recognized only as a non-voting member of the Geospatial Working Group (GWG)—the body that established geospatial standards within the DoD Information Technology Standards Committee (ITSC), M&S users should be represented in the GWG via their Service and Component representatives, and the M&S Technical Working Group (TWG) should become a voting member of the GWG to represent combined M&S interests.
- A Geospatial Task Force should be established to coordinate first across the body of M&S users, then with the command and control (C2) community. This Task Force should identify current in-use set of geospatial standards, define subcategories and relationships among the subcategories, and identify where commonalities and overlaps exist among formats in the subcategories.
- The Geospatial Task Force should identify the potential for, and means of influence, to drive convergence in formats, focusing on mediation formats first. The result should be a geospatial data roadmap, similar in scope to the LVCAR roadmap.
- The Geospatial Task Force should develop a standards strategy that clearly identifies what Standards Development Organizations (SDOs) will be engaged to develop and maintain DoD-used standards, how DoD representation will be achieved in these SDOs, and how a unified DoD position will be presented to these SDOs.

Table 2-1: Geospatial Data Summary

Criterion	State
Number of formats (total / active)	93/80
Identified subcategories	Digital Elevation Models, 2D and 3D terrain, Vector maps, Geo-referenced raster imagery, GIS databases, METOC, Air and Space data
Organizations working on standardized formats	11 [National Geospatial Intelligence Agency (NGA), International Organization for Standardization (ISO), OGC, SEDRIS Group, Digital Geographic Information Working Group (DGIWG), American Society for Photogrammetry and Remote Sensing (ASPRS), LandXML.org, NATO, University Corporation for Atmospheric Research (UCAR), World Meteorological Organization (WMO), International Hydrographic Organization (IHO)]
Political conflict	Substantial political conflict. Proliferation due to political concerns, legacy formats/systems, domain-specific requirements, substantial industry investment in proprietary formats, and runtime requirements.
Maturity	Productized (96%), Experimentation (2%), Reference Implementation (1%), Proof of Concept (1%)
Complexity	Extremely complex.
Mediation formats	10 storage [Digital Geographic Information Exhange Standard (DIGEST), GML, CityGML, SEDRIS Transmittal Format (STF), Standard Interchange Format (SIF), IHO S-57, S1000, Skyline Multi-Resolution Model, SE Core Master Database (MDB), Common Database (CDB)], 9 conceptual [Environmental Data Coding Specification (EDCS), Shaded Relief Model (SRM), DGIWG Feature Data Dictionary (DFDD), Feature and Attribute Coding Catalog (FACC), Urban Topographic Data Store (UTDS), Local Topographic Data Store (LTDS), Regional Topographic Data Store (RTDS), Global Topographic Data Store (GTDS), Joint METOC Conceptual Data Model (MCDM)]

Criterion	State
Related COIs	M&S, GWG, Defense Critical Infrastructure Program (DCIP), Defense Installation Spatial Data Infrastructure (DISDI), Installation Management (IM), METOC, Overhead Non Imaging Infrared (ONIR), Symbology (SYM)
Key Stakeholders	DoD stakeholders include data providers (e.g., NGA), data integrators (e.g., SECore), operational users [e.g., Joint Forces Command (JFCOM)], and M&S users [e.g., Future Combat Systems (FCS)]. Geospatial stakeholders outside the DoD include tool vendors, imagery providers (e.g., satellite, aerial, etc.), database providers, and GIS service providers (e.g., Google, Mapquest, etc.), standards organizations (e.g., ISO, OGC, DGIWG, etc.), and the METOC community.

2.2 MANMADE ENVIRONMENTAL FEATURES

The manmade environmental features category is here defined as encompassing 3D models of non-geospatial data. This excludes terrain, vector map data, environmental conditions, etc., but includes 3D models which may include geospatial positioning data including buildings, vehicles, or any other model of a man-made element that may be incorporated into a synthetic natural environment at runtime that can be stored independently of its geospatial positioning.

Team members have identified 20 currently used data storage formats for manmade environmental features, 17 of which are actively maintained, and eight of which have been explicitly designed as mediation formats. There is substantial overlap in identified usage for many of these formats, with many existing primarily as reflections of the internal implementation of the tools that generate them.

A combination of engagement with identified communities of interest and economic incentives can likely reduce the number of formats used in M&S without limiting capabilities to exchange and display 3D models. Engagement has already produced results tailored for the M&S community with OpenFlight and X3D. The study team recommends the formation of a 3D Modeling COI whose tasking would be to first identify the core domain needs of M&S 3D models and then to determine what, if any, specific use cases have requirements not generally supported.

This space is mature and rich enough in existing open standard formats that new format and standards development is not needed. The team recommends focusing post-assessment COI

efforts on the semantic extension of existing formats that meet the identified core requirements, and then only when specific use case gaps are identified. Formats particularly suitable for such extension are COLLADA, an open, extensible, XML-based format for 3D moving models, and CityGML, an open, XML-based application schema for GML designed for urban environment modeling and arbitrary semantic annotation. Additional focus should also be paid to OpenFlight and X3D as entrenched players in this space, though reliance upon proprietary formats controlled by a single company, like OpenFlight, is to be generally avoided. Once the COI has determined a minimal subset of formats that meet identified M&S use case requirements economic incentives can be used to encourage future development and conversion of existing models to one of these formats based on intended use without any lost capability.

Table 2-2 provides a summary of the manmade environmental features.

Table 2-2: Manmade Environmental Features Summary

Criterion	State
Number of formats (total / active)	20 / 17
Identified subcategories	3D moving models, Scenegraph transfer, Urban modeling, computer-aided design (CAD) / computer-aided manufacturing (CAM), Architectural modeling
Organizations working on standardized formats	8 [ISO, OGC, Khronos Group, Web3D, SEDRIS Group, Open Design Alliance (ODA), buildingSMART, OpenNurbs (McNeel)]
Political conflict	Little political conflict beyond open/ proprietary standards choice. Proliferation primarily due to specialized subcategory needs with increasing collaboration within subcategories the rule and cross-domain collaboration increasing (COLLADA extensions).
Maturity	Productized (81%), Experimentation (19%)
Complexity	Complex but well understood category. Complexity primarily due to increasingly advanced visualization capabilities.
Mediation formats	8 [Extensible Three Dimensional (X3D), COLLADA, SEDRIS Transmittal, CityGML, Autodesk FilmBox(FBX), Industry Foundation Classes Standard for the Exchange of Product model data (IFC STEP), Lightwave, 3D Model (3DM).
Related COIs	M&S, GEOINT Standards, Installation Management
Key Stakeholders	DoD stakeholders include data providers and integrators (e.g., SECore), operational users (e.g., SOCOM), and M&S users [e.g., Program Manager, Combined Arms Tactical (PM CATT), Distributed Mission (DMT), etc.]. 3D modeling stakeholders outside the DoD include tool vendors, media companies (e.g., movies, advertising, etc.), the video game industry, and professional design industries (e.g., industrial design, architecture).

2.3 UNIT ORDER OF BATTLE/FORCE STRUCTURE

The unit order of battle (UOB) category consists of the identification, command structure, strength, and disposition of personnel, equipment, and units of the forces included in an operation, exercise, or simulation event. Standard unit configurations are defined in tables of organization and equipment (TO&E) which may be locally modified for specific units, based on mission needs. Organizational data is organized hierarchically in a tree structure, with superior and subordinate units and their assigned personnel and equipment assets. Units are uniquely designated for each echelon or level of command and type. Order of battle information includes task organization and attachment and detachment of units from their organic structure, with a set of defined command and support relations derived from the organic structure, that may be modified according to doctrine for each mission or operational phase. As defined in this study, an "order of battle" has no geospatial content, such that a "force laydown" that positions units within the operational environment is considered part of the Plans/Scenarios category.

The study team identified ten (10) currently used data storage formats for order of battle data. Two (2) other identified formats have been deprecated and two (2) more are in development at present. Six (6) of the active formats are mediation formats, three (3) are consumer formats and one (1) is a reference standard used to define the contents of unit symbology. Order of battle data is often closely linked to electronic orders of battle and operational plans and scenarios; indeed, the standard US military operations order (OPORD) format describes the order of battle for friendly and enemy forces. For this reason, many of the formats found and analyzed in this category were also allocated to these categories.

Because the functional boundaries between order of battle and plans/scenarios are complex, there is considerable overlap between mediation formats used to define forces in LVC simulations, to define plans to be executed by those forces, and to issue orders for execution by those forces. For example, the Military Scenario Definition Language (MSDL), by agreement in SISO, has proponency for the first two of these functions, while the Coalition Battle Management Language (C-BML) has responsibility for issuing orders to live (human and robotic) as well as simulated units in an exercise context. The Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM) also enables the description of unit composition in terms of tables of organization, equipment and personnel. Although individual simulations enable the user to define unit organizations and identifying characteristics in accordance with their respective conceptual model, there is a strong need to ensure compatible unit attributes across a simulation environment to ensure consistency of message traffic initiated by both live and simulated players. There are also cost and resource considerations associated with having to manually enter similar or the same data across multiple heterogeneous simulation and C2 systems.

The survey of source, mediation and consumer formats in this category indicates that there are a number of robust and generally mature mediation formats available. Less clear is the potential for full convergence to one or just a few mediation formats. Moreover, the presence of XML-based mediation formats that are still in development and/or various states of upgrade would indicate that the data interchange mechanism in this category is not yet settled, and that some enhancement of the current state is possible. The most important consideration in this area is to ensure that government-owned proprietary standards are exposed to the commercial community in the form of recognized open standards. The maturation of C-BML as well as the deconfliction of C-BML with related standards (e.g., MSDL and JC3IEDM) is a critical milestone to achieve this. The Joint Land Component Constructive Training Capability (JLCCTC) Entity Resolution Federation (ERF), Multi-Resolution Federation – Warfighter's Simulation (WARSIM) (MRF-W) and Multi-Resolution Federation – Corps Battle Simulation (CBS) (MRF-C) would offer an appropriate reference implementation for wider LVCAR applicability.

Table 2-3 provides a summary of the UOB force structure.

Table 2-3: UOB Summary

Criterion	State
Number of formats (total / active)	14 / 10
Identified subcategories	Operational Command and Control systems, Entity Resolution simulations and federations, Aggregate level simulations and federations, interface to live ranges and simulations
Organizations working on standardized formats	(9) Office of the Deputy Undersecretary of Defense (ODUSD), Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics (OUSD-ATL), DISA, JFCOM, Program Executive Office, Simulation, Training and Instrumentation (PEO STRI), Lawrence Livermore National Laboratory (LLNL), Joint Chiefs of Staff (JCS J8), Navy Warfare Development Command (NWDC), SISO
Political conflict	Open and proprietary mediation standards are not synchronized, resulting in considerable redundancy and confused boundaries.
Maturity	Productized/Mature (64%); Concept (22%); Proof of Concept (14%)
Complexity	Moderate Complexity, but intertwined with other event-specific data domains (e.g., plans and scenarios, behaviors, logistics)
Mediation formats	9 (JC3IEDM, Joint Training Data Services (JTDS) Order of Battle Service (OBS) Schema, Military Scenario Definition Language, Joint Conflict and Tactical Simulation (JCATS) Integrated Force Plan (FPLAN) file, Global Force Management Information Exchange Data Model, Unit Object Standard (deprecated), Integrated Gaming System XML Schema, C-BML, WARSIM Common Data Format)

Criterion	State
Related COIs	Air Force Readiness, Global Force Management (GFM), M&S
Key Stakeholders	DoD stakeholders include data providers (e.g., Global Force Management Initiative), data integrators (e.g., JFCOM JTDS), training developers (e.g., PEOSTRI), operational users (e.g., SOCOM), and M&S users [e.g., Joint Live-Virtual-Constructive (JLVC) Federations].

2.4 ELECTRONIC ORDER OF BATTLE/NETWORK

The electronic order of battle (EOB) (see Table 2-4) category includes network organization and topology at the application, physical and transport layers, electronic footprint, initialization of communications models and databases that define mappings between simulated forces and live systems. The formats associated with this category are used to define and disseminate logical and physical address locations across live and simulated tactical networks. This data is utilized (as a minimum) to initialize these networks, and to support the modeling of communications media and effects within the operational environment. Network topology and routing mechanisms are also defined upon initialization through this mechanism. While constitution of ad hoc networks and dynamic addressing lie outside the scope of this category, consumer formats must take these functions into consideration if the simulated environment includes them.

The study team identified thirteen (13) total formats in this category, ten (10) of which are currently in use. Of these, seven (7) were identified as mediation formats, four (4) of which are currently being used. In their current state, the extant mediation formats support limited definition of electronic addressing associated with current force Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR) systems, but do not support seamless and lossless import and export of simulation specific data used to define network topology and to simulate discovery and policy services in a service oriented architecture.

Although, consumer formats are maturing in this category, there is some evidence to suggest that additional changes will be required as both C2 systems and C2 simulations evolve. The communications effects models utilized in many distributed simulations are often used in a stand-alone mode as well as part of a distributed simulation environment. In order for mediation formats to support these models effectively, the full range of their initialization parameters must be taken into account. In general, static addressing schemes for digital battle command systems

have been successfully migrated into formats consumable by distributed simulation systems. The Simulation to Command, Control, Communications, Computers and Information (C4I) Interoperability (SIMCI) program has provided a useful complement to both constructive simulation programs as well as networked battle command systems in facilitating this progress. As with other C2-related categories, JC3IEDM offers at least a partially functional mediation format that could be extended to address the full range of data integration needed in this category. It is unclear whether C-BML or MSDL have sufficient scope to address electronic order of battle functions.

At this point, a combination of the "multiple producer/multiple consumer" and "partial convergence" models represent the "as-is" state of this category. Due to the very strong position that commercial tools vendors occupy in the communications effects modeling space, and the relative immaturity of government off-the-shelf (GOTS) solutions for network-centric simulation, it is unlikely that a "government-proprietary" standard will be fully effective. Consequently, this category represents a potentially fruitful area for a pilot project, with concrete benefits to be achieved if recognized government standards are extended into an published open standard that is also reflected in the DISR baseline. This suggests that JC3IEDM may be further extended, that MSDL be integrated with the C-BML/JC3IEDM baseline to address electronic order of battle considerations and that SISO develop an appropriately focused study group consisting of the relevant stakeholders from government and private industry to advance this goal. In terms of the scope of a pilot project, it is suggested that the union of C3 Grid, Qualnet, Opnet and Orion models with an updated Lightweight Directory Access Protocol [(LDAP) Data Interchange Format (LDIF)] be considered as a baseline configuration for experimentation, test, and training implementation.

Table 2-4: EOB Summary

Criterion	State
Number of formats (total / active)	13/10
Identified subcategories	Unit address lists/Unit reference numbers; physical network addressing/ electronic footprint; operational C4ISR routing space definition; communications effects model initialization
Organizations working on standardized formats	(13) NGA, OUSD (ATL), Internet Engineering Task (ITEF), Program Executive Office, Command Control Communications - Tactical (PEO C3T), US Army Research, Development, and Engineering Command (RDECOM), Opnet Technologies, Scaleable Network Technologies, US Army Electronic Proving Ground (EPG), PEO STRI, SISO, JFCOM, Training and Doctrine Command (TRADOC), DISA

Criterion	State
Political conflict	Similar overlap with Order of Battle as well as Plans and Scenarios category; this domain has more specialized applications. There is direct competition among radio frequency (RF) propagation models with few extant standards.
Maturity	Productized/Mature (68%); Concept (8%); Proof of Concept (8%); Experimentation (8%); Reference Implementation (8%)
Complexity	Consumer formats are relatively simple, but diverse in scope.
Mediation formats	DoD Discovery Metadata Specification (DDMS) Intelligence, Surveillance, and Reconnaissance (ISR) Extensions, JC3IEDM, Advanced Field Artillery Tactical Data System (AFATDS) Joint Master Unit List (JMUL), Orion Gateway XML file, Military Scenario Definition Language, C-BML, JCATS Integrated (FPLAN) File
Related COIs	Common Sensor, Computer Network Defense (CND), Information Operations, Joint Airborne Networking-Tactical Edge (JAN-TE), M&S, NetOps COI
Key Stakeholders	DoD stakeholders include data providers (e.g., intelligence agencies), data integrators (e.g., SIMCI, DISA, etc.), training developers (e.g., PEOSTRI), operational users (e.g., JFCOM, FCS, etc.), and M&S users [e.g., JLVC Federations, Army Test and Evaluation (ATEC), etc.].

2.5 PLATFORM/WEAPONS PERFORMANCE AND/OR CHARACTERISTICS

The platforms/weapons performance and characteristics data category, often referred to as characteristics and performance (C&P), is here defined as encompassing all data storage formats for the representation of physical parameters of warfighting platforms and weapons systems. It does not include messaging formats for controlling or communicating with these systems, nor the performance of an humans operating them.

The team identified 15 data storage formats for C&P data (see Table 2-5), only 11 of which are known to be actively maintained. Two of the active formats are not strictly speaking formats, but rather databases. However, one of these databases is the Army Materiel Systems Analysis Activity (AMSAA) database from which AMSAA exports 126 different Standard File Formats (SFFs). In almost all cases, the AMSAA data is the source of authoritative data reformatted into other formats.

Given the preeminence of AMSAA as the source of authoritative data and the success of data consumers transforming this data, no action is recommended with respect to the data that AMSAA currently produces. However, neither the Navy nor the Air Force has a similar organization with the authority to produce comparable source data for their weapons and platforms. These two Services should be engaged to determine the desirability and feasibility of providing such authoritative data and agreeing upon common formats.

Table 2-5: C&P Data Summary

Criterion	State
Number of formats (total / active)	15/11
Identified subcategories	None
Organizations working on standardized formats	OGC, S1000D
Political conflict	Although there are several proprietary formats, all substantially used formats rely on AMSAA for source data.
Maturity	Productized/Mature (80%); Concept (13%); Reference Implementation (7%)
Complexity	Although the AMSAA SFF database contains over 2500 elements, they can be represented in a spreadsheet.
Mediation formats	The only active mediation format is S1000D which is narrowly focused on producing maintenance manuals.
Related COIs	Anti-Submarine Warfare (ASW), Chemical, Biological, Radiological and Nuclear (CBRN), Common Sensor, Joint Service Explosive Ordnance Disposal, Joint Strike Fighter (JSF) Munitions/Ordnance Data, Mine Warfare, M&S
Key Stakeholders	DoD stakeholders include data providers (e.g., AMSAA, intelligence agencies, etc.), data integrators (e.g., PEOSTRI), training developers (e.g., PEOSTRI), operational users (e.g., JFCOM), and M&S users (e.g., JLVC Federations, ATEC, PM CATT). Stakeholders outside the DoD include commercial publishers (e.g., *Jane's*).

2.6 PLANS/SCENARIOS

The plans and scenarios category includes operational plans, orders and tasking instructions issued to live, virtual and constructive players in a simulated event or exercise. These instructions are documented in the form of text, tables and associated graphics. The US Army has recently published a new doctrinal manual, FM 5-0, "The Operations Process," which

breaks down the planning, preparation, execution and assessment of military operations into five steps. These steps are (1) Planning, (2) Design, (3) Preparation, (4) Execution and (5) Assessment. This process extends the older "Military Decision Making Process" which focused on the production of plans and orders prior to the execution of a military operation. These processes are conducted hierarchically and in a combination of sequential and concurrent activities that decompose plans, orders and related artifacts to lower and lower levels. Plans are generally used only once; the Prussian General von Moltke once wrote "no plan of operations extends with any certainty beyond the first contact with the main hostile force" [Reference (j)]. Scenarios relate to planning in that they describe a future sequence of events. For non-deterministic simulations, the scenario describes the initial conditions and static variables that do not change during the execution of the simulation. From the standpoint of data storage formats, scenario files capture the initial state of plans and orders when the simulation is started. Online planning tools may update or modify these plans and orders during scenario execution. These changes may or may not be persistent during the execution of the simulation – or they may be saved at specific time intervals, or when the simulation is paused or checkpointed. When operational C2 systems are involved, this raises the question of sychronizing the state of plans and orders across the C2-simulation boundary. Interchange of plans and scenario data becomes an issue both prior to event execution and during a simulation event or exercise itself. The team identified twenty-two (22) total formats in this category, twenty (20) of which are currently in use. Of ten (10) mediation formats identified, eight (8) are currently in use. One (1) mediation format used by C2 systems, Command and Control Information Exchange Model (C2IEDM) has been superceded by JC3IEDM. Another simulation-specific mediation format, C-BML, is in development and is closely linked to JC3IEDM. For stabilization operations and Operations Other Than War (OOTW), one mediation format, the National Information Exchange Model (NIEM), is mandated in the DISR and maintained by the Department of Justice (DoJ). This model superceded previous mediation formats used in OOTW scenarios. Source data for scenarios may either be generated manually from predefined scenario products or imported from external databases such as TPFDD. For this reason, creation of simulation-capable scenarios can be a complex and time-consuming process.

As previously stated, there is substantial overlap between the Order of Battle and Plans/Scenarios categories. Individual consumer models, such as OneSAF, JCATS, and FireSim, must translate generic plans and orders that are designed to be executable by humans into machine readable and executable form. By design and SISO agreement, MSDL provides planning data in the form of unit locations and overlays that must be assigned to tasks defined external to the data interchange mechanism. C-BML and IBML, on the other hand, are designed to provide at least partial support for the direct tasking of computer generated forces and aggregate constructive models. The MSG-048 demonstration conducted at George Mason University in late 2009 provided a proof-of-concept for the battle management language approach. Control of live and simulated unmanned systems is also a consideration for Battle

Management Language (BML) integration. Depending on the level of automous control exercised over these systems, the data structures may resemble those utilized by a typical Computer Generated Forces (CGF) application, with routes defined by waypoint designation, or movement controlled in relation to another live or simulated platform. In most cases, robotic C2 systems are either embedded in standard digital battle command systems, or take the form of stand-alone controllers that interface to operational C2 devices.

The plans/scenarios category (see Table 2-6) represents a space where standardization and rationalization of data storage formats could provide tangible benefits in terms of flexibility and cost savings. In the current environment, it is necessary to delineate the relationship, scope and fundamental limitations of the three existing and overlapping mediation formats: J3CIEDM, MSDL and C-BML. Because many current and evolving LVC simulations have not been integrated using these mechanisms, it would be erroneous to understate the scope and difficulty of the problem. Semantic as well as syntax issues must be fully addressed, and not merely on the basis of C4ISR system requirements. The diversity of conceptual models underlying the simulations examined as part of this study implies that the risks associated with integrating multiple resolution constructive models and entity based computer generated forced would offer significant challenges to a pilot effort. However, this is clearly an area that needs to be addressed in the long term.

Table 2-6: Plans/Scenarios Summary

Criterion	State
Number of formats (total / active)	22/20
Identified subcategories	Operational Scenarios (Full Spectrum including conventional and stabilization operations); Defense Planning Guidance Scenarios, Training Scenarios, Test Scenarios
Organizations working on standardized formats	NGA, PEO C3T, OUSD (ATL), DISA, JCS J-7, DOJ/Department of Homeland Security (DHS), PEO STRI, NAVAIR, SISO, US Army CIO (G-6), JFCOM, NWDC, US Army Space and Missile Defense Command, TRADOC
Political conflict	C-BML scope and maturity is not resolved. Ad hoc solutions are driving current solution set. There is no dominant or common mediation format for entity level federations and aggregate level simulation. Operational C2 space is also evolving as digital battle command systems evolve in the direction of service oriented architectures and unmanned systems control.

Criterion	State
Maturity	Productized/Mature (77.5%); Concept (4.5%); Proof of Concept (4.5%); Experimentation (9%); Reference Implementation (4.5%)
Complexity	Highly complex, with significant redundancy across the board.
Mediation formats	ABCS 6.4 Publish and Subscribe Services, JC3IEDM, NIEM, Military Scenario Definition Language, Mission Data Exchange Format, JTDS OBS Schema, JCATS Integrated FPLN File, C-BML, Integrated Battle Management Language (IBML)
Related COIs	Adaptive Planning and Execution (APEX), Air Force Flight Scheduling COI, Air Operations, Anti-Submarine Warfare (ASW) COI, Blue Force Tracking (BFT), C2 Interoperability Group, Civil Military Information Exchange (CMIE), Coalition C2 Interoperability (Coal C2), Command and Control Space Situational Awareness (C2 SSA), Force Projection, Improvised Explosive Device (IED) Defeat Significant Activity (SIGACT) COI, Joint Service Explosive Ordnance Disposal, Joint Air Track (JAT) , Joint Air and Missile Defense, Joint Targeting Intelligence (JTI), Joint Task Force Command and Control (JTF C2), Maritime Domain Awareness, Messages - Tactical Data Enterprise Services (MSG-TDES), M&S, Strike COI, Tasker Integration Service (TIS) COI, Time Sensitive Targeting, Undersea Warfare (USW) XML, United States Message Text Format (USMTF)
Key Stakeholders	DoD stakeholders include data providers [e.g., Defense Intelligence Agency (DIA), Joint Staff, JFCOM, TRADOC, etc.], data integrators (e.g., JFCOM JTDS), training developers (e.g., PEOSTRI), operational users (e.g., SOCOM), and M&S users (e.g., JLVC Federations, ATEC).

2.7 BEHAVIOR

The behavior category (see Table 2-7) includes all representations of human behavior including organizational and individual. This category is challenged by the lack of fundamental concurrence about how human psychology affects human behavior at both the individual and organizational levels. There is also the complexity of the domain space in which results are desired, e.g., how an individual will behave in a crowd vs. how a cultural group will respond to a message from a particular source delivered through a particular medium.

The study team identified 11 data storage formats for behavior data, 10 of which are known to be actively maintained. However, none of them qualify as a Common Data Storage Format (CDSF) in the sense of the other data categories analyzed in this study. Two of them are Lisp; two are Java; two are text-based scripts; and concrete information about the format of the remaining six formats is insufficient to categorize them, but they are probably also some form of script.

The commercial offerings have no real incentive to standardize as a great deal of their competitive advantage would likely be lost in the process of standardization on a format as they would likely need to reveal their implementations to participate in standardization. The academic research community might be more open to a CDSF defined through an open standards process (assuming such a thing is feasible in this domain), possibly coming out of programs such as the OSD Combating Terrorism Technical Support Office (CTTSO)/ONR Human, Social, Cultural, Behavioral (HSCB) program, but they lack the skills or motivation to do it themselves. Progress in this category should be monitored, but it is too early to expect that active engagement will result in quantitative progress in the near future.

Table 2-7: Behavior Summary

Criterion	State
Number of formats (total / active)	11/10
Identified subcategories	University-run generic Artificial Intelligence (AI) systems, commercial generic AI systems, and embedded behavior modules within GOTS simulations. However, none of these formats are really CDSFs as each storage format is bound to the particular AI implementation, so the subcategories are for systems more than domains.
Organizations working on standardized formats	Argonne National Laboratory, Carnegie Mellon University, University of Michigan[6]
Political conflict	Because this domain is so immature, it's marked more by chaos than political conflict.
Maturity	Productized/Mature (91%)[7]; Concept (9%)
Complexity	The most complex of all the formats considered in this study
Mediation formats	None
Related COIs	M&S[8]
Key Stakeholders	DoD stakeholders include data integrators (e.g., ONR, CTTSO, etc.), training developers (e.g., PEOSTRI), and M&S users (e.g., JFCOM). Stakeholders outside the DoD include a number of research institutions and commercial analytics companies.

[6] Interestingly, there are no open standards organizations actively working in this area although SISO is currently considering an effort in this domain.

[7] This statistic is very misleading because the simulation developers have settled on their formats, but there is no interoperability between the simulations and their associated formats.

[8] It is not entirely self-referential that the only COI with which to coordinate is M&S because all other communities use real human beings to represent human beings.

2.8 LOGISTICS

The logistics category (see Table 2-8) includes the management and control of supply, transportation, maintenance and other support functions in support of an operation. Authoritative data sources describe the basic allocation of equipment and consumables to military units down to the individual and platform level. These allocations may change for a specific mission or operation. Many supply and maintenance management organizations utilize client-server systems to track inventories and to transport logistics assets to units undergoing replenishment during an operation. To the extent that simulations' conceptual models both track supply states and provide transient stimulation to Logistics C2 systems, their internal data models must align with those systems and also respond to updates periodically [not necessarily in the same time reference frame as the federated combat simulation(s)].

The team identified nine (9) total formats in this category, eight of which are currently active. Four (4) of these are mediation formats, three (3) of which are currently active. (One of these, the Object/Class Hierarchy for Deployment Models, was a developmental mediation format that has been discontinued.) The remaining formats in the survey population are consumer formats at a high degree of maturity. The data models associated with these formats are highly complex and not easily visible to external systems, including simulations. At this stage, there is no dominant mediation format, although JC3IEDM offers a working baseline from which to start. The predominant data exchange paradigm at present is clearly the base state of multiple producer and consumer formats.

The Logistics category offers a number of attractive features for a CDSF pilot project. There are few competing initiatives in the simulation space, and a reference implementation would provide a common baseline for greater flexibility and potential improvements in cost and quality of logistics representation in LVC simulations. The study team proposes to extend JC3IEDM to enable the direct interchange of logistics data into JLCTCC Entity Resolution Federation components as an initial task, which may be extended to support aggregate level constructive simulations and interaction with live systems through Logistics C2 systems. This federation is selected because it enables the exploration of data interchange among LVC simulations as well as live and virtual players and C4I systems. Data interchanges relating to entity level models will also facilitate interchange of aggregated data among live and simulated logistics C2 nodes.

Table 2-8: Logistics Summary

Criterion	State
Number of formats (total / active)	9/8
Identified subcategories	Supply chain logistics, maintenance operations, transportation and deployment, manufacturing and inventory management
Organizations working on standardized formats	OUSD(AT&L), US Army Force Management Support Agency, ISO, Defense Logistics Agency (DLA), PEO STRI, JFCOM
Political conflict	None observed, albeit this is an often neglected area. For example, logistics metadata schema are not strongly represented in the DoD Metadata Registry.
Maturity	Productized/Mature (89%); Concept (11%)
Complexity	High degree of complexity which has yet to be fully developed in mediation formats used by M&S.
Mediation formats	JC3IEDM, Object/Class Hierarchy for Deployment Models (Deprecated), Product Data Interchange, JCATS Integrated FPLN File
Related COIs	M&S, Logistics, C2 Interoperability, Training
Key Stakeholders	DoD stakeholders include data providers (e.g., DLA, DISA, etc.), data integrators (e.g., JFCOM JTDS), training developers (e.g., PEOSTRI), operational users (e.g., exercise participants), and M&S users (e.g., JLVC Federations, ATEC).

2.9 EVENT RESULTS

The event results category (see Table 2-9) is here defined as encompassing data formats for the capture, transfer, and analysis of the results of LVC events. This includes the high-level domain-specific interactions, runtime architecture-specific messages [e.g., High Level Architecture (HLA), Distributed Interactive Simulation (DIS), Test and Training Enabling Architecture (TENA)], and network traffic [e.g., Internet Protocol (IP) packets, network topology, etc.].

This category is unusual, as common data storage formats do not seem to exist. This is likely because event results are collected and utilized at the end of the simulation event, with the next step in the chain of consumption involving human experts. Hence the pre-processed event logs tend to be tool-specific and the final outputs tend to be human readable documents in common document formats [e.g., MicroSoft (MS) Word, OpenDocument, Portable Document Format (PDF)]. Therefore, this category has been eparated into three sections. The first contains broad event logging tools and technologies, and contains five entries. The second contains architecture-specific logging tools and contains four entries. The third contains more specialized event or service logging tools and contains five entries, though this last section should not be considered exhaustive. With two exceptions all of the tools and technologies surveyed actually record and store data within product-specific database tables with often dynamically generated schemas.

While individual tools for creating simulation after action reviews may be quite mature, there is no ecosystem for event report interchange between tools. No common logging format has been produced and no ontology for event results has been agreed upon. Even within the C4I space where interchange formats exist (e.g., USMTF) for runtime messaging, there is no standard for the logging of these messages for later analysis and reporting. The recommended action in this category is therefore to create a COI tasked with two activities. First, a common vocabulary for event results metadata needs to be developed to allow the annotation and aggregation of results from different sources in different logging formats. Second, a great deal of coordination needs to occur with the training and operational communities, and the tool vendors that support them, to establish event log requirements. Given the widely varying needs of these communities and the existing tool infrastructure, it is too early to tell at this point whether a common logging format can be developed or whether domain-specific log formats will evolve and be correlated with the developed metadata. The former option presents a unique opportunity while the possibility of the latter is supported by common logging formats that have evolved organically in other domains [e.g., Library for Packet Capture (LIBPCAP), logging system (SYSLOG), etc.].

Table 2-9: Event Results Summary

Criterion	State
Number of formats (total / active)	14 / 13[9]
Identified subcategories	General logging, architecture event logging, simulation-specific logging
Organizations working on standardized formats	0
Political conflict	None.
Maturity	Productized (86%), Proof of Concept (7%), Experimentation (7%)
Complexity	Unknown, as no comprehensive study has been done and no common, cross-cutting storage format implementation has occurred.
Mediation formats	0
Related COIs	M&S, NetOps[10]
Key Stakeholders	DoD stakeholders include data providers (e.g., exercise participants) and data integrators for AAR (e.g., analysts, unit commanders, etc.). Stakeholders outside the DoD include data logger tool vendors.

[9] Only one of these, the libpcap packet logging file format, really qualifies as a "common data storage format". The rest of the entries use relational database tables with schemas specific to the generating and utilizing tool.

[10] All COIs with a need to collect, analyze, or utilize M&S event logs are touched on to some degree by this category though they are unlikely to have an interest in the development of the storage format itself.

3 IMPLEMENTATION PLAN

3.1 QUESTIONNAIRE RESPONSES

In addition to questions about specific formats, the questionnaire included some questions to elicit inputs on the standardization process and priorities.

3.1.1 What and How to Standardize

In addition to assessing the current state of categories of formats, the online questionnaire asked for opinions about what should be standardized and in what forum.

The first of these two questions was, "Where do you believe standardizing data formats is appropriate/effective?" The first three responses were suggested by the study team, with the option for respondents to suggest other levels under the fourth option:

- Data product formats – data in the format that it is used by the end application.
- Source data formats – initializing produced by authoritative data producer, e.g., NGA or AMSAA.
- Data mediation standards – used to translate between source data formats and data product formats, and potentially store as an intermediate format.
- Other.

Figure 3-1 indicates there was not a single clear outcome for this question. However, it is clear that the community sees value in standardizing at some "end" format, i.e., the source or application format, not at some intermediate point.

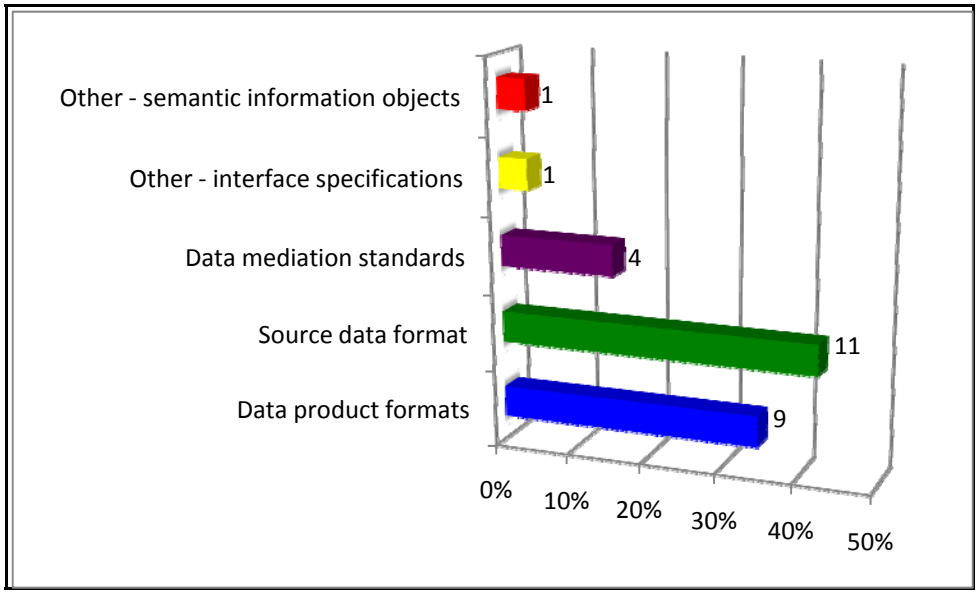

Figure 3-1: "Level" at Which to Standardize Data Formats

The second of these two questions was, "Where do you think these data storage format standards should be established? All four responses reported were suggested by the study team:

Where do you think these data storage format standards should be established?

- Independent standards development
- Government
- Industry consortia
- Single vendor

Figure 3-2 indicates that there wasn't a single overwhelming choice, but vendor-specific formats are clearly contraindicated, nor were industry consortia viewed particularly favorably.

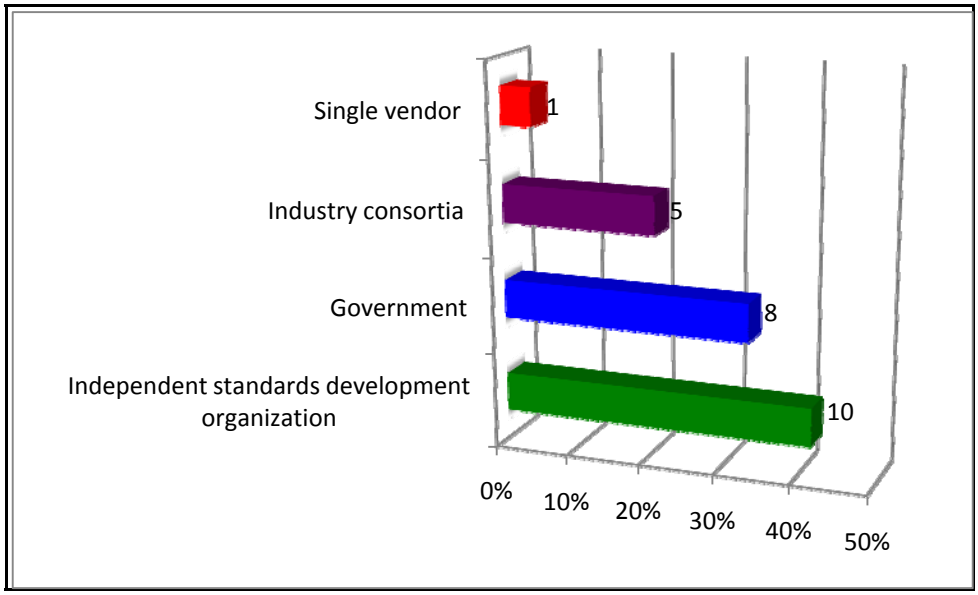

Figure 3-2: How/Where to Standardize Data Formats

3.1.2 Priorities Based on Community Input

The primary purpose of the questionnaire was to establish priorities for formats independent of the feasibility of doing so as assessed in the preceding subsection. For each of the categories of data in the preceding subsection, respondents were asked to answer three questions:

1. What types of data do you need to use or produce to perform your mission?
2. What types of data do you believe are most urgently in need of common data storage formats/schemas/data models (standards)?
3. For which of the following types of data do you believe too many competing formats exist (proliferation)?

Table 3-1 summarizes the questionnaire results. The normalized need measure is explained in Section 3.2.

Table 3-1: Questionnaire Results[11]

Type	Need for Mission	Urgency	Proliferation	Normalized Need Measure
Manmade features	69.2%	61.5%	38.5%	65.4%
Geospatial	69.2%	53.8%	30.8%	61.5%
Event results	76.9%	38.5%	7.7%	57.5%
Platform/weapons performance	61.5%	38.5%	15.4%	50.0%
UOB/force structure	53.8%	46.2%	7.7%	50.0%
Plans/scenarios	69.2%	30.8%	7.7%	50.0%
EOB/network	53.8%	30.8%	7.7%	42.3%
Behavior	61.5%	30.8%	0%	46.2%
Logistics	46.2%	23.1%	7.7%	34.7%

The team looked for categories that maximized all three categories, indicating that the format was mission critical, in need of a standardized format, and hampered by a proliferation of existing formats. These categories are sorted to the top of the table.

In general, there's a roughly downward trend across all three questions for most categories with the following exceptions:

- Although Event was the most needed, it was only in the middle third in terms of urgency, and in the large cluster near the bottom of format proliferation.
- With only one exception, the single response (7.7%) of too many formats (proliferation) came from different sources for the different categories, i.e., there wasn't a single individual who responded that there were too many formats in several cases. There was one individual respondent who identified two.

The consensus priority results from the workshop participants support the trends observed in the questionnaire results.

1. Geospatial
2. METOC
3. Order of Battle
4. Scenario
5. Behavior

[11] Given the small sample size for the questionnaire, the margin of error is approximately 25%.

3.2 FEASIBILITY AND PRIORITIES

In this section, the formats were prioritized to standardize based on two axes:

1. The community's stated need for a reduced number of formats.
2. Difficulty of achieving reduction in the number of formats.

Analyzing the state of the format categories in conjunction with the priorities established via the questionnaire and the workshop, the format was prioritized categories into the graph in Figure 3-3. Although the survey responses indicate that there is a need for standardization in all format categories, and the analysis of the format categories indicate that standardization will not be a trivial task for any category, the data for the format categories was normalized to establish a basis of comparison. The y-axis, critical need vs. desirability, is based on the results in Table 3-2 The "Need for mission" and "Urgency" responses were averaged and normalized to determine the y-axis values as listed in Table 3-3.

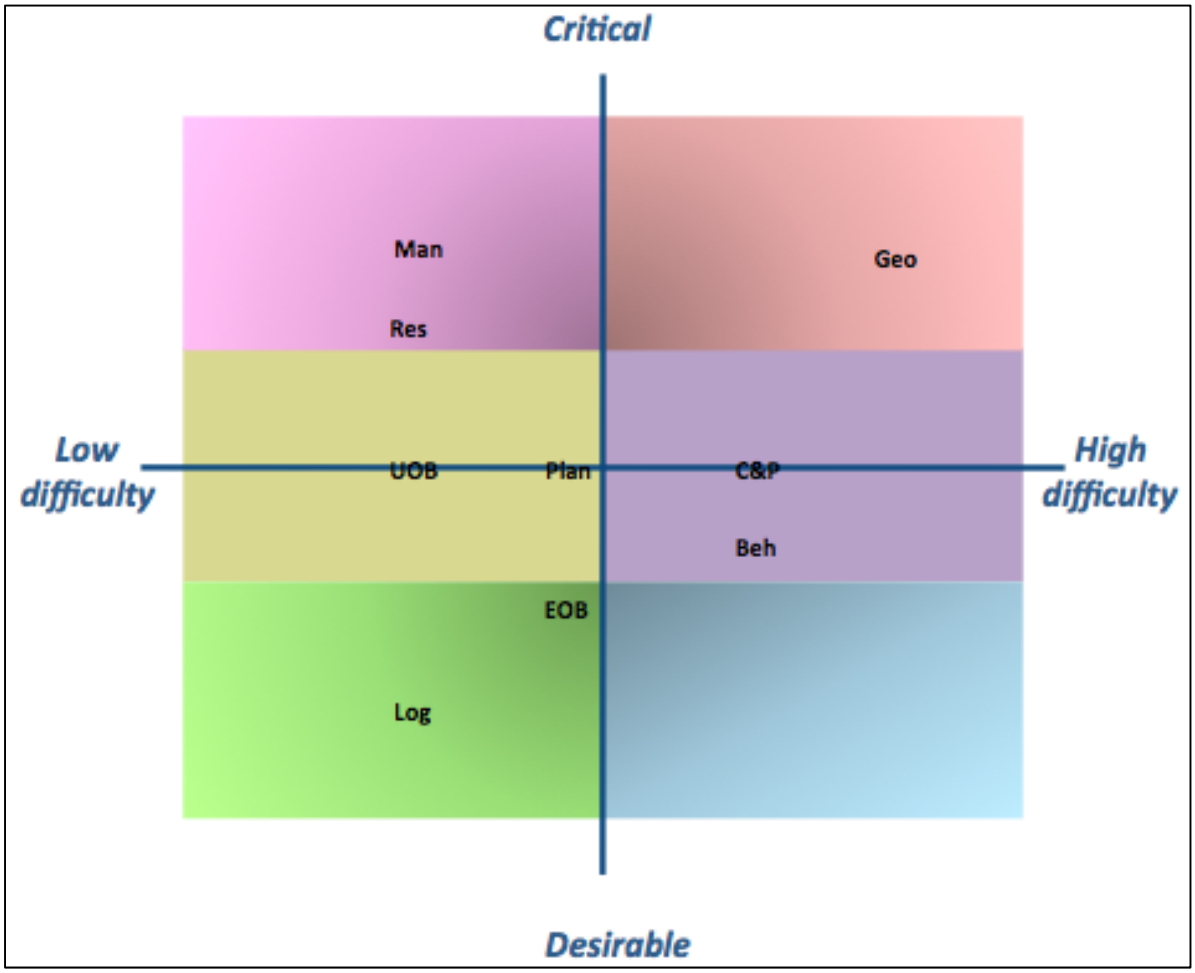

Figure 3-3: Recommendations Graph

Table 3-2 summarizes the difficulty of reducing the number of formats in each of the data categories based on the assessment in Section 1.

Table 3-2: Difficulty Summary

Category	Summary Description	Technical Difficulty	Organizational /Coordination Difficulty	Normalized Difficulty
Geospatial	Mature, complex environment; numerous formats with multiple standards bodies working comprehensive solutions; vendors developing proprietary data models. Services and agencies working independently with substantial political conflict.	3 High	3 High	4
Manmade features	Mature, rich in open standard formats. Complex, but well understood. Little political conflict.	2 Medium	1 Low	1
UOB/force structure	Moderately complex; line between UOB, Logistics, and Plans/Scenario is not always clear. Redundancy between open and proprietary mediation standards.	1 Low	2 Medium	1
EOB/ network	Specialized applications. Direct competition among RF models.	2 Medium	2 Medium	2
Platform /weapons performance	Not complex; mature authoritative data provided by Army AMSAA, but not for other Services. Little political conflict.	3 High	2 Medium	3
Plans/ scenarios	Highly complex and maturing; significant redundancy with blurred lines with logistics and UOB.	2 Medium	2 Medium	2
Behavior	High degree of complexity due to lack of structure; very immature domain with little political conflict.	2 Medium	3 High	3
Logistics	High degree of complexity with very mature consumer formats. Little political conflict.	1 Low	2 Medium	1
Event results	Currently no existing data formats; immature domain; no political conflict.	1 Low	2 Medium	1

The x-axis "difficulty" values listed in the rightmost column of Table 3-2 were established using the following algorithm:

- Two measures, technical and organization/coordination complexity, were established.
- The technical difficulty took into consideration the total number for formats that exist for a category, the complexity of those formats (i.e., size of the data model/schema that would be necessary to describe data in the category), and the number of existing mediation formats for the category.
    - "High" values were assigned where a large number of formats existed in conjunction with multiple mediation formats, and the category exhibited high format complexity.

  - "Low" values were assigned where the number of existing formats was relatively small, a small number for mediation formats existed, and the format complexity was relatively low.
  - Other categories were assigned a "medium" value.
- Organizational/coordination difficulty took into account the number of organizations standardizing formats for a category, whether political conflicts were known to exist among stakeholders for that category, whether formats were mature or still in the formative stages, the number of subcategories, and the number of COIs that would need to be involved in cross-COI collaboration.
  - "High" values were assigned where political conflicts were evident, a large number of organizations were actively setting (potentially conflicting) standards or no clear community of standards-setters (e.g., behavior) had emerged.
  - A "low" value was assigned to 3D models of manmade features where a few dominant standards have existed for a long time and appear to have been embraced across the stakeholders for that category.
  - All other categories were assigned a complexity value "medium."

The technical and organizational/coordination difficulty numbers were added, then normalized. The detailed assessment and calculation of need and difficulty can be found in Appendix F.

Additionally, the format categories have been prioritized from the graph in the following order, from highest to lowest:

1. Low difficulty and critical need
2. High difficulty and critical need
3. Low difficulty and medium need
4. High difficulty and medium need
5. Low difficulty and desirable
6. High difficulty and desirable

Using this prioritization approach, the standardized formats should be pursued in the following order:

Priority 1

- Manmade features
- Event results

Priority 2

- Geospatial

Priority 3

- Unit Order of Battle (UOB)
- Plans/scenarios

Priority 4

- Platform/Weapons performance
- Behavior

Priority 5

- Electronic Order of Battle (EOB)/network
- Logistics

3.3 STRATEGIES FOR EACH FORMAT CATEGORY

The team identified the following list of general engagement strategies for improving the state of any category:

- Engage with ongoing efforts to ensure they include LVC-specific requirements;
- Establish forum/process for mediating between dissenting communities;
- Initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists;
- Accelerate promising, but slow, ongoing efforts;
- Management/cooperation changes; and
- Monitor until sufficient meaningful direction emerges.

The first three general strategies call for engagement with other organizations and activities. Appendix D, COI Coordination Matrix, and Appendix E, Namespace Coordination Matrix, identify organizations and ongoing activities with which to engage.

Table 3-3 consolidates the recommendations in Section 1, and the feasibility and priority in Section 3.2, with these general strategies to provide specific strategies and timelines for each category.

Table 3-3: Implementation Plans

Category	Strategy	Timeline
Manmade features	Engage with ongoing efforts to ensure they include LVC-specific requirements: • Determine M&S-specific set of requirements for 3D manmade features representation. • Work with existing standards bodies to ensure requirements not yet met by their specifications are incorporated in the next iteration (Khronos Group - COLLADA, OGC - CityGML, Web3D - X3D).	Start: Fall 2010 SIW Duration: 2 years

Category	Strategy	Timeline
Geospatial	Establish forum/process for mediating between dissenting communities; management/cooperation changes: • M&S TWG petitions for voting status in the GWG. • Establishment of an M&S Geospatial Task Force. This task force would be tasked with coordinating with the C2 community to establish broad format requirements. • Development of a standards strategy, including the potential for convergence on a common set of mediation formats and identification of the SDOs responsible for managing and extending those formats.	Start: Immediately Duration: 5 years • GWG voting status – 6 months • M&S Geospatial Task Force – 6 months • Standards strategy – 2-5 years
Event results	Monitor until sufficient meaningful direction emerges: • Observe ongoing development in the Joint Digital Collection, Analysis, and Review System (JDCARS) and One Semi-Automated Forces (OneSAF) logging/AAR efforts with the goal of discovering commonalities in the development event results data models. • Coordinate with SMEs who regularly utilize event results data to generate AAR reports to gather their input requirements.	Start: 1 year Duration: 2 years
Platform /weapons performance	Initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Determine the Air Force and Navy's desire/need to establish authoritative data sources and formats analogous to those produced by AMSAA.	Start: 6 months Duration: 6 months
UOB/force structure	Engage with ongoing efforts to ensure they include LVC-specific requirements • Ensure that government-owned proprietary standards are exposed to the commercial community in the form of recognized open standards. • Deconflict C-BML with related standards. • Utilize JLCCTC as a reference implementation for wider LVCAR applicability.	Start: Fall 2010 SIW Duration; 2-5 years

Category	Strategy	Timeline
Plans/ scenarios	Engage with ongoing efforts to ensure they include LVC-specific requirements; initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Move towards standardization and rationalization of data storage formats by delineating the relationship, scope and fundamental limitations of J3CIEDM, MSDL and C-BML. • Ensure that semantic as well as syntactic issues are addressed as exising mediation formats for plans and scenarios evolve. • Explore the reconciliation of plans and scenario representations in multi-resolution federations.	Start: Immediately Duration: 2 years
EOB/ network	Engage with ongoing efforts to ensure they include LVC-specific requirements; initiate activity to bring key stakeholders together to develop format where no clear viable solution currently exists: • Extend recognized government standards [JC3IEDM, C-BML, MSDL into a published open standard that is also reflected in the DoD Information Technology Standards and Profile Registry (DISR) baseline]. • Establish an appropriately focused SISO study group consisting of the relevant stakeholders from government and private industry. • Explore a pilot project consisting of commercial off-the-shelf (COTS) and GOTS models with an updated LDIF as a baseline configuration.	Start: Fall 2010 SIW Duration: 2-3 years
Behavior	Monitor until sufficient meaningful direction emerges: • SISO has established an HSCB study group to determine if any standards are feasible in this area. Participate in this activity. • The OSD/ONR HSCB program funds several key model developers, but they are indifferent or antagonistic to standards at this point. Continue to engage with this effort and attempt to improve understanding and acceptance of common data storage formats.	Start: N/A Duration: revisit feasibility in 1.5 – 2 years

Category	Strategy	Timeline
Logistics	Accelerate promising, but slow, ongoing efforts: • Explore a pilot project. That extends JC3IEDM to enable the direct interchange of logistics data into JLCTCC Entity Resolution Federation components. • Extend initial JLCTCC pilot effort to support aggregate level constructive simulations and interaction with live systems through Logistics C2 systems.	Start: January 2011 Duration: 2 years

APPENDIX A: REFERENCES

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(c) Universal Core 2.0, https://ucore.gov/ucore, 2010

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(j) Hughes, D. J. (Eds.), *Moltke on the art of war: Selected writings*. New York, NY: Presidio Press, 1993.

(k) DoD Metadata Registry, https://metadata.dod.mil/mdr/homepage.htm.

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APPENDIX B: CURRENT STATE

Section 1, Current State and Feasibility Assessment, is based upon the detailed data about the current state in each category that is provided by this appendix. For each category, there is a table containing all the relevant formats identified in that category and the following data:

- The owner of the format,
- Whether or not it's in active use,
- Whether it's an open or proprietary format as defined below,
- Its status in the DISR,
- Its maturity as defined below,
- Whether it's a producer, mediation, or consumer format as defined below, and
- A brief description of the format.

The following definitions apply to column 4 of the tables below:

- Open – A specification that is developed by a standards organization or a consortium to which membership is open, and which is available to the public for developing compliant products (with or without some license fee); sometimes referred to as a voluntary consensus standard.
- Proprietary – a standard that is developed by a single sponsor organization and does not meet the criteria for an open standard. Open publication of a proprietary standard may be limited by the sponsor or freely distributed under the sponsor's control.

The following definitions apply to column 7 of the tables below.

- Concept – The technology is conceptually feasible, but has not been implemented.
- Proof-of-concept – The technology has been demonstrated, but a prototype may require work-arounds or expert support.
- Reference implementation(s) – The technology has at least one implementation that is sufficiently stable so as not to require expert support, but does not necessarily have the support tools, materials, and services that accompany a mature product.
- Experimentation – Proof-of-concept or reference implementation(s) are being evaluated by multiple users under multiple use cases.
- Productized/mature market – The technology is stable; at least one mature product is available with appropriate support tools, materials, and services.

The following definitions apply to columns 8 – 10 of the tables below.

- Producer - A system or organization that provides data for use by one or more external consumers (not part of their organization), potentially through some mediation process.
- Mediation – A format or system for translating data, and potentially combining and deconflicting data from one or more sources for use by one or more consumers.
- Consumer - A system or organization that uses data provided by one or more data producers.

Table B-1: Synthetic Natural Environment Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
National Imagery Transmission Format (NITF) Standard (NITFS) Military Standard (MIL-STD)-2500 (A-C)	NGA	Yes	Open	Mandated	Productized		X		Meta-format wrapping and tying together numerous other NGA geospatial formats
Multiresolution Seamless Image Database (MrSID)	Lizard Tech	Yes	Proprietary	Not Present	Productized		X		Proprietary format for encoding geo-referenced raster graphics
Spot Image Dictionary Maintenance Programs (DIMAP)	Spot Image	Yes	Proprietary	Not Present	Productized		X		Format for the delivery of Spot Image satellite imagery. Format consists of Tagged Image File Format (TIFF) formatted imagery and greographic metadata in XML
Buckeye	AGC	Yes	Proprietary	Not Present	Productized		X		3D stereoscopic image format produced by aircraft-deployed imaging system
Light Detection and Ranging (LIDAR)	ASPRS	Yes	Open	Not Present	Productized		X		ASPRS LAS is a sequential binary format used for the encoding, transfer, and processing of LIDAR data. Encoded as ASPRS LASer (LAS) File Format.
Digital Point Positioning Database (DPPDB)	NGA	Yes	Proprietary	Active	Productized		X		DPPDB consists of parametric support data, compressed reference graphics, and high-resolution national imagery stereo pair sets covering a nominal 60 nautical mile (NM) by 60 NM area.
Digital Aeronautical Flight Information File (DAFIF)	NGA	Yes	Proprietary	Not Present	Productized		X		Vector file format (VPF) for the representation of aeronautical data, including airports, airways, airspaces, and navigation data.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Vector Product Format (VPF) MIL-STD-2407, Vector Relational Format (VRF)	NGA ISO	Yes	Open	Mandated	Productized		X		The Vector Product Format is a standard format, structure, and organization for databases based on a georelational data model. VPF data can be read directly without prior conversion to an intermediate form. VPF is designed to be used with any digital geographic data in vector format that can be represented using nodes, edges, and faces.VPF defines the format of data objects, and the georelational data model provides a data organization within which software can manipulate the VPF data objects. VPF has been adopted by NATO under the name "Vector Relational Format" (DIGEST/VRF).
Enhanced Compressed Raster Graphic (ECRG) MIL-PRF-32283	NGA	Yes	Open	Not Present	Productized		X		Compressed raster graphic format for multi-resolution representation of aerial and satellite photography.
Raster Product Format (RPF) MIL-STD-2411	NGA	Yes	Open	Mandated	Productized		X		The RPF is intended to define a common format for interchange of raster data between producers of such data in DoD and users of the data, to help facilitate interoperability among mission-critical systems.
(Compressed) Arc second Raster Chart (ARC) Digitized Raster Graphics ((C)ADRG) MIL-PRF-89038 (Multi-Resolutions)	NGA	Yes	Open	Active	Productized		X		Raster format for the representation of digitized maps and charts compatible with NITFS. CADRG has a nominal compression ratio of 55:1 over ADRG.
Digital Terrain Elevation Data (DTED) MIL-PRF-89020 (A,B) (Levels 0-2)	NGA	Yes	Open	Not Present	Productized		X		Standard format developed in the 1970s consisting of a matrix of terrain elevation values. Most common elevation data format.
High Resolution Elevation (HRE)	NGA	Yes	Proprietary	Emerging	Productized		X		The HRE product specification describes the data content, structure and metadata requirements required to create a suite of raster elevation data products. These products are defined within this document as a set of spatial resolution layers and are named HRE data.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Military Intelligence Integrated Data System - Intelligence Database (MIIDS-IDB) / Modernized Integrated Database (MIDB)	DIA	Yes	Proprietary	Not Present	Experimentation		X		Worldwide general military intelligence database with GIS capabilities.
Digital Geographic Information Exchange Standard Standardization Agreement - NATO STANAG 4545, NSIF 1.0	NGA, DGIWG, ISO	No	Open	Not Present	Productized	X			DWIG format to facilitate the exchange of digital geographic information between nations. Specific goals included harmonization with the NATO Secondary Imagery Format (NSIF) and with the International Hydrographic Organization S-57 data. Now obsolete.
Digital Feature Analysis Data (DFAD) (Multi-Resolutions)	NGA [Legacy Defense Mapping Agency (DMA)]	No	Open	Not Present	Productized		X		Vector format predecessor to VPF used by the DoD. Now obsolete. Supports radar return simulation, navigation and terrain obstruction studies.
Geography Markup Language (GML) ISO 19136:2007	OGC, ISO, NGA	Yes	Open	Mandated	Productized	X			International standard XML grammar for representing geographical features. The core schema has been designed to be both modular and extensible. On the modular side, the concept of profiles was introduced, where a profile defines a subset of the total feature set useful for a particular community. The specification also allows for community-specific extensions via application schemas.
Keyhole Markup Language (KML)	Google	Yes	Open	Emerging	Productized			X	Native GIS format for Google Earth. The format is normally found in KMZ files bundled with linked COLLADA models representing 3D structures. The format was submitted to OGC, and abstract structures in common with GML are being normalized with the goal of making KML a GML application schema.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
CityGML OGC 08-007r1	OGC	Yes	Open	Not Present	Experimentation	X			Feature application schema for GML which allows for the representation of semantically rich models of 3D man-made and natural objects. Designed to represent urban environments, both for visualization and semantically useful annotation of structures and objects, it also supports robust terrain representation.
Simple Features	OGC	Yes	Open	Not Present	Productized		X		Reduced-functionality profile for GML for the simple representation of 2D maps.
LandXML	LandXML. org Industry Consortium	Yes	Open	Not Present	Productized		X		Consortium-guided standard designed for the use of civil engineers and surveyors. Ongoing work sponsored by the U.S. Army Corps of Engineers to create a mapping to the GML 3 schema constructs to create LandGML, which would be a GML application schema.
SEDRIS Interchange [DRM, (Abstract) Transmittal Format, STF ISO/IEC 18023-(1,2,3):2006(E)]	SEDRIS Group, ISO, NATO	Yes	Open	Emerging	Productized	X			Platform-independent format which contains a visual database mapped onto the SEDRIS Data Representation Model (DRM). This format allows for the lossless transfer of visual and geospatial information between systems that may not utilize the same underlying native visual database implementation.
Standard Interchange Format (SIF) (MIL-STD-1821)	Simulator Database Facility (SDBF)	Yes	Proprietary	Not Present	Productized	X			Standard format for the interchange of geospatial data among simulators. Data in this format is provided by the National Aeronautics and Space Administration's (NASA) Boreal Ecosystem-Atmosphere Study (BOREAS) project and NAVTEQ.
JPEG2000	ISO/ International Electro technical Commission (IEC)	Yes	Open	Mandated	Productized		X		Wavelet-based image compression and coding format which includes extensible XML metadata. Extensions to this metadata can and have been used to add geolocation information to images encoded in the JPEG2000 format.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
OpenFlight	Presagis	Yes	Proprietary	Not Present	Productized			X	OpenFlight is an open visual database standard used in many real-time image rendering contexts (e.g., flight simulators). It supports levels of detail, culling volumes, switch nodes, drawing priority, and binary separation of planes.
MetaFlight	Presagis	Yes	Proprietary	Not Present	Productized			X	High-level XML meta-data for OpenFlight.
Terrapage	Presagis	Yes	Proprietary	Not Present	Productized			X	Terrain database format that supports paging of large datasets.
X3D Earth	Web 3D Consortium	No	Open	Not Present	Proof-of-Concept			X	Attempt to map the SEDRIS SRM onto X3D to produce a geospatially aware version of the X3D format. Seemingly no work has been done in the last two years.
AutoCAD Desk Exchange Format (DXF)	Autodesk	No	Proprietary	Not Present	Productized		X		CAD data format developed to allow interoperability between AutoCAD and other CAD software.
Environmental Systems Research Institute (ESRI) Shapefile	ESRI	Yes	Proprietary	Not Present	Productized		X	X	Vector format for representation of geospatial data. Format consists of three files (data, index, and dBase) and is maintained as a quasi-open standard by ESRI to promote interoperability with third party tools.
ESRI Grid	ESRI	Yes	Proprietary	Not Present	Productized		X		Binary or ASCII raster GIS format maintained as a quasi-open standard by ESRI to promote interoperability with third-party tools.
ESRI GeoDatabase (GeoDB)	ESRI	Yes	Proprietary	Not Present	Productized		X		Common data storage format for ArcGIS.
MapInfo	MapInfo	No	Proprietary	Not Present	Productized		X		Proprietary vector-based GIS format used by the MapInfo suite of tools.
Topologically Integrated Geographic Encoding and Referencing (TIGER)	US Census Bureau	No	Open	Not Present	Productized		X		TIGER is a format used by the United States Census Bureau to describe land attributes such as roads, buildings, rivers, and lakes, as well as areas such as census tracts.
Digital Raster Graphics (DRG) (Mulit-Resolutions)	USGS	No	Open	Not Present	Productized		X		Digital scans of paper maps.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Spatial Data Transfer Standard (SDTS)	USGS, American National Standards Institute (ANSI)	No	Open	Not Present	Productized		X		SDTS is a way of transferring earth-referenced spatial data between dissimilar computer systems with the potential for no information loss. It is a transfer standard that embraces the philosophy of self-contained transfers, i.e., spatial data, attribute, georeferencing, data quality report, data dictionary, and other supporting metadata all included in the transfer. United States Coast Guard (USGS) data, such as Digital Elevation Model (DEM) files are delivered in this format.
Digital Line Graph (DLG) and DLG enhanced (DLGe)	USGS	No	Open	Not Present	Productized		X		Digital vector representations of cartographic information derived from either aerial photographs or from cartographic source materials using manual and automated digitizing methods.
Gridded Binary (GRIB)	WMO	Yes	Open	Mandated	Productized		X		Concise data format for the storage of historical and forecast weather data.
Binary Universal Form for the Representation of meteorological data (BUFR)	WMO	Yes	Open	Mandated	Productized		X		Binary, tabular data format developed by WMO to replace numerous existing formats for the representation of meteorological data. Designed to be compact, concise, and universal, the format can represent arbitary data, associated temporal and spatial information, and arbitrary metadata.
Standard Gridded Data Meteorological Message (METGM) STANAG 6022	NATO	Yes	Proprietary	Not Present	Productized		X		NATO standard format for METOC data very similar to GRIB.
Network Common Data Format (netCDF)	UNIDATA	Yes	Open	Not Present	Productized		X		NetCDF (is a set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.
Environmental Data Cube Support System (EDCSS) Comma Separated Variables (CSV)	ESG / EDCSS	Yes	Proprietary	Not Present	Productized			X	CSV file format representation of the underlying environment representation obtained from the Environmental Scene Generator (ESG) component of the EDCSS system.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Character form for the Representation and EXchange of data (CREX)	WMO	Yes	Open	Not Present	Productized		X		Human-readable textual representation of the same data represented using BUFR.
GeoTIFF	Public Domain	Yes	Open	Active	Productized		X	X	TIFF-based raster format for georeferenced raster imagery.
Map Overlay and Statistical System (MOSS)	Public Domain	No	Open	Not Present	Productized		X		The first widely deployed, vector-based GIS system, MOSS is no longer actively used. However, lots of data does exist, particularly from the Bureau of Land Management (BLM) and US Fish and Wildlife Service (USF&WS).
GeoJSON	MetaCarta, Creative Commons	Yes	Open	Not Present	Reference Implementation		X		Format for encoding geographic data structures in JavaScript Object Notation (JSON)
ERDAS Imagine Hierarchical File Format (HFA) IMG	ERDAS, Inc.	Yes	Proprietary	Not Present	Productized		X		Multi-layer georeferenced raster file format used by ERDAS Imagine
Enhanced Compression Wavelet (ECW)	ERDAS, Inc.	No	Proprietary	Not Present	Productized		X		Compressed wavelet compression format for use with aerial and satellite raster imagery.
Terragen Terrain	Terragen	Yes	Proprietary	Not Present	Productized			X	Terrain format natively used by Terragen, a broadcast and film quality terrain and environment rendering package from Planetside Sotfware. Format exported to a different format before inclusion into 3D simulation environments.
MetaVR Metadesic	MetaVR	Yes	Proprietary	Not Present	Productized			X	Metadesic™ is MetaVR's round-earth virtual terrain architecture that represents the earth's surface in a geocentric coordinate system that represents the curvature of the earth and handles ordinate axis convergence at the poles.
Compact Terrain Database (CTDB)	PEO STRI	Yes	Proprietary	Not Present	Productized			X	Compact terrain representation used in JSAF/ModSAF/OneSAF.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Virtual Battle Space (VBS) Terrain	Bohemia Interactive	Yes	Proprietary	Not Present	Productized			X	Runtime terrain format for the Bohemia Interactive VBS engine. Take as input raw DTED, shape files, and raster data to generate VBS terrain for runtime use. Deployable Virtual Training Environment (DVTE) utilizes VBS terrain.
VR-Forces GDB Terrain	MAK Technologies	Yes	Proprietary	Not Present	Productized			X	Annotated terrain database for use with the VR-Forces product. Exporters exist for third party terrain generation products, most notably from Terragen.
National Transfer Format (NTF) BS 7567	British Standards Insitute	Yes	Open	Not Present	Productized		X		Format designed in 1988 for the transfer of geospatial information. Currently the British standard for data collected in the Ordnance Survey.
Canadian Digital Elevation Data (CDED)	Canada	Yes	Open	Not Present	Productized		X		Canadian equivalent to DTED.
Objective Terrain Format (OTF)	OneSAF	Yes	Proprietary	Active	Productized			X	OneSAF terrain database. Binary format which contains terrain, skin, features, and Ultra-High Resolution Buildings (UHRB) models.
OneSAF Objective System (OOS) Environmental Data Model (EDM)	OneSAF	Yes	Proprietary	Active	Productized			X	The OOS EDM defines all the features and attributes for terrain, atmosphere, ocean, pace, UHRB, Nuclear, Biological, Chemical (NBC) for OOS and WARSIM. The OOS EDM is the baseline EDM for the SE Core program.
Combined Arms and Support Task Force Evaluation Model (CASTFOREM) Terrain	Consolidated Analysis Center, Incorporated (CACI) TRADOC Analysis Command (TRAC)	Yes	Proprietary	Not Present	Productized			X	Internal terrain database format used by CASTFOREM.
Battlespace Terrain and Reasoning Awareness (BTRA)	Army Geospatial Center (AGC)	Yes	Proprietary	Not Present	Productized		X	X	Data format incorporating terrain, weather, and analytics data for integration into C4ISR situation awareness simulations.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Water Resouces Database (WRDB)	AGC	Yes	Proprietary	Not Present	Productized		X		Name for both the set of database tables and ancillary forms used to store water resources data and the .NET-based software system used to display and enter data into said tables.
International Hydrographic Association (IHO) S-57	International Hydrographic Organization & International Hydrographic (IHB)	Yes	Open	Not Present	Productized	X			Vector interchange format for the exchange of nautical charts maintained by the International Hydrographic Organization.
Joint METOC Broker Language (JMBL)	JMBL	Yes	Proprietary	Mandated	Productized	X			XML-based format designed to broker information between METOC data providers and user applications, most ofter via web service interfaces to the providers.
S1000	Defense Advanced Research Projects Agency (DARPA), JFCOM J9	No	Proprietary	Not Present	Productized	X			Native terrain format for Simnet.
Terrasim Tiled Scene Graph (TSG)	TerraSim	Yes	Proprietary	Not Present	Productized			X	This a standard format used within the METOC and space communities. There are no formal overall standard dictionaries but there has been some attempt to develop some for specific connunities.
GeoPDF	Adobe	Yes	Proprietary	Not Present	Productized			X	Extension to the PDF specification to allow the embedding of georeferenced graphics and maps.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
TrueTerrain	Harris	Yes	Proprietary	Not Present	Productized			X	Harris ImageLinks creates TrueTerrain™ visualization and simulation products by merging and mosaicking multi-source satellite and aerial imagery of different resolutions on an elevation surface to provide realistic geo-specific terrain features. This requires that all data is orthorectified, seamlessly co-registered, tonally balanced, and feather blended mosaics created from different resolution source data. This data is normally then delivered in simulation-specific formats as TrueTerrain mosaics are normally too large to be used as runtime data.
RealSite / LiteSite	Harris, NGA	Yes	Proprietary	Not Present	Productized		X	X	Proprietary format for the encoding of 3D urban and terrain digital elevation models overlaid with high resolution raster imagery.
Skyline Image MPU	Skyline	Yes	Proprietary	Not Present	Productized			X	Native TerraTools format for raster and elevation data.
Skyline Multi-Resolution Model	Skyline	Yes	Proprietary	Not Present	Productized	X	X		Native TerraTools format for georeferenced 3D models.
Joint Theater Level Simulation (JTLS) Hex-grid	JFCOM	Yes	Proprietary	Not Present	Productized			X	JTLS terrain is represented as a hexagonal grid overlay on a map projection, with each scenario limited to a bounding region of 2000 by 2000 nautical miles.
Environment for Visualizing Images (ENVI)	International Telephone & Telegraph (ITT)	Yes	Proprietary	Not Present	Productized		X	X	Name of both a file format and the software that manipulates it. Format used to represent hyperspectral imagery.
Homeland Infrastructure Feature Level Database (HIFLD)	Federal Geographic Data Committee (FGDC)	Yes	Proprietary	Not Present	Productized			X	Custom GIS/imagery database developed for homeland security purposes, including law enforcement and emergency services.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
SE Core MDB	PEOSTRI	Yes	Proprietary	Not Present	Productized	X	X		Master database format created and maintained by the SE Core Database Virtual Environment Development (DVED) project. Based on the SEDRIS EDCS, the format is realized as a custom database schema.
Air Force Training System Product Group (TSPG) common dataset	Air Force Materiel Command (AFMC)/ TSPG	Yes	Proprietary	Not Present	Productized			X	Master database format created and maintained by the Air Force TPSG.
Navy Portable Source Initiative (NPSI)	NAVAIR Naval Aviation Maintenance (NAMP)	Yes	Proprietary	Not Present	Productized			X	Master database format created and maintained by the Navy Portable Source Initiative.
Common Database	Presagis, USSOCOM	Yes	Proprietary	Not Present	Productized	X		X	USSOCOM Synthetic Natural Environment (SNE) database format. Managed by Presagis and wrapping several Presagis SNE formats including most notably OpenFlight.
Oracle Spatial	Oracle	Yes	Proprietary	Not Present	Productized	X		X	Native geospatial support (representation, search, etc.) for the Oracle database server.
PostGIS	Refractions Research	Yes	Proprietary	Not Present	Productized	X		X	Native geospatial support (representation, search, etc.) for the Postgresql database server.
MySQL Spatial Extensions	Oracle	Yes	Proprietary	Not Present	Productized	X		X	Native geospatial support (representation, search, etc.) for the MySQL database server.
SQL Server Spatial Data	Microsoft	Yes	Proprietary	Not Present	Productized	X		X	Native geospatial support (representation, search, etc.) for the SQL Server database server.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Environmental Data Coding Specification (EDCS) ISO/IEC 18025:2005(E)	SEDRIS Group, ISO, NATO	Yes	Open	Emerging	Productized	X			The EDCS provides a mechanism to specify the environmental 'things' that a particular data model construct is intended to represent. That is, a 'tree' could be represented alternatively as a <Point Feature>, an <Aggregate Geometry>, a <Data Table>, a <Model>, or some combination of these and other data modeling constructs. Which of these the data modeler (i.e., the data provider of a SEDRIS transmittal) chooses is orthogonal to the semantic of the 'thing' that is represented (and its location).
SRM ISO/IEC 18026:2006(E)	SEDRIS Group, ISO, NATO	Yes	Open	Emerging	Productized	X			The SRM captures and unifies the spatial models used by SEDRIS, plus the many others that are not currently used but can be easily added. These models include inertial, quasi-inertial, geo-based, and non-geo-based (purely arbitrary Cartesian) systems. The SRM provides a unifying mechanism for specification and inclusion of any spatial reference frame and coordinate system. Its algorithms are designed to retain a high degree of accuracy during transformation and conversion operations (1mm accuracy).
Terrain Scenario Generation and Archiving (TSGA)	Modeling & Simulation Coordination Office (MSCO), AGC	Yes	Proprietary	Not Present	Productized			X	The DMSO TSGA project developed an EDM for 3D models. The goal was to develop a sufficiently rich classification and attribution schema so that any 3D model from a variety of legacy model libraries could be unambiguously identified by its classification code and attribute values (instead of by the use of an arbitrary, but unique, name). TSGA was developed as an extension to EDCS in support of files encoded using STF.
Five Dimensional Representation (FDR)	ESG / EDCSS	Yes	Proprietary	Not Present	Productized			X	Physical data model representing data as a 5D "data cube" (x,y,z spatial dimensions, time, parameter/entity reference). Doesn't actually store data, but determines how data will be stored.

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
DGIWG Feature Data Dictionary Version 2007-1	DGIWG	Yes	Open	Mandated	Productized	X	X		The NATO standard (DGIWG Feature Data Dictionary - DFDD) specifies geospatial information concepts used by member nations of the multi-national DGIWG community. These concepts characterize aspects of real-world entities (or objects) and related properties, including those that are not necessarily visible or have a tangible physical form (e.g., airspace). The DFDD is a comprehensive dictionary and coding scheme for feature types, feature attributes (properties or characteristics associated with features), and attribute values (domain of feature attributes).
DGIWG Feature and Attribute Coding Catalogue	DGIWG	Yes	Open	Mandated	Productized	X	X		Obsoleted by DWIG DFDD. Served the same purpose as DFDD.
National System for Geospatial-Intelligence Feature Data Dictionary	NGA, NSG	Yes	Open	Emerging	Productized	X	X		This emerging NSG standard (NSG Feature Data Dictionary - NFDD) specifies those spatial information concepts intended for use within the NSG. These concepts characterize aspects of realworld entities (or objects) and related properties, including those that are not necessarily visible or have a tangible representation.
Urban Topographic Data Store (UTDS) Entity Catalog	NGA	Yes	Open	Emerging	Productized	X	X		Urban specialized subset of the NFDD
Local Topographic Data Store (LTDS) Entity Catalog	NGA	Yes	Open	Emerging	Productized	X	X		Local specialized subset of the NFDD
Regional Topographic Data Store (RTDS) Entity Catalog	NGA	Yes	Open	Emerging	Productized	X	X		Regional specialized subset of the NFDD
Global Topographic Data Store (GTDS) Entity Catalog	NGA	Yes	Open	Emerging	Productized	X	X		Global specialized subset of the NFDD

Table B-1: Synthetic Natural Environment Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
GRIB Parameter Codes (1-127 WMO) (128-256 Various Producer specified)	WMO, Producer	Yes	Open	Mandated	Productized		X		Enumerated parameter codes used for the creation of GRIB encoded files.
Joint METOC Conceptual Data Model	JMB	Yes	Proprietary	Not Present	Productized	X	X		Conceptual data model required to encoded Joint METOC data (e.g., JMBL)

Table B-2: Manmade Environmental Feature Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
X3D ISO/IEC 19775-1.2:2008	Web3D, ISO	Yes	Open	Mandated	Productized	X	X	X	X3D is a royalty-free open standards file format and run-time architecture to represent and communicate 3D scenes and objects using XML. It provides a system for the storage, retrieval and playback of real time graphics content embedded in applications, within an open architecture to support a wide array of domains and user scenarios. X3D has a rich set of componentized features that can tailored for various application domains.
Virtual Reality Markup Language (VRML) ISO/IEC 14772-1:1997 and ISO/IEC 14772-2:2004	Web3D, ISO	No	Open	Mandated	Experimentation		X	X	A standard text-based format for the representation of 3D objects and scenegraphs designed for the web. The format has been superseded by X3D.
COLLADA	Khronos Group	Yes	Open	Not Present	Productized	X	X	X	COLLADA is a COLLAborative Design Activity for establishing an open standard digital asset schema.. COLLADA defines an XML database schema that enables 3-D authoring applications to freely exchange digital assets without loss of information, enabling multiple software packages to be combined into extremely powerful tool chains.. The COLLADA schema supports all the features that modern 3-D interactive applications need, including programmable shader effects and physics simulation. It can also be extended end users.
OpenFlight	Presagis	Yes	Proprietary	Not Present	Productized		X	X	OpenFlight is a de facto visual database standard used in many real-time image rendering contexts (e.g., flight simulators). It supports levels of detail, culling volumes, switch nodes, drawing priority, and binary separation of planes.
SEDRIS Transmittal Format ISO/IEC 18023-(1,2,3):2006(E)	SEDRIS Group, ISO	Yes	Open	Emerging	Productized	X	X	X	Platform independent format which contains a visual database mapped onto the SEDRIS DRM. This format allows for the lossless transfer of visual and geospatial information between systems that may not utilize the same underlying native visual database implementation.

Table B-2: Manmade Environmental Feature Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
CityGML OGC 08-007r1	OGC	Yes	Open	Not Present	Experimentation	X	X	X	CityGML is an information model for the representation of 3D urban objects. It defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantical and appearance properties. CityGML is realised as an open data model and XML-based format for the storage and exchange of virtual 3D city models. It is implemented as an application schema for the Geography Markup Language 3 (GML3).
Google Sketchup (SKP)	Google	Yes	Proprietary	Not Present	Productized		X	X	This is the native format for Google Sketchup. The version 7 format supports the most common constructs in 3D modeling and CAD software. It is notable chiefly because Sketchup makes 3D modeling accessible to people without modeling expertise, and because Google has created a searchable model repository to which the tool is directly linked.
FilmBox (FBX)	Autodesk	Yes	Proprietary	Not Present	Productized	X	X	X	This is a proprietary format owned by Autodesk, with open APIs provided by Autodesk (C++) and other user communities (Python, Java). The purpose of the format is to allow interoperability between Autodesk products and other 3D and animation digital content creation tools. The format is natively used by the VBS2 game engine, natively produced by Autodesk and Oxygen 2 (VBS2 editor), and has import/export filters availble for numerous 3D editing tools.
3D Studio Max (3ds Max)	Autodesk	Yes	Proprietary	Not Present	Productized			X	Native file format for Autodesk 3ds Max. Capable of representing the full set of features in 3ds Max, including 3D models, textures, shading, animation, physics, dynamic effects, and fully rendered and dynamically lit scenes.

Table B-2: Manmade Environmental Feature Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Autodesk Maya (MA - ASCII, MB - binary)	Autodesk	Yes	Proprietary	Not Present	Productized			X	Native file format for Autodesk Maya. Capable of representing standard 3D constructs (polygons, NURBS, subdivision surfaces), as well as hair, fur, rigid body and particle physics, and advanced movie-specific special effects.
Object File (OBJ)	Open	No	Proprietary	Not Present	Productized			X	Originally designed for Wavefront Technologies Advanced Visualizer, the format, now open, is considered a de facto standard for the delivery of simple geometry data for 3D models. Supports basic polygonal geometry and NURBS, but nothing else.
AutoDesk Drawing Exchange Format (DXF)	Autodesk	Yes	Proprietary	Not Present	Productized		X	X	CAD file format developed by Autodesk to promote interoperability and excahnge of data between AutoCAD and other CAD programs.
OpenDWG /AutoCAD Drawing Format (DWG)	Open Design Alliance (ODA), Autodesk	Yes	Open	Not Present	Productized			X	Originally the proprietary format for AutoCAD, the format is now maintained by the Open Design Alliance (ODA) as a universal CAD format. This format can be considered as a stand-in, with SolidWorks, for the more than 50 extant CAD formats, none of which are fed directly as 3D models into simulations.
SolidWorks (Assembly, 2D, 3D)	Dassault Systèmes Solid Works Corp.	Yes	Proprietary	Not Present	Productized			X	Technically the three SolidWorks CAD formats are really meta-formats using the Microsoft Structured Storaged format to include a number of proprietary binary files. SolidWorks is used extensively, claiming more than 1M users worldwide (http://www.solidworks.com/sw/655_ENU_HTML.htm).
OpenSceneGraph Binary (IVE)	Open Scene Graph Project	Yes	Proprietary	Not Present	Productized		X	X	This is a binary dump of the internal structures used by OSG to render the 3D scene, so it carries not only 3D information but also implementation baggage for the scenegraph engine.

Table B-2: Manmade Environmental Feature Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
IFC STEP ISO/ IS 16739	ISO, building-Smart International Alliance for Interoperabil-ity	Yes	Open	Mandated	Experimentation	X	X	X	This format was designed to help those in the building industry share information regarding "design, construction, procurement, maintenance, and operations." The format covers both standard 3D CAD information and complex annotations (the ISO spec includes a complex data dictionary) for everything from CO2 emissions to ductwork to fire prevention systems. This data has many hypothetical uses in M&S beyond simple 3D display, but there's no evidence of any current use in DoD M&S.

Table B-3: Unit Order of Battle/Force Structure Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JC3IEDM	OUSD (AT&L)	Yes	Proprietary	Not Present	Productized	X			This package contains XML Tags for the complete JC3IEDM 3.0 / Relational Database Management System (RDBMS) specification. About 1244 relationships. C-BML utilizes JC3IEDM 3.0.2. Very robust support for task organization prior to initialization.
C2IEDM	DISA	No	Proprietary	Not Present	Proof-of-Concept	X			Superceded by JC3IEDM.
Joint Training Data Services Order of Battle Service Schema	JFCOM	Yes	Proprietary	Not Present	Productized	X			XML schema represents unit and task organizations for JLVC and JLTCC federations.
Military Scenario Definition Language	PEO STRI	Yes	Open	Not Present	Productized	X		X	MSDL is an XML-based means of specifying the necessary details of a military scenario for consumption by a simulation, planning tool, or any other applicable computerized military application. Strong representation of / Order of Battle (OOB) and CGF formations, but no assignable behaviors - mission assignment is implicit…some support for association of C3 networks with units and platforms.
JCATS Integrated FPLN File	LLNL	Yes	Proprietary	Not Present	Productized	X		X	JCATS imports force structure data from the JTLDS OBS and other authoritative soruces.
Global Force Management Information Exchange Data Model	JCS J8	Yes	Proprietary	Not Present	Proof-of-Concept	X	X		The specification of how data will be exchanged between the suite of Global Force Management (GFM) organization servers and other systems that require GFM data.
Common Warfighting Symbology	DISA	Yes	Proprietary	Mandated	Productized		X	X	MIL-STD-2525 is designed to equip the DoD with a standard solution that provides sets of C2 symbols, a coding scheme for symbol automation and information transfer, and technical details to support systems. The standard provides support through interoperability and users' input, which are essential to ensure that the standard continues to meet the warfighter's requirements. MIL-STD-2525 is the primary directive that DoD uses to standardize warfighting symbology.

Table B-3: Unit Order of Battle/Force Structure Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Unit Object Standard	Army Modeling and Simulation Office (AMSO)	No	Proprietary	Not Present	Concept	X			AMSO attempted to standardize unit representations. This capability is obsoleted.
JTLS Scenario File	JFCOM	Yes	Proprietary	Not Present	Productized			X	JTLS recognizes relevant terrain, weapons, movement, attrition tables, unit characteristics, and TPFDD information as input to an Oracle database. There are no hard-coded data items; therefore, the creation of a database is complex and time-consuming when starting from scratch. The model is distributed with an example database with many reusable sections. Development time for a new database is six to eight months.
JSAF unit .rdr files.	NWDC and JFCOM J9 (JSAF)	Yes	Proprietary	Not Present	Productized			X	JSAF uses the following files to define and create units: - echelondb.rdr - libphysdb - unit_type.cdf - units_macros.rdr
OneSAF Unit Composition files	PEO STRI	Yes	Proprietary	Not Present	Productized			X	OneSAF stores unit compositions in an XML format file that is used to create aggregate units with assignable behaviors in a OneSAF scenario file. These unit compositions are stored for each OneSAF resolution/level (e.g., medium resolution).
Integrated Gaming System XML Schema	Booz Allen Hamilton	No	Proprietary	Not Present	Concept	X			Data model supporting Apex adaptive planning system: based on Universal Core 2.0. Decent schema for OOB. May be useful for other applications as well. Looks to be focused on high-level constructive modeling domain.

Table B-3: Unit Order of Battle/Force Structure Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
C-BML	SISO	No	Open	Not Present	Concept	X			A Battle Management Language is an unambiguous language used to: a. Command and control forces and equipment conducting military operations. b. Provide for situational awareness and a shared, common operational picture. It can be seen as a standard representation of a digitized commander's intent to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding. A Coalition BML developed and applied by all Services and by coalition members would not only allow interoperability among their C4ISR systems and simulations, but also among themselves. C-BML does not support OOB directly, but does so indirectly through JC3IEDM. Also supports reorganization through this mechanism
WARSIM Common Database Format	PEO STRI	Yes	Proprietary	Not Present	Productized	X		X	WARSIM utilizes an Oracle database to store unit, equipment and organizational information, as well as tactical plans, scenarios and logistics data used for initialization. WARSIM imports tactical graphics from Army Battle Command Systems (ABCS) systems and is working to import OOB data in a spreadsheet format. Integration with JLTCC entity-level components is being pursued through an interface to the JFCOM OBS format (capability planned but not developed yet).

Table B-4: Electronic Order of Battle/Network Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
DoD Discovery Metadata Specification ISR Extensions	NGA	No	Proprietary	Not Present	Proof-of-Concept	X			The Intelligence, Surveillance, and Reconnaissance (ISR) Extension Specification documents the set, categories, elements, and profiles used to extend the core metadata layer defined in the DoD DDMS, v.1.4.1, dated August 2007, to capture ISR-specific metadata elements. This schema includes platform and sensor metadata relevant to discovery in tactical C4ISR systems and therefore could be relevant to live-simulation environment interplay.
JC3IEDM	OUSD (AT&L)	Yes	Proprietary	Not Present	Productized	X			This package contains XML Tags for the complete JC3IEDM 3.0 RDBMS specification. About 1244 relationships. Moderate support for electronic order of battle, but not to the level of network topology.
LDAP Data Interchange Format	ITEF	Yes	Open	Mandated	Productized			X	LDAP Data Interchange Format is typically used to import and export directory information between LDAP-based directory servers, or to describe a set of changes which are to be applied to a directory. Commercial standard is RFC 2849, released in draft in 2000, never finalized. OneSAF imports LDIF files to configure the C4I Adapter for live-constructive C2 traffic.
AFATDS Joint Master Unit List	PEO C3T	Yes	Proprietary	Not Present	Productized	X		X	The JMUL is the “address book” of units and systems with which the AFATDS interoperates. For each protocol, the correct message template(s) is invoked so that AFATDS may send to that particular system. Each AFATDS version requires a unique JMUL database. The JMUL from one software version cannot be loaded as a segment on another software version. Once the JMUL is loaded onto AFATDS, it becomes a Master Unit List (MUL) for the system. Excis uses the AFATDS JMUL as an input file to configure the system for use. See: https://www.us.army.mil/suite/doc/7497490

Table B-4: Electronic Order of Battle/Network Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Army Battle Command Systems (CSAT) Modeling and Simulation Object (MSO) File	US Army RDECOM	Yes	Proprietary	Not Present	Experimentation			X	CSAT creates a MSOformat file used by hlaControl which includes: Platform definitions, Unit definitions, Force structure, Force laydown, Communications topology, Execution architecture, and respective HLA interaction(s). Not released with MATREX 1.3 but available for use with that release.
Opnet	Opnet Technologies	Yes	Proprietary	Not Present	Productized			X	Opnet has ASCII traffic file formats.
Qualnet Communications Effects Server Configuration input file	Scaleable Network Technologies	Yes	Proprietary	Not Present	Productized			X	The Qualnet Communications Effects Server uses three input file formats: •<filename>.config: This is the primary input file for Communications Effects Server (CES) and specifies the network scenario and parameters for the simulation. •<filename>.nodes: This file is referenced by the configuration file (as the parameter NODE-POSITION-FILE) and specifies the initial position of nodes in the scenario. •<filename>.app: This file is referenced by the configuration file [as the parameter (Application [APP]-CONFIG-FILE and specifies the applications running on the nodes in the scenario.]
Orion Gateway XML file	US Army Electronic Proving Ground (EPG)	No	Proprietary	Not Present	Reference Implementation	X		X	The Orion DIS Gateway reads a jointly defined XML file that contains the bindings of Unit URN numbers to named transceivers in the Orion/EWEW palette of transceivers.
Military Scenario Definition Language	PEO STRI	Yes	Open	Not Present	Productized	X		X	MSDL is an XML-based means of specifying the necessary details of a military scenario for consumption by a simulation, planning tool, or any other applicable computerized military application. Strong representation of OOB and CGF formations, but no assignable behaviors - mission assignment is implicit…some support for association of C3 networks with units and platforms. MSDL now imports LDIF files for the electronic order of battle.

Table B-4: Electronic Order of Battle/Network Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
C-BML	SISO	No	Open	Not Present	Concept	X			A Battle Management Language (BML) is an unambiguous language used to: a. Command and control forces and equipment conducting military operations. b. Provide for situational awareness and a shared, common operational picture. It can be seen as a standard representation of a digitized commander's intent to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding. A Coalition BML developed and applied by all Services and by coalition members would not only allow interoperability among their C4ISR systems and simulations, but also among themselves. C-BML does not support EOB directly, but does so indirectly through JC3IEDM. Also supports reorganization through this mechanism.
JCATS Integrated FPLN File	LLNL	Yes	Proprietary	Not Present	Productized	X		X	JCATS imports force structure data from the JTLDS OBS and other authoritative sources.
Firesim Input Processor Rules	TRADOC	Yes	Proprietary	Not Present	Productized			X	Firesim imports system and weapon performance data, force structure, target files, entity positions, and environmental data; using an input processor, it creates an input log and transfer file used to initialize the simulation.
Aircraft Display Symbology, MIL-STD-1787C	DISA	Yes	Proprietary	Mandated	Productized		X	X	This standard defines the symbology requirements for a primary flight reference and describes some fundamental relationships between symbol motion and aircraft system states. It describes symbols, symbol formats, and information content for electro-optical displays that provide aircrew members with information for takeoff, navigation, terrain following/terrain avoidance, weapon delivery, and landing. It also provides (in appendixes) non-binding information on symbol geometry, fonts, recommended dimensions, and mechanizations.

Table B-5: Platform/Weapons Performance and/or Characteristics Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JSAF .rdr	JFCOM J9	Yes	Proprietary	Not Present	Productized		X	X	Proprietary text format defining platform parameters.
OneSAF Parametric and Initialization Repository (PAIR)	PEO STRI	Yes	Proprietary	Not Present	Productized			X	XML schemas, Excel, and csv files that specify C&P data.
OneSAF Objective System Excel/csv	PEO STRI	Yes	Proprietary	Not Present	Productized			X	Excel or csv files that specify C&P data.
MetaFlight	Presagis/ PEO STRI	Yes	Proprietary	Not Present	Productized			X	Used by Common Moving Models (CM2).
Advanced Logistics Program (ALP) Logical Data Model (LDM)	RDECOM	No	Proprietary	Not Present	Reference Implementation				Cognitive Agent Architecture (Cougaar) evolved out of the DARPA ALP program, but now focuses on the multi-agent architecture aspects of the program.
SensorML	OGC	Yes	Open	Emerging	Productized			X	Specifies models and XML encoding that provide a framework within which the geometric, dynamic, and observational characteristics of sensors and sensor systems can be defined.
S1000D International Specification for Technical Publications	S1000D	Yes	Open	Emerging	Productized	X	X		Standard for producing technical documentation, including maintenance manuals for weapons systems.
C&P Data Interchange Format (DIF)	JMASS	No	Proprietary	Not Present	Concept	X			National Ground Intelligence Center (NGIC) effort to supply authoritative data for modeling and simulation applications out of their System Parametric Information Relational Intelligence Tool (SPIRIT) database.
Army Equipment ontology	DARPA	No	Proprietary	Not Present	Concept	X			Developed for DARPA as part of the DARPA Agent Markup (DAML) effort that led to World Wide Web (W3C's) Web Ontology Language (OWL).

Table B-5: Platform/Weapons Performance and/or Characteristics Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
AMSAA Standard File Formats (SFFs)	AMSAA	Yes	Proprietary	Not Present	Productized		X		There are 126 of these. Only 4 users take AMSAA data: OneSAF – takes AMSAA data in directly; OneSAF still has to directly link entities with data from AMSAA. Center for Army Analysis (CAA) models theater-level; Combat Sample Generator (COSAGE) does some modeling and calculates kill rates forJoint Integrated Campaign Model (JICM); TRAC White Sands Missile Range (WSMR) models brigade and below; moving from JANUS to OneSAF and from CASTFOREM to Combat XXI; TRAC Leavenworth models corps/division; moving from Vector In Commander (VIC) to Advanced Warfighting Simulation (AWARS). All users except OneSAF have to perform some mediation to use the AMSAA data.
Modernized Integrated Database (MIDB)/ Military Equipment Parametric Engineering Database (MEPED)			Proprietary	Not Present	Productized		X		SPIRIT is the internal C&P database that supplies data to MEPED, the distributed US DoD Intelligence Information System (DODIIS) migration system. The lack of current publicly available data may indicate that this program is highly classified.
Extended Air Defense Simulation (EADSIM) Specific System Representations (SSR) ruleset language	U.S. Army Space and Missile Defense Command	Yes	Proprietary	Not Present	Productized			X	EADSIM rulesets in XML capture some C&P data.
Interactive Tactical Environment Management System (ITEMS)	Canadian Aviation Electronics (CAE)	Yes	Proprietary	Not Present	Productized		X	X	ITEMS allows for the creation of new platform types and the definition of behaviors. It uses an “offline database management system” as its storage format. That’s probably just a proprietary indexed file format.
JCATS	JFCOM J7	Yes	Proprietary	Not Present	Productized			X	C&P is contained in the “fchar” text file format and Prob hit/Prob kill interaction data is in the “phpk” text file format.

Table B-5: Platform/Weapons Performance and/or Characteristics Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Air Warfare Simulation (AWSIM)	Raytheon/ Air Force Agency for Modeling and Simulation (AFAMS)	Yes	Proprietary	Not Present	Productized			X	An Oracle databasec that contains entity type definitions, C&P data, and the interaction parameters (probability of hit/kill for weapons, probability of detection/identification for sensors).

Table B-6: Plans/Scenario Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Aircraft Collection Tasking Message (ACTM)	NGA	Yes	Proprietary	Not Present	Productized		X	X	The ACTM is a National Geospatial-Intelligence Agency, Tactical Data Integration Branch created standardized message for aircraft collection tasking. The ACTM, which is defined by the Aircraft Collection Tasking Message Standard, utilizes community-acceptable field names, data structures, and format necessary to consolidate, transmit, and import airborne Imagery Intelligence (IMINT) and Signals Intelligence (SIGINT) collection information for automated display and ingestion by sensor and/or mission planning systems. Tactical message format with limited applicability to M&S.
ABCS 6.4 Publish and Subscribe Services	PEO C3T	Yes	Proprietary	Not Present	Productized	X		X	Publish and Subscribe Service (PASS) Interface Control Document (ICD) Version 1. C (May 2004) Contains ABCS 6.4 PASS XML schema. Rated as developmental in DoD Metadata Registry (MDR) in 2005, not updated since. Backbone format of Army tactical C2 systems.

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JC3IEDM	OUSD (AT&L)	Yes	Proprietary	Not Present	Productized	X			This package contains XML Tags for the complete JC3IEDM 3.0 RDBMS specification. About 1244 relationships. C-BML utilizes JC3IEDM 3.0.2. Very robust support for plans and scenarios prior to initialization. Some overlap with MSDL.
C2IEDM	DISA	No	Proprietary	Not Present	Proof-of-Concept	X			Superceded by JC3IEDM.
Time Phased Force Deployment (TPFD)	JCS J-7	Yes	Proprietary	Not Present	Productized		X		Joint Operation Planning and Execution System (JOPES) Output. Used as input to JTLS.
Common Warfighting Symbology	DISA	Yes	Proprietary	Mandated	Productized		X	X	MIL-STD-2525 is designed to equip the DoD with a standard solution that provides sets of C2 symbols, a coding scheme for symbol automation and information transfer, and technical details to support systems. The standard provides support through interoperability and users' input, which are essential to ensure that the standard continues to meet the warfighter's requirements. MIL-STD-2525 is the primary directive that DoD uses to standardize warfighting symbology. Mandated in DISR. Encapsulated in MSDL.
National Information Exchange Model	DoJ/DHS	Yes	Proprietary	Not Present	Experimentation	X	X	X	The NIEM is designed to develop, disseminate, and support enterprise-wide information sharing standards and processes across the whole of the justice, public safety, emergency and disaster management, intelligence, and homeland security enterprise at all levels and across all branches of government

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Military Scenario Definition Language	PEO STRI	Yes	Open	Not Present	Productized	X		X	MSDL is an XML-based means of specifying the necessary details of a military scenario for consumption by a simulation, planning tool, or any other applicable computerized military application. Strong representation of OOB and CGF formations, but no assignable behaviors - mission assignment is implicit (relies on C-BML to do this)…some support for association of C3 networks with units and platforms.
Mission Data Exchange Format	NAVAIR	Yes	Proprietary	Mandated	Productized	X			MIL_STD-3014 defines a format for digital data files used for mission-level programming of weapon systems. This standard defines a standard file format that will provide a compact and consistent way to pass data needed by weapons through networks, data links, and aircraft data busses, independent of the physical channel being used.

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Coalition - Battle Management Language	SISO	No	Open	Not Present	Concept	X			A Battle Management Language (BML) is an unambiguous language used to: a. Command and control forces and equipment conducting military operations. b. Provide for situational awareness and a shared, common operational picture. It can be seen as a standard representation of a digitized commander's intent to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding. A Coalition BML developed and applied by all Services and by coalition members would not only allow interoperability among their C4ISR systems and simulations, but also among themselves. C-BML incorporates JC3IEDM and therefore provides very comprehensive support for defining plans, scenarios as well as orders and reports. In its current state, C-BML itself only describes the mission statement (Paragraph 2 of an Operations Order) with some support for the description of Commander's intent (in text-based form) found in paragraph 3. Other elements of the Operations Order format are indirectly supported in C-BML, as are most elements of the Common Operating Picture (COP) (including OOTW extensions introducted in J3CIEDM). Together with J3CIEDM, this is a highly complex mediation format.
Integrated Battle Management Language (IBML)	US Army CIO (G-6)	Yes	Open	Not Present	Reference Implementation	X		X	A collection of shared and integrated products and specifications serving as a common foundation for the development and production of advanced C2 processes across BML stakeholders including orders, reports, and geospatial capabilities.

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JTLS Scenario File	JFCOM	Yes	Proprietary	Not Present	Productized			X	JTLS recognizes relevant terrain, weapons, movement, attrition tables, unit characteristics, and TPFDD information as input to an Oracle database. There are no hard-coded data items; therefore, the creation of a database is complex and time-consuming when starting from scratch. The model is distributed with an example database with many reusable sections.
Joint Training Data Services Order of Battle Service Schema	JFCOM	Yes	Proprietary	Not Present	Productized	X			XML schema represents unit and task organizations for JLVC and JLTCC federations.
JSAF scenario file	NWDC and JFCOM J9 (JSAF)	Yes	Proprietary	Not Present	Productized			X	JSAF saves its scenario database in an XML file format; in a distributed mode, it sends an HLA save interaction over the Run-Time Infrastructure (RTI), whereupon the JSAF federates publish their state variables in the form of a serialized text file which is read and stored by the SAFHost. This is similar to how the J-BML web service sends commands to JSAF (e.g., native to the JSAF distributed C2 database).
OneSAF scenario files	PEO STRI	Yes	Proprietary	Not Present	Productized			X	OneSAF saves its internal overlays and scenarios in an XML format database. Imported MSDL files are automatically converted into this format, so that additional information can be entered in the OneSAF. Currently, OneSAF must assign unit behaviors to units to create an executable scenario.
JCATS Integrated FPLN File	LLNL	Yes	Proprietary	Not Present	Productized	X		X	JCATS imports force structure data from the JTLDS OBS and other authoritative sources.

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
WARSIM Common Database Format	PEO STRI	Yes	Proprietary	Not Present	Productized			X	WARSIM utilizes an Oracle database to store unit, equipment and organizational information, as well as tactical plans, scenarios and logistics data used for initialization. WARSIM imports tactical graphics from ABCS systems and is working to import OOB data in a spreadsheet format. Integration with JLTCC entity level components is being pursued through an interface to the JFCOM OBS format (capability planned but not developed yet).
EADSIM Routes and Formats Datasets	U.S. Army Space and Missile Defense Command	Yes	Proprietary	Not Present	Productized			X	EADSIM provides capabilities to interface with operational planning tools and standard databases. The planning tools include aircraft routing tools to provide the details of an aircraft flight plan. The standard databases include Air Task Orders, allowing a large number of missions to be automatically deployed.
FireSim Input Processor Files	TRADOC	Yes	Proprietary	Not Present	Productized			X	FireSim imports system and weapon performance data, force structure, target files, entity positions, and environmental data; using an input processor, it creates an input log and transfer file used to initialize the simulation.
Tactical Simulation (TACSIM)	PEO STRI	Yes	Proprietary	Not Present	Productized			X	TACSIM can import initialization data from intelligence databases and combat simulations, includin JCATS, EADSIM and FireSim.
Joint Non Kinetic Effects Model (JNEM) Database Neighborhood File	JFCOM	Yes	Proprietary	Not Present	Experimentation			X	JNEM uses an application specific scenario file, which may be combined with a combat simulation to generate Grey and White force behaviors and effects.

Table B-6: Plans/Scenario Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Aircraft Display Symbology, MIL-STD-1787C	DISA	Yes	Proprietary	Mandated	Productized		X	X	This standard defines the symbology requirements for a primary flight reference and describes some fundamental relationships between symbol motion and aircraft system states. It describes symbols, symbol formats, and information content for electro-optical displays that provide aircrew members with information for takeoff, navigation, terrain following/terrain avoidance, weapon delivery, and landing. It also provides (in appendices) non-binding information on symbol geometry, fonts, recommended dimensions, and mechanizations.

Table B-7: Behavior Formats

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Recursive Porous Agent Simulation Toolkit (REPAST)	Argonne National Laboratory	Yes	Open	Not Present	Productized		X	X	The REPAST Simphony application storage format actually consists of two separate stoage formats, .score and Java bytecode. Runtime behavior can be specified declaratively in a .score file (XML), programmatically in either Java or Groovy, then compiled to Java bytecode, or with a combination of declarative and programmatic elements.
OneSAF	PEO STRI/PM OneSAF	Yes	Proprietary	Not Present	Productized		X	X	OneSAF behavior is defined in an XML file containing metadata, inputs, (in the case of composite behaviors) outputs, and control definitions defining the effect of a behavior; Composite Behavior Description DIF has a ruleset specified in XML (that presumably specifies which primitive behaviors to execute during the execution timeline); Primitive Behavior Description DIF references a Java class that actually implements the behavior
Adaptive Control of Thought-Rational (ACT-R)	Carnegie Mellon University	Yes	Open	Not Present	Productized		X	X	The data storage format for ACT-R is inseparable from its implementation, being extensions and implementations of constructs in Common Lisp.
Simulation of Adaptive Response (SOAR)	University of Michigan	Yes	Open	Not Present	Productized		X	X	As with ACT-R, the data storage format for SOAR is a custom dialect of Common Lisp.
Synthetic Environments for Analysis and Simulation (SEAS)	Purdue University/ Simulex, Inc.	Yes	Proprietary	Not Present	Productized		X	X	Seems to be an application-specific database, but unclassified implementation data is limited.
Common Human Behavior Representation and Interchange System (CHRIS)	DMSO	No	Proprietary	Not Present	Concept	X			Appears to be notional, but never implemented.
EADSIM SSR ruleset language	U.S. Army Space and Missile Defense Command	Yes	Proprietary	Not Present	Productized		X	X	EADSIM rulesets are scripted actions represented in text in the ruleset.elem file.
WARSIM Behavior Definition Frames (BDFs)	PEO STRI	Yes	Proprietary	Not Present	Productized		X	X	XML schema.
JSAF .rdr	JFCOM J9	Yes	Proprietary	Not Present	Productized		X	X	Proprietary text file format specifying unit and entity behaviors.

Table B-7: Behavior Formats (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Presagis AI.Implant	Presagis	Yes	Proprietary	Not Present	Productized		X	X	Proprietary (binary?) file format during project development requires compilation before distribution to utilizing systems.
Interactive Tactical Environment Management System	CAE	Yes	Proprietary	Not Present	Productized		X	X	ITEMS allows for the creation of new platform types and the definition of behaviors. It uses an "offline database management system" as its storage format. That's probably just a proprietary indexed file format.

Table B-8: Logistics

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JC3IEDM	OUSD (AT&L)	Yes	Proprietary	Not Present	Productized	X			This package contains XML Tags for the complete JC3IEDM 3.0 RDBMS specification. About 1244 relationships.
Object/Class Hierarchy for Deployment Models	AMSO	Yes	Proprietary	Not Present	Concept	X			The EXtensive Hierarchy and Object Representation for Transportation (EXHORT) Simulations is a collection of three hierarchies that constitute a standard and consistent class attribute representation and behavior that could be used directly by a large set of deployment simulations. The first hierarchy is the Transportation Class Hierarchy (TCH), which describes a significant portion of the defense transportation system; the other two hierarchies deal with infrastructure and resource classes. EXHORT allows deployment simulations to use the same set of underlying class data, ensures transparent exchanges, reduces the effort needed to integrate simulations, and permits a detailed analysis of the defense transportation system. This proposed standard is the TCH.
Army Manpower Requirements Criteria (MARC) Maintenance Data Base (AMMDB)	US Army Force Management Support Agency	Yes	Proprietary	Not Present	Productized		X		Contains the value for each item of equipment, by line item number, for which the unit maintenance and direct support requirements are identified.

Table B-8: Logistics (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Product Data Interchange	ISO	Yes	Open	Mandated	Productized	X			ISO 10303 is an ISO standard for the computer-interpretable representation and exchange of product manufacturing information. Its official title is Industrial automation systems and integration - Product data representation and exchange, known as STEP or Standard for the Exchange of Product model data. Typically STEP can be used to exchange data between CAD, Computer-aided manufacturing, Computer-aided engineering, Product Data Management/EDM and other CAx systems. STEP is addressing product data from mechanical and electrical design, Geometric dimensioning and tolerancing, analysis and manufacturing, with additional information specific to various industries.
Corporate Logistic Data Model (CLDM)	DLA	Yes	Proprietary	Mandated	Productized		X	X	Represents the identification, description and structure of logistics concepts and characteristics for all logistics sub-functions; including materiel management, materiel distribution, materiel maintenance, transportation and services at all mission levels.
Federal Logistics Information System (FEDLOG)	DLA	Yes	Proprietary	Mandated	Productized		X	X	Database to be used by engineering, technical research, provisioning, procurement/contracting, supply, cataloging, maintenance, distribution, storage, transportation, quality assurance and disposal personnel to retrieve management, part/reference number, supplier, Commercial and Government Entity (CAGE), freight, Interchangeability and Substitutability (I&S) and characteristics information recorded against National Stock Numbers (NSNs).
Joint Deployment Logistics Model	PEO STRI	Yes	Proprietary	Mandated	Productized			X	Map-centric, comprehensive logistics simulation and training software that depicts detailed transportation, supply, maintenance, medical, personnel and multi-modal infrastructure behaviors.
WARSIM Common Database Format	PEO STRI	Yes	Proprietary	Not Present	Productized			X	WARSIM utilizes an Oracle database to store unit, equipment and organizational information, as well as tactical plans, scenarios and logistics data used for initialization. WARSIM imports tactical graphics from ABCS systems and is working to import OOB data in a spreadsheet format. Integration with JLTCC entity level components is being pursued through an interface to the JFCOM OBS format (capability planned but not developed yet).

Table B-8: Logistics (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
JCATS Integrated FPLN File	LLNL	Yes	Proprietary	Not Present	Productized	X		X	JCATS imports force structure data from the JTLDS OBS and other authoritative sources.

Table B-9: Event Results

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
U.S. Army Joint Digital Collection, Analysis, and Review System (JDCARS)	ATEC	Yes	Proprietary	Not Present	Productized		X	X	JDCARS was developed by the US Army Electronic Proving Ground. It is a data collection and analysis system that is part of the US Army C4ISR Test Tool Kit. It combines a data collection system with an after-action review system to provide a tool for both operational and technical data collection and analysis. It links the digitized force with a customer-user to provide feed-back for technical testing analysts, operational training assessors, and unit commanders. It enables users to analyze event activities, produce reports, and prepare after-action review products.
OneSAF Joint After Action Review (JAAR) Architecture	OneSAF Group	Yes	Proprietary	Not Present	Productized		X	X	OneSAF JAAR is a project within OneSAF to develop an extensible after action report architecture to support the collection and aggregation of simulation data and the generation of reports meeting the needs of various user communities.
Inter-Range Instrumentation Group (IRIG) 106 - telemetry	IRIG	Yes	Open	Not Present	Productized		X	X	Comprehensive telemetry standard for reporting developed and maintained by the Telemetry Group of the Range Commanders Council.

Table B-9: Event Results (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
libpcap / tcpdump	Lawrence Berkeley Lab	Yes	Open	Not Present	Productized		X	X	Library which defines a common file format for the capture and storage of IP packets on a network. Used by most network traffic capture software including Wireshark, Snort, Kismet, etc.
Distributed Debrief Control Protocol (DDCP) SISO-REF-028-2009	SISO	Yes	Open	Not Present	Experimentation		X		From the study group description in SISO: "The goal of the DDCP Study Group is to evaluate industry and government interest in developing a distributed debrief control protocol standard. The Study Group will evaluate the potential for a standards product addressing interoperability between distributed debrief (AAR) systems from multiple sources."
Pitch Recorder	Pitch	Yes	Proprietary	Not Present	Productized		X	X	Pitch product for the recording, analysis, and playback of data exchanged in an HLA federation. Data saved in a custom database with schema defined by the structure of the FOM for the simulation being recorded.
MAK Data Logger	MAK	Yes	Proprietary	Not Present	Productized		X	X	MAK product for the recording, analysis, and playback of DIS and HLA simulation event data. Stores data in database tables with schemas determined by the simulation data under review.
Redsim DIS Army Protocol Data Unit (PDU) Logger	Redsim	Yes	Proprietary	Not Present	Productized		X	X	Program for the analysis of PDU capture files generated by DIS Link Monitor. Reports exported to plain text or csv files.
Raytheon hlaResults	Raytheon	Yes	Proprietary	Not Present	Productized		X	X	Raytheon product for the recording, analysis, and playback of both HLA and DIS simulation events. Data saved in custom database tables.
S2 Focus	General Dynamics	Yes	Proprietary	Not Present	Productized		X	X	An all-encompassing distributed simulation tool suite for project development and run-time. S2Focus is object-oriented software specifically designed to run on the Windows® Operating System and specifically for High Level Architecture, with continuing support for DIS interoperability.
ModIOS AAR	General Dynamics	Yes	Proprietary	Not Present	Productized		X	X	Data recorder that captures messages stripped from RF data feeds from deployed weapons systems in the field.

Table B-9: Event Results (continued)

Format Name	Owner	Active	Standard	DISR	Maturity	Mediation	Producer	Consumer	Description
Mobile Automated Instrumentation Suite (MAIS)	Riptide	Yes	Proprietary	Not Present	Productized		X	X	HITS supports collective maneuver training for platoon-through-battalion units. Part of the Live Training Transformation - Family of Training Systems (LT2-FTS) and is based on the Common Training Instrumentation Architecture (CTIA). Ongoing efforts to standardize the generated AAR format used with the system.
Homestation Instrumentation Training System (HITS)	PEO STRI	Yes	Proprietary	Not Present	Productized		X		HITS supports collective maneuver training for platoon-through-battalion units. Part of the LT2-FTS and is based on the CTIA. Ongoing efforts to standardize the generated AAR format used with the system.
Combat Training Center Objective Instrumentation System (CTC-OIS) AAR	Riptide	Yes	Proprietary	Not Present	Concept			X	Combat Training Center Objective Instrumentation System (CTC OIS) modernizes the Instrumentation System (IS) at the National Training Center (NTC), Fort Irwin, CA and Joint Readiness Training Center (JRTC), Fort Polk, LA with one that meets the Army's existing and future advanced collective training objectives. A common AAR system and format is being developed as part of this effort.

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APPENDIX C: QUESTIONNAIRE RESULTS

C.1 ORIGINAL QUESTIONNAIRE

Using the following questionnaire, the study team solicited input from across the LVC community. Questions were based on initial feedback from the Common Capabilities Workshop held at JHU/APL on 4-5 November 2009. Potential respondents included workshop participants, members of SISO groups associated with various data categories and formats, and those identified by study team members as having experience and/or a vested interest in data formats. Those contacted were encouraged to forward the information and link for the online questionnaire to others who might also have relevant input.

LVCAR Reusable Development Tools and Common Data Storage Formats

DEFINITIONS

For the purpose of this questionnaire, the following definitions provide the scope you should consider in your responses:

1. LVC environments – any simulation environment that uses live assets, virtual simulators, constructive simulations, or any combination of these three technologies (L, V, C, LV, LC, VC, and LVC).

2. Development tools - software used for the specification, development, execution, and analysis of LVC environments. Viewed another way, this is all the software that is used in the HLA FEDEP, DIS Recommended Practice for Exercise Management and Feedback, or TENA Logical Range ConOps. For the purposes of this questionnaire, the interfaces to live systems, virtual and constructive simulations, and middleware/gateways that provide runtime data exchange are excluded.

3. Reuse – Using a previously developed tool again, either for the purpose for which it was originally developed or for a new purpose or in a new context.

4. Common data storage formats - data storage and interchange formats used in LVC environments, except those that govern the run-time exchange of data.

1) Please identify yourself.

First Name:	
Middle Initial:	
Last Name:	
Organization	
Primary organizations supported:	
Email Address:	
Phone Number:	Format: 999-999-9999

2) What is your organization type?

- ☐ Government
- ☒ Industry
- ☐ Academia
- ☐ Other (please specify)

If you selected other, please specify:

3) Please identify your role with respect to development tools and data storage formats. [Check all that apply.]

- ☐ Federate developer/integrator - responsible for developing and integrating a simulation into a federation
- ☐ Federation engineer/integrator – responsible for selecting, integrating, and testing federates within a federation (or in DSEEP terms, the member applications within a simulation environment)
- ☐ Federation manager - responsible for managing a federation execution, including coordinating federation participants
- ☐ Federation tester – responsible for establishing the test criteria to ensure that the federation is meeting requirements
- ☐ Tool developer – responsible for developing tools that enable the creation, execution, and evaluation of results from LVC environments.
- ☐ Program manager – responsible for managing to schedule and budget, allocating personnel, ensuring establishment and adherence to program level processes
- ☐ Security engineer - responsible for establishing security requirements for a federation, for any facilities in which federation members are housed, and security issues related to software, personnel, and storage media used in a federation
- ☐ Sponsor - an individual for whom a federation is being developed, likely responsible for funding and contract issues
- ☐ User/operator - responsible for running a simulation during integration, testing, and execution
- ☐ Verification and validation agent - responsible for verifying and validating an asset or federation
- ☐ Other (please specify)

If you selected other, please specify:

COMMON DATA STORAGE FORMATS

14) Check all the types of data that apply for each of the following questions.

	What types of data do you need to use or produce to perform your mission? [Check all that apply.]	What types of data do you believe are most urgently in need of common data storage formats/ schemas/data models (standards)? [Check all that apply.]	For which of the following types of data do you believe too many competing formats exist? [Check all that apply.]
Geospatial data (including METOC and air/space)	☐	☐	☐
Manmade environmental features (e.g., 3d models)	☐	☐	☐
Unit order of battle/force structure (including manning and readiness)	☐	☐	☐
Electronic order of battle/network	☐	☐	☐
Platform/weapons performance and/or characteristics	☐	☐	☐
Plans/scenarios (including TPFDD)	☐	☐	☐
Behavior (including organizational and individual)	☐	☐	☐
Logistics	☐	☐	☐
Event (testing, training, analysis, etc.) results	☐	☐	☐
Discovery metadata (metacards, card catalogs entries, etc.)	☐	☐	☐

Additional comments:

Please specify the formats you use for each of the types of data you checked above.

15) Geospatial data (including METOC and air/space)

16) Manmade environmental features (e.g., 3d models)

17) Unit order of battle/force structure (including manning and readiness)

18) Electronic order of battle/network

19) Platform/weapons performance and/or characteristics

20) Behavior (including organizational and individual)

21) Logistics

22) Event (testing, training, analysis, etc.) results

23) Discovery metadata (metacards, card catalogs entries, etc.)

24) Other (specify)

25) Where do you believe standardizing data formats is appropriate/effective? [Check all that apply.]

- ☐ Source data formats
- ☐ Data mediation standards
- ☐ Data product formats
- ☐ Other (please specify)

If you selected other, please specify:

26) Where do you think these data storage format standards should be established?

- ☐ Independent standards development organization (e.g., IEEE, ISO, SISO)
- ☐ Industry consortia
- ☐ Single vendor
- ☐ Government
- ☐ Other (please specify)

If you selected other, please specify:

Additionally, there was one question in the Reusable Tools portion of the questionnaire that pertained to Common Data Storage Formats. The question preceding it set the context:

12) Do you use different development tools to perform the same task when operating with different architectures?

- ☐ Yes
- ☐ No

Additional comments:

And then the participants were asked:

13) Would common data storage formats mitigate the issue?

C.2 RESPONSES

Of the nearly two hundred email notices sent in December and January 2009, thirteen responses were recorded by 30 April 2010. The responses are summarized in the following tables. Personal information, name of respondent, e-mail, phone numbers, and organizational association are not included because of privacy concerns.

C.2.1 Organizations

The primary organizations supported are:

- DoD M&S Community
- DoD
- AFAMS
- Army Test and Evaluation Command
- Naval Sea Systems Command (NAVSEA)
- United States Joint Forces Command (USJFCOM) Joint Personnel Recovery Agency (JPRA), Defense Threat Reduction Agency (DTRA), Air Force Agency for Modeling and Simulation (AFAMS)
- Aviation and Missile Command (AMCOM)
- Army, Navy, AirForce
- US ARMY Research, Development, and Engineering Command (RDECOM)
- United States Navy

The types of these organizations can be summarized as follows:

- Seven (7) Government
- Five (5) Industry
- Zero (0) Academia
- One (1) Other

Figure C-1 shows the distribution of responses according to participants' organization types. In tables C-2 through C-15, the responses are grouped by the participants' type of organization. Positive answers to questions that required a "check" or "check all that apply" are denoted by the word "Yes" in the table. If the participant did not place a check in the corresponding column, the answer is reflected as "No" in the table.

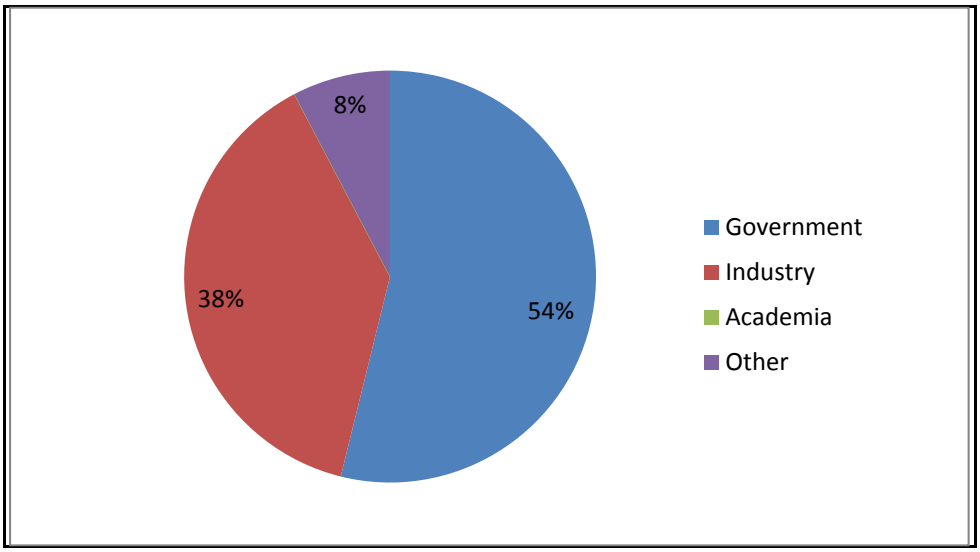

Figure C-1: Participants Organization Type

C.2.3 Roles

Each of the participants was asked to identify their role with respect to common data storage formats and development tools. Definitions of roles are as follows:

- Federate developer/integrator - responsible for developing and integrating a simulation into a federation.
- Federation engineer/integrator - responsible for selecting, integrating, and testing federates within a federation [or in Distributed Simulation Engineering and Execution Process (DSEEP) terms,the member applications within a simulation environment].
- Federation manager - responsible for managing a federation execution, including coordinating federation participants.
- Federation tester- responsible for establishing the test criteria to ensure that the federation is meeting requirements.
- Tool developer - responsible for developing tools that enable the creation, execution, and evaluation of results from LVC environments.
- Program manager - responsible for managing to schedule and budget, allocating personnel, ensuring establishment and adherence to program level processes.
- Security engineer - responsible for establishing security requirements for a federation, for any facilities in which federation members are housed,and security issues related to software, personnel, and storage media used in a federation.
- Sponsor - an individual for whom a federation is being developed, likely responsible for funding and contract issues.
- User/operator - responsible for running a simulation during integration, testing, and execution.
- Verification and validation agent - responsible for verifying and validating an asset or federation.

Table C-1: Participant Roles

Unique Id	Federate Developer/ Integrator	Federation Integrator/ Engineer	Federation Manager	Federation Tester	Tool Developer	Program Manager	Security Engineer	Sponsor	User/ Operator	Verification & Validation Agent	Other	Specified Other Coments
1	No	No	No	No	No	Yes	No	No	No	No	No	Providing Help Desk customers with information on LVC tools
2	No	No	No	No	No	Yes	No	No	No	No	Yes	Educator
3	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	
4	No	No	No	No	Yes	No	No	No	Yes	No	No	
5	No	No	No	No	No	No	No	No	Yes	No	No	
6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	
7	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	No	
8	No	No	No	No	No	No	No	No	No	No	Yes	Senior Executive over a Simulation enterprise
9	No	No	No	No	Yes	No	No	No	No	No	Yes	Material Developer for the Army
10	No	No	No	No	Yes	No	No	No	No	No	No	
11	No	No	No	No	Yes	Yes	No	No	No	No	No	
12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	
13	Yes	No	No	No	Yes	No	No	No	No	No	No	

C.2.3 Would common data storage formats mitigate lack of tools reuse?

The responses below in Table C-2 are to questions in the Reusable Tools portion of the questionnaire but are relevant to this study.

Table C-2: Reusable Tools and Common Data Storage Formats

Unique Id	What is your organization type?	Do you use different development tools to perform the same task when operating with different architectures?	Comments	Would common data storage formats mitigate the issue?
1	Government	No		Yes, possibly
2	Government	No	not sure	Not sure
3	Industry	Yes		
4	Industry	Yes		To a minor extent
5	Government	No		Not sure
6	Industry	Yes	Tools selected based on requirements	No, but they would help
7	Government	Yes		Not qualified to answer
8	Government	Yes		Marginally.
9	Government	Yes	I personally do not have hands on with the different development tools but i do know there are different development tools that each project advocates as the nubmer one capability to us, but each do not contain the Holy Grail.	Unknown at this time; too many formats to consider with many customers wanting it their way. This is why we need a common data model, then we can move towards making it a standard. this way everyone will know what that is and they should be able to code towards that process.
10	Government	No		Possible. However, depending on the type of training, Air, Ground, dismount each platform present unique storage format needs. The importance of bringing in the command and control area
11	Industry	No	We have built a generic platform that allows the developer to be in the luxary of not need to be concered of the underlying architecture: i.e. focus on the what not how.	Yes and No. No if it is to be one format for all; would not work; just look at JC3IEDM that is said to capture all C2 related issues for the military domain; but you can not express information regarding civil organizations that you need to cooperate with etc;Yes: if there is standardized domain/role/agency specific formats.
12	Other	Yes		
13	Industry	Yes	We reuse what we can,; but sometimes we need tools specific to a platform,like a Linux-compatible compiler.	No. We already use XML.

C.2.4 Geospatial Data

The geospatial data category is here defined as encompassing all data storage formats for the representation of synthetic natural environments. This includes elevation models, 2D and 3D terrain, vector maps, geo-referenced raster imagery, GIS databases, meteorological and oceanographic (METOC) data, and air and space data. This category covers all natural features and phenomena that are defined by a specific geographical location.

Table C-3: Geospatial Data

Unique Id	What is your organization type?	Do you need Geospatial Data ((including METOC and air/space) to use or produce to perform your mission?	Do you believe that Geospatial data (including METOC and air/space) is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Geospatial data (including METOC and air/space)
1	Government	Yes	Yes	Yes
2	Government	No	Yes	No
3	Industry	Yes	No	No
4	Industry	No	No	No
5	Government	No	No	No
6	Industry	Yes	Yes	Yes
7	Government	Yes	Yes	No
8	Government	Yes	Yes	Yes
9	Government	Yes	Yes	No
10	Government	No	No	No
11	Industry	Yes	No	No
12	Other	Yes	Yes	Yes
13	Industry	Yes	No	No

C.2.5 Manmade Environmental Features

The manmade environmental features category is here defined as encompassing 3D models of non-geospatial data. This excludes terrain, vector map data, environmental conditions, etc., but includes 3D models that may include geospatial positioning data including buildings, vehicles, or any other model of a man-made element that may be incorporated into a synthetic natural environment at runtime, but which can be stored independently of its geospatial positioning.

Table C-4: Manmade Environmental Features:

Unique Id	What is your organization type?	Do you need Manmade environmental features (e.g., 3d models) to use or produce to perform your mission?	Do you believe that Manmade environmental features (e.g., 3d models) is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Manmade environmental features (e.g., 3d models) ?
1	Government	Yes	Yes	No
2	Government	No	Yes	No
3	Industry	No	No	No
4	Industry	Yes	Yes	Yes
5	Government	No	No	No
6	Industry	Yes	Yes	Yes
7	Government	Yes	No	No
8	Government	Yes	Yes	Yes
9	Government	Yes	Yes	No
10	Government	Yes	No	Yes
11	Industry	No	Yes	No
12	Other	Yes	Yes	Yes
13	Industry	Yes	No	No

C.2.6 Unit Order of Battle Data

The UOB category consists of the identification, command structure, strength, and disposition of personnel, equipment, and units of the forces included in an operation, exercise, or simulation event. As defined in this study, an "order of battle" has no geospatial content. As a result, a "force laydown" that positions units within the operational environment is considered part of the Plans/Scenarios category.

Table C-5: Unit Order of Battle Data

Unique Id	What is your organization type?	Do you need Unit order of battle/force structure data (including manning and readiness) to use or produce to perform your mission?	Do you believe that Unit order of battle/force structure data (including manning and readiness) is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Unit order of battle/force structure data (including manning and readiness) ?
1	Government	No	No	No
2	Government	No	Yes	No
3	Industry	Yes	Yes	Yes
4	Industry	Yes	Yes	No
5	Government	No	No	No
6	Industry	Yes	No	No
7	Government	Yes	No	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	No	Yes	No
11	Industry	Yes	Yes	No
12	Other	No	No	No
13	Industry	No	No	No

C.2.7 Electronic Unit Order of Battle Data:

The EOB category includes network organization and topology at the application, physical and transport layers; electronic footprint; and initialization of communications models and databases that define mappings between simulated forces and live systems. The formats associated with this category are used to define and disseminate logical and physical address locations across live and simulated tactical networks.

Table C-6: Electronic Order of Battle/Network

Unique Id	What is your organization type?	Do you needElectronic order of battle/network data to use or produce to perform your mission?	Do you believe that Electronic order of battle/network data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Electronic order of battle/network data ?
1	Government	No	No	No
2	Government	No	No	No
3	Industry	No	No	No
4	Industry	No	No	No
5	Government	No	No	No
6	Industry	Yes	Yes	Yes
7	Government	Yes	No	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	Yes	No	No
11	Industry	Yes	Yes	No
12	Other	Yes	Yes	No
13	Industry	No	No	No

C.2.8 Weapons Performance and Characteristics Data

The platforms/weapons performance and characteristics data category, often referred to as characteristics and performance (C&P), encompasses all data storage formats for the representation of physical parameters of warfighting platforms and weapons systems.

Table C-7: Weapons Performance and Characteristic Data

Unique Id	What is your organization type?	Do you need Platform/weapons performance and/or characteristics to use or produce to perform your mission?	Do you believe that Platform/weapons performance and/or characteristics data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Platform/weapons performance and/or characteristics data ?
1	Government	No	No	No
2	Government	No	Yes	Yes
3	Industry	Yes	Yes	Yes
4	Industry	No	No	No
5	Government	No	No	No
6	Industry	Yes	Yes	No
7	Government	Yes	No	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	Yes	No	No
11	Industry	Yes	No	No
12	Other	No	No	No
13	Industry	Yes	Yes	No

C.2.9 Plans and Scenario Data

The plans and scenarios category includes operational plans, orders and tasking instructions issued to live, virtual and constructive players in a simulated event or exercise. These instructions are documented in the form of text, tables and associated graphics.

Table C-8: Plans and Scenario Data

Unique Id	What is your organization type?	Do you need Plans/scenarios (including TPFDD) to use or produce to perform your mission?	Do you believe that Plans/scenarios (including TPFDD) data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Plans/scenarios (including TPFDD) data ?
1	Government	No	No	No
2	Government	No	No	No
3	Industry	Yes	No	No
4	Industry	Yes	Yes	No
5	Government	No	No	No
6	Industry	Yes	No	No
7	Government	Yes	Yes	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	No	No	No
11	Industry	Yes	No	No
12	Other	Yes	Yes	Yes
13	Industry	Yes	No	No

C.2.10 Behavior Data

The behavior category includes all representations of human behavior including organizational and individual.

Table C-9: Behavior Data

Unique Id	What is your organization type?	Do you need Behavior (including organizational and individual) data to use or produce to perform your mission?	Do you believe that Behavior (including organizational and individual) data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Behavior (including organizational and individual) data ?
1	Government	No	No	No
2	Government	No	No	No
3	Industry	Yes	No	No
4	Industry	No	No	No
5	Government	No	No	No
6	Industry	Yes	No	No
7	Government	Yes	No	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	No	Yes	No
11	Industry	Yes	Yes	No
12	Other	Yes	Yes	No
13	Industry	Yes	No	No

C.2.11 Logistics Data

The logistics category includes the management and control of supply, transportation, maintenance and other support functions in support of an operation. Authoritative data sources describe the basic allocation of equipment and consumables to military units down to the individual and platform level.

Table C-10: Logistics Data

Unique Id	What is your organization type?	Do you need Logistics data to use or produce to perform your mission?	Do you believe that Logistics data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Logistics data ?
1	Government	Yes	Yes	Yes
2	Government	No	No	No
3	Industry	Yes	Yes	No
4	Industry	No	No	No
5	Government	No	No	No
6	Industry	No	No	No
7	Government	Yes	No	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	No	No	No
11	Industry	Yes	No	No
12	Other	No	No	No
13	Industry	No	No	No

C.2.12 Event Results Data

The event results category encompasses data formats for the capture, transfer, and analysis of the results of LVC events.

Table C-11: Event Results Data

Unique Id	What is your organization type?	Do you need : Event (e.g., testing, training, analysis, etc.) data results to use or produce to perform your mission?	Do you believe that Event (e.g., testing, training, analysis, etc.) data is one of the types of data urgently in need of common data storage formats/schemas/data models (standards)?	Do you believe that too many competing formats exist for Event (e.g., testing, training, analysis, etc.) data ?
1	Government	Yes	No	No
2	Government	No	No	No
3	Industry	Yes	No	No
4	Industry	Yes	Yes	No
5	Government	No	No	No
6	Industry	Yes	Yes	Yes
7	Government	Yes	Yes	No
8	Government	Yes	No	No
9	Government	Yes	Yes	No
10	Government	No	No	No
11	Industry	Yes	Yes	No
12	Other	Yes	No	No
13	Industry	Yes	No	No

C.2.13 Where Data Standardization Should Occur

Data storage formats can be categorized as producer (format used by the original data producer or collector), consumer (format that an LVC tool reads without conversion), or mediation (an intermediate format to which producer formats can be transformed and from which consumer formats can be transformed).

Table C-12: Data Standardization

Unique Id	What is your organization type?	Source Data Formats	Data Mediation Standards	Data Product Formats	Other	Specified Other Comments
1	Government	Yes	No	Yes	No	
2	Government	Yes	Yes	Yes	Yes	Standardizing formats is NEVER a "bad" thing.
3	Industry	Yes	No	No	No	
4	Industry	Yes	No	No	No	
5	Government	No	No	No	No	
6	Industry	Yes	No	Yes	No	
7	Government	Yes	Yes	Yes	No	
8	Government	Yes	No	Yes	Yes	Interface specifications
9	Government	Yes	Yes	Yes	No	
10	Government	Yes	No	Yes	No	
11	Industry	Yes	Yes	Yes	Yes	Semantic information objects
12	Other	No	No	No	No	
13	Industry	Yes	No	Yes	No	

C.2.14 Data Formats Used by Category

This question serves as input to determination of priorities for reducing the number of formats in a category.

Table C-13: Data Formats Used

Unique Id	What is your organization type?	Geospatial data	Manmade environmental features	Unit order of battle/force structure	Electronic order of battle/network	Platform/ weapons performance/ characteristics	Behavior	Logistics	Event (testing, training, analysis, etc.) results	Discovery metadata	Other (specify)
1	Government										
2	Government										Not sure about this.
3	Industry										
4	Industry		TIREM, DTED, OTF	LDIF					Wireshark trace files		
5	Government										
6	Industry	DTED,CTDB , OTH-G, DIS, RTI-S	CTDB	JSAF .rdr	JSAF .rdr	JSAF .rdr	Repast	none	SNN log	None yet	
7	Government										
8	Government										
9	Government	Unknown at this time. I would need to get with our developers to anwer these.	same	same	same	same	same	same	same	same	

Unique Id	What is your organization type?	Geospatial data	Manmade environmental features	Unit order of battle/force structure	Electronic order of battle/network	Platform/ weapons performance/ characteristics	Behavior	Logistics	Event (testing, training, analysis, etc.) results	Discovery metadata	Other (specify)
10	Government		Multispectual LIDAR source data, Openflight - 3D, COLLADA - Gamebased; OneSAF Terrain Format – Behavior Geospatical (DTED, GeoTIFF. CADRG)	CJMTK	CADRG	COTS	OneSAF format				
11	Industry	ESRI , Google kmz, own formats	Cad	MSDL; C-BML; Gov supplied formats, own formats	C-BML; Gov supplied formats, own formats	Gov supplied formats, own formats	Gov supplied formats, own formats	Gov supplied formats, own formats	Gov supplied formats, own formats		
12	Other										
13	Industry	DTED for terrain	We haven't yet decided on a 3D model format.			We use an internal data file for entity characteristics. We use SISO DIS enumerations for identification.			HDF5 for data recording and analysis		

C.2.15 Establishment of Data Storage Formats (Organization)

This question serves as input to determination of the mechanism or organization to be used for standardization.

Table C-14: Organizations Responsible for Data Standardization

Unique Id	What is your organization type?	Independent standards development organization (e.g., IEEE, ISO, SISO)	Industry consortia	Single vendor	Government	Other	Other Specific Comments
1	Government	No	No	No	Yes	Yes	Possibly new M&S catalogue
2	Government	Yes	Yes	No	Yes	No	
3	Industry	No	No	No	Yes	No	
4	Industry	Yes	Yes	No	Yes	No	
5	Government	No	No	No	No	No	
6	Industry	Yes	No	No	Yes	No	
7	Government	Yes	Yes	Yes	Yes	No	
8	Government	Yes	No	No	No	No	
9	Government	Yes	Yes	No	Yes	No	
10	Government	No	Yes	No	Yes	No	
11	Industry	Yes	No	No	No	Yes	Open standard formats - and not only for military purposes.
12	Other	Yes	No	No	No	No	
13	Industry	Yes	No	No	No	No	

APPENDIX D: COI COORDINATION MATRIX

Table D-1 is a listing, description, and cross-reference by data storage format category of all Global Information Grid (GIG) COIs with which to engage when pursuing improvements in each category. Mission descriptions were extracted verbatim from the DoD Metadata Registry except for correction of minor typographical errors.

Table D-1: GIG COI Coordination Cross-Reference Matrix

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Adaptive Planning and Execution (APEX)	Mission statement not present in DoD Metadata Registry.						X			
Air Force Flight Scheduling COI	To provide warfighters a net-centric solution for mission planning, execution, and review						X			
Air Force Readiness	The Air Force Readiness COI falls under the AF/A3/5 Operational Sub-Integrated Product Team (IPT) for Transparency. The COI is currently performing vocabulary development and authoritative data sourcing for Air Force Readiness systems. It is currently focusing on the DRS as a Pathfinder system for Transparency.			X						

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Air Operations	The purpose of the Air Operations COI is to ensure that the Air Operations data produced or consumed by Air Force systems are identified and exposed across the enterprise to all authorized users through the establishment of semantic metadata. This facilitates the development and awareness of Air Operations, and provides to the extent possible Air Operations information to users with unanticipated needs. Benefits to this approach include: enabling data transparency across the Air Operations domain, enable standard data-driven services for managers at all levels and reduce data entry, homegrown systems, and the need for record re-creation.						X			
Anti-Submarine Warfare (ASW) COI	To implement ASW Data Strategies and Open Architecture principles in support of DoD and Navy goals. The ASW COI has data responsibilities related to the Battlespace Awareness, Command & Control, Force Application and Force Protection Domains within the Warfighter Mission Area (WMA). COIs with associated interests include MASINT, METOC, Mine Warfare and Maritime Domain Awareness. Data sharing and interoperability with US Coast Guard and coalition forces are key components of effective ASW warfighting.					X	X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Blue Force Tracking	Develop and provide a BFT Information Exchange Standard that facilitates BFT across Joint and Allied/Coalition forces to effectively ensure that data is visible, accessible, trusted, understandable and in accordance with the DoD Net-Centric Data Strategy and Directive 8320.2.						X			
C2 Interoperability Group (CIG)	The mission of the C2 Interoperability Group is to increase interoperability of automated C2 information exchanges between US C2 systems as well as between C2 systems of US and coalition partners as it maintains the US-JC3IEDM in support of STANAG 5525. The CIG will interface with other interoperability groups to identify common technical issues and develop common solutions, when possible. The CIG will assist in coordinating the interoperability of US C2ISR at the strategic, operational and tactical levels. The CIG is charged with maintaining the US extensions to the JC3IEDM. The CIG will capture US requirements, and develop and maintain US extensions, a set of specifications, a common implementation, and other products in support of the US-JC3IEDM. Provide the US position on JC3IEDM changes and issues to the US delegation to Multilateral Interoperability (MIP).						X			
Chemical, Biological, Radiological, and Nuclear (CBRN)	Mission statement not present in DoD Metadata Registry.					X				

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Civil Military Information Exchange	This COI will serve to better facilitate communications and collaboration between the DoD and non-government organizations, International Organizations (IO), interagency partners, private volunteer organizations (PVO) during complex humanitarian emergencies such as Humanitarian Assistance (HA), Disaster Relief (DR), and Stabilization and Reconstructions (S&R).						X			
Coalition C2 Interoperability	The aim of the Coalition C2 is to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to the lowest appropriate level, in order to support multinational, combined and joint operations and the advancement of digitization in the international arena, including NATO. The Army wants to comprehensively manage the development and growth of Coalition C2 Interoperability efforts.						X			
Command and Control Space Situational Awareness	To ensure Space Situational Awareness (SSA) data and information required to monitor, assess, plan, and execute the operational and tactical commander's intent in a net-centric environment is visible, accessible, and understandable						X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Common Sensor	To serve as the focal point for Common Sensor Processing, Exploitation, and Dissemination (PED) Development; National Signatures Program; Common Sensor PED Customer Outreach; Common Sensor Metadata, Product Standards, and Portal; Common Sensor policy; Common Sensor related issues pertaining to Electro-Optical, Radar, CBRNE, Radio-Frequency, Seismic, Acoustic, Magnetic, Infrasonic, Laser, Synthetic Aperture Radar (SAR), Spectral, Thermal, Biometrics; Common Sensor Testing and Evaluation				X	X				
Computer Network Defense	The primary objective of the Computer Network Defense Community of Interest is to provide a collaborative environment where persons with a CND mission can contribute to the development of the vocabulary and rules for how CND data assets will be identified, organized, and shared. The data assets will be retrieved primarily from the Enterprise Sensor Grid and will support the User Defined Operational Picture (UDOP).				X					
Defense Logistics Management System (DLMS) Data Management COI	Consistently manage data quality issues, configuration management concerns, and technical issues related to the implementation of DLMS Data Elements and Information Exchanges as defined by DoD 4000.25-M.								X	

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Defense Critical Infrastructure Program (DCIP)	The DCIP is a DoD risk management program that seeks to ensure availability of Defense Critical Infrastructure or those DoD and non-DoD assets essential to planning, mobilizing, deploying, executing, and sustaining US military operations worldwide. Activities include the identification, assessment, and security enhancement of assets essential for executing the National Military Strategy.	X								
Defense Installation Spatial Data Infrastructure (DISDI)	The DISDI is the geospatial oversight program responsible for leveraging spatial information across Installation and Environment (I&E) business mission areas to better manage global installations and bases.	X								
Distribution Data COI	The mission of the Distribution Data COI is to collaboratively develop and maintain a data strategy for improving data and information sharing in a distribution net-centric environment across the Joint Deployment and Distribution Environment using a shared vocabulary for exchanging information in the pursuit of shared goals, interests, missions, business processes, and data interoperability.								X	
Focused Logistics	Mission statement not present in DoD Metadata Registry.								X	
Force Projection	Develop the relationships, governance, and connectivity to create a responsive knowledge-based process that enables decision-makers at all levels the ability to make timely, accurate global force projection decisions via a services-oriented architecture						X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
GEOINT Standards COI (GWG COI)	The GWG supports the ITSC in the configuration management of GEOINT standards within the DISR. Additionally, the GWG provides a standards-focused forum that the NSG community can use as a means to exchange and communicate issues regarding GEOINT standards requirements, development, implementation, and conformance. The GWG recommends GEOINT standards for data, systems, and their interfaces to ensure interoperability with DoD and non-DoD systems. The GWG serves as a community-based forum to advocate for IT standardization activities related to GEOINT. In this capacity, the GWG supports the Director of NGA in carrying out GEOINT functional manager responsibilities for standards. The GWG performs two major roles: 1. as a technical working group of the ITSC, with all the responsibilities of an ITSC member and, 2. as a coordinating body for the GEOINT community to address all aspects of GEOINT standards. Through the GWG, community consensus is formed to advance GEOINT standards that enable interoperability, meeting the requirements of community members. The GWG provides a standards-focused forum that will: • Exchange information and discuss issues • Propose DoD and IC positions • Identify emerging standards and provide advice on the need to develop new standards; coordinate the	X	X							

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	development of new standards or specifications when appropriate • Serve as the subject matter expert within the DoD and the IC for GEOINT standards matters									
Global Force Management	GFM is a process that enables insight into global availability of US forces, and provides a means to assess risks associated with proposed allocation, assignment and apportionment. GFM data will be transparent, universal and accessible on demand in a net centric environment. Global Force Management requires the implementation of a common force structure, for which there are three key elements. 1. A joint hierarchical way to organize force structure data for integration across Service-lines, known as the Force Structure Construct. 2. Force structure data that is rigorously specified via a GFM Information Exchange Data Model and its semantics unambiguously defined so that sophisticated computer programs can economically exploit it via the net-centric data strategy. 3. A common naming convention and data tagging technology, known as Enterprise Wide Identifiers, that must be accepted and used across DoD including adoption by future Joint systems such as Defense Readiness Reporting System (DRRS), Defense Integrated Military Human Resources System (DIMHRS), and Blue Force			X						

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	Tracker], with the capability of being extended through interagency and coalition boundaries. In support of these goals the GFM-COI marshals the collective expertise of force management data users from Joint Staff, the four Services plus the USCG, DoD agencies OSD (P&R), OSD (PA&E), ASD NII, ASD HA, as well as the functional Combatant Commanders (COCOMs).									
Improvised Explosive Device (IED) Defeat Significant Activity (SIGACT) COI	Establish and execute a SIGACT information sharing solution that is quickly institutionalized across DoD and the IC for IED relevant data that provides decision makers the ability quickly learn from experience, to predict future events and alert warfighters enabling IED defeat						X			
Information Operations	Establish and execute a SIGACT information sharing solution that is quickly institutionalized across DoD and the IC for IED relevant data that provides decision makers the ability quickly learn from experience, to predict future events and alert warfighters enabling IED defeat				X					
Installation Management	Provide, operate, and sustain, in a cost-effective and environmentally sound manner, the installation assets and services necessary to support our military forces in both peace and war.	X	X							

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Joint Service Explosive Ordnance (EOD) Disposal	The mission of Explosive Ordnance Disposal (EOD) in all the Military Services is to support the national security strategy during operations in war and in Operations Other Than War, by reducing or eliminating explosive hazards that threaten personnel, operations, installations, or materiel.					X	X			
Joint Air	Develop the collaborative environment of users, data sources, and services that supports exposure of air track data.						X			
Joint Air and Missile Defense (AMD)	Develop a common vocabulary, based on required capabilities and associated functions, for defining Joint AMD-specific data that must be shared among Joint, Interagency and Multinational (JIM) AMD platforms in the execution of the AMD mission, as well as the data required to support future AMD capabilities. Provide a resource to the Air Defense and Missile Defense Namespace Managers to ensure that AMD-specific metadata stored in those Namespace repositories are consistent with the common AMD vocabulary and harmonized with associated metadata from within their respective Namespaces as well as other associated COIs' supporting Namespaces within the DoD Registry. Enable the discovery, posting, and subscription to Air and Missile Defense-specific data by all organizations associated with the DoD in accordance with the DoD Network Centric Data Strategy.						X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Joint Airborne Networking-Tactical Edge	Develop interoperable joint message, protocol standards and schema frameworks for emerging tactical edge networks tactical data exchange. Example networks include, but are not limited to, Tactical Targeting Network Technology (TTNT), Multifunction Advance Data Link (MADL), and Intra-Flight Data Link (IFDL). The COI's goal is development of interoperable message sets for employment across applicable JAN-TE links as well as "gateway" documentation necessary to ensure interoperability with advanced networks (e.g., Common Data Links (CDLs) and legacy data links (e.g., Link 11, Link 16, Link 22, VMF, IBS).				X					
Joint Strike Fighter (JSF) Munitions/ Ordnance Data	This COI will facilitate the identification, definition, development, coordination, control, and verification & test assessment of munitions related data interfaces between the JSF Autonomic Logistics Information Management (ALIS) system and applicable government information management systems, in accordance with the Information Exchange Requirements (IERs) defined in the Joint Strike Fighter Contract Specification (JCS). This COI will function as a forum by which SMEs from all tiers of the JSF development organization and JSF user stakeholders address and resolve issues associated with interface coordination, requirements, development, baselining, and change request management. Additionally this COI will facilitate the verification activities of the operational					X				

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	suitability of these interfaces within the bounds of the JSF System Development and Demonstration (SDD) contract. It is beyond the scope of this COI to debate the relative merits of the JCS requirements. If a Service has concerns with the JCS requirements and/or Performance-Based Logistics (PBL) concepts of the JSF program they need to be expressed to the JPO outside the forum of this COI. This COI is responsible for developing and verifying the ALIS munitions data interfaces that will include Service sponsored development of their capabilities related to the interface. Eventual testing of the interfaces will require Service supported verification activities. Service COI members are responsible to facilitate tasking of and funding for this development and verification activity from within their organizations									
Joint Strike Fighter (JSF) Unit Readiness	This COI will facilitate the identification, definition, development, coordination, control, and verification & test assessment of unit readiness and end item inventory status reporting related data interfaces between the JSF ALIS system and applicable government information management systems, in accordance with the IERs defined in the Joint Strike Fighter Contract Specification. This COI will function as a forum by which SMEs from all tiers of the JSF development organization and JSF user stakeholders address and resolve issues associated with interface coordination, requirements, development,								X	

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	baselining, and change request management. Additionally this COI will facilitate the verification activities of the operational suitability of these interfaces within the bounds of the JSF SDD contract. It is beyond the scope of this COI to debate the relative merits of the JCS requirements. If a Service has concerns with the JCS requirements and/or PBL concepts of the JSF program they need to be expressed to the JPO outside the forum of this COI. This COI is responsible for developing and verifying the ALIS unit readiness and end item inventory reporting data interfaces that will include Service sponsored development of their capabilities related to the interface. Eventual testing of the interfaces will require Service supported verification activities. Service COI members are responsible to facilitate tasking of and funding for this development and verification activity from within their organizations.									
Joint Strike Fighter (JSF) Air Vehicle Status	This COI will facilitate the identification, definition, development, coordination, and verification of maintenance status related data interfaces between the JSF ALIS system and applicable government information management systems, in accordance with the IERs defined in the Joint Strike Fighter Contract Specification. This COI will function as a forum by which SMEs from all tiers of the JSF development organization and JSF user stakeholders address issues associated with interface								X	

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	coordination, requirements and development. Additionally this COI will facilitate the verification activities of the operational suitability of these interfaces within the bounds of the JSF SDD contract. It is beyond the scope of this COI to debate the relative merits of the JCS requirements. If a Service has concerns with the JCS requirements and/or PBL concepts of the JSF program they need to be expressed to the JPO outside the forum of this COI. This COI is responsible for developing and verifying the ALIS maintenance status data interfaces which will include Service sponsored development of their capabilities related to the interface. Eventual testing of the interfaces will require Service supported verification activities. Service COI members are responsible to facilitate tasking of and funding for this development and verification activity from within their organizations.									
Joint Strike Fighter (JSF) Transportation COI	This COI will facilitate the identification, definition, development, coordination, control, and verification & test assessment of Transportation and consignment tracking status reporting related data interfaces between the JSF ALIS system and applicable government information management systems, in accordance with IERs defined in the Joint Strike Fighter Contract Specification. This COI will function as a forum by which SMEs from all tiers of the JSF development organization and JSF user stakeholders address and resolve issues associated with								X	

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	interface coordination, requirements, development, baselining, and change request management. Additionally this COI will facilitate the verification activities of the operational suitability of these interfaces within the bounds of the JSF SDD contract. It is beyond the scope of this COI to debate the relative merits of the JCS requirements. If a Service has concerns with the JCS requirements and/or PBL concepts of the JSF program they need to be expressed to the JPO outside the forum of this COI. This COI is responsible for developing and verifying the ALIS unit readiness and end item inventory reporting data interfaces that will include Service sponsored development of their capabilities related to the interface. Eventual testing of the interfaces will require Service supported verification activities. Service COI members are responsible to facilitate tasking of and funding for this development and verification activity from within their organizations.									

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Joint Targeting Intelligence	Joint targeting intelligence to support deliberate planning and ultimately execution. COI Products: Targeting tables in MIDB, Joint Targeting Database (JTDB), Joint Target Materials Program, Joint Targeting Toolbox (JTT), Military Targeting Committee (MTC), Joint Targeting Automation Steering Group (JTASG), Targeting Issues Working Group (TIWG), Combat Assessment Working Group (CAWG), Defense Intelligence Agency Instruction (DIAI) 57-24, Schema sets for target folders, target lists etc.						X			
Joint Task Force (JTF) Command and Control	The JTF C2 COI will provide an authoritative resource to Joint Task Force commanders, staffs and components to support enhanced information sharing, planning, and decision support. The JTF C2 COI will coordinate with JTF C2-related COIs to promote data interoperability and visibility, understandability, and accessibility of authoritative data. The JTF C2 COI will develop and support a common data vocabulary based on required capabilities and associated JTF C2 functions across the JTF Headquarters (HQ) and components in accordance with the DoD Net-Centric Data Strategy.						X			
Logistics Community of Interest (Log COI)	Implements overarching direction supporting DoD, AF and AF A4/7 information strategies and visions to ensure all logistics data is visible, accessible, timely, discoverable, reliable and available.								X	

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Logistics Data Integration	The emerging community of interest for logistics data integration. Provides common logistics data, business standards and information between DoD logistics systems. Promotes consistent and accurate information. Provides DoD-wide logistics supply and transportation data that is visible, available, and useable for searching, sorting, and reporting.								X	
Maritime Domain Awareness (MDA)	MDA COI is a new initiative to standardize data for Maritime Domain Awareness. It is composed of a steering committee and four working groups.						X			
Messages - Tactical Data Enterprise Services	To facilitate the configuration management of US bit-oriented messaging data and standards.						X			
Meteorology-Oceanography	Improve the interoperability, standardization and usage of METOC data, products and value-added net-centric services for the Joint Warfighter. * Provide a dynamic, authoritative, collaborative forum for establishment of DoD standards associated with Joint METOC information and services. * Improve joint usage and availability of meteorological, oceanographic, and space environmental architectures. * Define standards for METOC data, algorithms and model applications, and associated METOC interfaces to the GIG. * Manage the METOC XML Namespace within the MDR and de-conflict XML components across the other community namespaces. * Identify and develop METOC COI-specific services that	X								

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	embody CES tenants. * Provide one authoritative venue for the standardization of Joint METOC data, products and services. COI Product: The Joint METOC Conceptual Data Model is the foundation for METOC information, implemented through the JMBL interface as the single, web-enabled request and response mechanism.									
Mine Warfare	Provides a location for creation and sharing of data to be used in the Mine Warfare arena					X				
Modeling and Simulation Community of Interest	The mission of the M&S COI is to make M&S data and services visible to the GIG user community, integrate M&S services into the GIG, and provide a forum for the M&S community to work within the COI to influence, advise, and educate the more global community with regard to M&S. Like other COIs, M&S will manage its Metadata registry, establish taxonomies and ontologies to enable discovery and retrieval services, and conduct prototype experiments or demonstration exploring the most appropriate services to enable GIG users in the key tasks of planning, training, sense-making and decision making. The M&S COI will promote Service and Joint collaboration in the use of emerging technology to adapt services for the GIG and recommend standards and architectures that will best support M&S as and Enterprise Service. Coordination across other COIs will be critical as M&S has roles that span several domains. The final shape of M&S services will depend upon the design and execution of near-term proof of principle demonstrations.	X	X	X	X	X	X	X	X	X

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
NetOps COI	To operationalize the Global Information Grid through network management, network defense, and content management. The NetOps COI focuses on enabling assured and timely net-centric services across strategic, operational and tactical boundaries in support of DoD's full spectrum of warfighting, intelligence, business, and enterprise infrastructure missions.				X					
Overhead Non Imaging Infrared COI	Begin definitions for ONIR information/management structure for data generation, dissemination, discovery	X								
Strike COI	The purpose of the Strike COI is to enable all authorized users to discover, access and collaborate on the data necessary to conduct time sensitive strikes.						X			
Supply Management	Facilitate continuous enterprise integration process improvements to logistics management and operations.								X	
Symbology	To develop and maintain Joint Warfighting Symbology MIL-STD-2525, for interoperability among C2 systems.	X								
Tasker Integration Service COI	The mission of the Task Management COI is to collaboratively develop and employ a strategy for exchanging data in a net-centric environment across the DoD using a shared vocabulary in the pursuit of shared goals, interests, missions, business processes, and data interoperability. Objectives: The COI will collaboratively identify the guiding principles, rationales, and implications for improving data interoperability in a net-centric environment to attain the following objectives: a) Identify capabilities that need to be enabled to support interoperable						X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
	tasking between Commander-in-Chief (CINC)/Service/Agency Groups(C/S/As), increase situational awareness with respect to taskings, and to improve the timeliness of taskings. b) Build and maintain a vocabulary through which task management data can be meaningfully exchanged and understood by members of the DoD task management community. This vocabulary shall take the form of an XML Schema(s). c) Build and maintain an interface(s) that can be implemented to enable capabilities defined in (a). This interface(s) shall take the form of a Web Services Description Language (WSDL(s)). d) Review DoD and Industry standards and adopt those deemed to be relevant to the vocabulary and capabilities.									
Time Sensitive Targeting (TST) Community of Interest	The TST COI will provide an authoritative resource to the Joint Warfighter's targeting community that ensures specific TST metadata is stored in the appropriate Namespace repository and is consistent with common targeting definitions from associated COIs. The Joint Pilot TST COI will ensure authoritative data is visible, understandable, and accessible in order to develop and support a common data vocabulary based on required capabilities and associated functions for defining targeting-specific data that must be shared among platforms in the execution of a TST mission in accordance with the DoD Net-Centric Data Strategy.						X			

Table D-1: GIG COI Coordination Cross-Reference Matrix (continued)

COI	Mission (verbatim from the DoD Metadata Registry)	Geospatial	Manmade Features	UOB	EOB	Platform/ Weapon C&P	Plans/ scenarios	Behavior	Logistics	Event Results
Undersea Warfare XML (USW-XML)	Create/assemble a common XML vocabulary to facilitate the establishment of coherent battlespace visualization capabilities for network-centric undersea warfare.						X			
United States Message Text Format	To facilitate the configuration management of US character-based messaging data.						X			
Weapon Systems Life Cycle Management (WSLM)	In support of WSLM Governance establish common schemas for WSLM activities and processes.								X	

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APPENDIX E: NAMESPACE COORDINATION MATRIX

This appendix is an assessment of the applicability of existing DoD Metadata Registry namespace contents with respect to data categories. These namespaces should be examined for reuse when endeavoring to establish new schemas in one of the data categories, including determining the future plans of those who populated these namespaces.

Namespace	Schemas	Geospatial	Manmade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
Adaptive Planning Deployment and Distribution Visibility (AP-DDV)	10						X		X	
Aerospace Operations (AOP)	69						X			
Air Battle Plan (ABP)	8						X			
Air Force Modeling and Simulation Training Toolkit (AFMSTT)	18						X			
Air Operations (AO) COI	11						X			
AirDefense (AD)	70				X		X			
Army Battle Command Systems (ABCS)	33				X					
Blue Force Tracking (BFT)	7				X					
Chemical Biological Radiological and Nuclear Defense (CBRN)	70	X	X	X		X	X			
Coalition (COAL)	103						X			
Combat Support (CSS)	3								X	
Command and Control (C2)	7						X			

Namespace	Schemas	Geospatial	Manmade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
Command and Control Space Situational Awareness (C2 SSA)	314						X			
Common Route Definition (CRD)	7					X	X			
Defense Readiness Reporting System (DRRS)	12			X			X			
Department of Navy Command, Control Communication (DoNC3)	2				X		X			
Department of Navy Information Warfare (DoNINWAR)	19				X					
Department of Navy Intelligence & Cryptology (DONINTEL)	6					X				
Department of Navy Logistics (DONLOG)	61								X	
Department of Navy Meterology & Oceanography (DONMETOC)	2	X								
Department of Navy Readiness (DONRED)	31			X			X			
Developers Resources (DEV)	106				X					
DLA Shared Data Services (DSDS)	8								X	
Force Projection (FP)	5						X			
Frequency Management Sub-Committee (FMSC)	15					X				
Friendly Order of Battle (FROB)	8			X						
GEM - Global Event Management (GEM)	22						X			
General Military Intelligence (GMI)	18									

Namespace	Schemas	Geospatial	Mannmade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
GEOINT Structure Implementation Profile (GSIP)	112	X								
Geospatial Intelligence (GEOINT)	10	X								
Geospatial Processing Services Spatial (GPSP)	16	X								
Geospatial Publicly Available Specifications (GPAS)	146	X								
Global Combat Support System - Marine Corps (GCSS-MC)	3						X			
Global Force Management (GFM)	19			X						
Global Force Management Data Initiative (GFMDI)	12			X						
Global Force Management Information Exchange Data Model (GFMXSD)	16			X						
Ground Operations (GOP)	51						X			
Improvised Explosive Device (IED)	1					X				
Information Assurance Computer Network Defense (IA/CND)	27				X					
Information Operations (IO)	27				X					
Intelligence (INT)	208				X		X			
Intended Route of Flight (IROF)	1						X			
Joint Air and Missile Defense (JAMD)	51					X	X			
Joint Force Management (JFM)	4						X			

Namespace	Schemas	Geospatial	Mammade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
Joint Organization Server Global Force Management Data Initiative (JOSGFMDI)	6			X						
Joint Targeting Intelligence (JTI)	39						X			
JointThreat Intelligence Database (JTID)	1				X					
Logistics (LOG)	13								X	
Management Interchange (MGTINTCG)	160								X	
Maritime Domain Awareness (MDADSCOI)	12						X			
MD Planning Operations (MDPLAN)	9						X			
Message Text Format Working Group (MTFWG)	1088						X			
Meteorological and Oceanographic (METOC)	196	X								
Mission Planning Ops (MPO)	1					X				
Modeling and Simulation (MLSM)	20	X								
Multi-Sensor (MS)	14					X				
NECC Adaptive Planning (NECC-AP)	678			X		X				
Net-Enabled Command Capability (NECC) C2 Information Exchange Data Model (C2IEDM) (NEC2IEDM)	70			X		X				
Net-Enabled Command Capability C2 Services (NECC-C2)	58	X				X				

Namespace	Schemas	Geospatial	Mannmade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
Network Operations (NetOps)	272				X					
Network Operations - Tactical (NetOpsT)	4				X					
Network Warfare Systems (NETWARS)	2				X					
Operation Net Assesment (ONA)	1							X		
Psychological Operations Planning (PSYOPPl)	6						X	X		
Security Equipment Integration Working Group (SEIWG)	10						X			
Space Command and Control (Space C2)	2					X				
Space Control (SPC)	64						X			
Standard Spectrum Resource Format (SSRF)	19					X				
Strategic Knowledge Integration WEB (SKIWEB)	5						X			
Supply (SUP)	33								X	
Symbology (SYM)	11	X					X			
Targeting (Tgts)	13					X				
Tasked Target Text Data (T3D)	1					X				
Theater Battle Management Core Systems (TBMCS)	7					X				
Tracks and Reports (TAR)	17					X				

Namespace	Schemas	Geospatial	Mammade Features	UOB	EOB	Plaform/Weapon C&P	Plans/Scenarios	Behavior	Logistics	Event Results
Transportation (TRP)	9								X	
United States Army Global Force Management Data Initiative (USAGFMDI)	9			X						
United States Marine Corps Global Force Management Data Initiative (MCGFMDI)	9			X						
Universal Core (UCore)	15	X	X	X	X	X	X	X	X	X
Weapon Systems (WPN)	1					X				
WebSked Distributed Services (WDS)	8						X			

APPENDIX F: ANALYSIS OF NEED AND DIFFICULTY

Table F-1 provides the metrics used to calculate the need and difficulty measures reported in Section 3.2.

Table F-1: Detailed Need and Difficulty Calculation

	Geospatial data	Manmade environmental features	Unit order of battle/force structure	EOB/ Network	Platform/ weapons performance and/or characteristics	Plans/ scenarios	Behavior	Logistics	Event results
Total Formats (Total/Active)	93 / 80	20 / 17	14 / 10	13 / 10	15 / 11	22 / 20	11 / 10	9 / 8	14 / 13
Number of mediation formats	20+	8	10	8	1	9	0	4	0
Complexity	Very complex	Complex	Moderate	Simple	Very Complex	Complex	Very complex	Complex	Unknown
Relative Technical Complexity	3	2	1	2	3	2	2	1	1
	High	Medium	Low	Medium	High	Medium	Medium	Low	Low
Number of standards organizations	11	8	9	13	2	12	3	7	0
Political conflict	Substantial	Little	Substantial	Little	Little	Moderate	Substantial	Non evident	None
Maturity	Productized/ Mature	Productized/ Mature	Moderate	Moderate	Moderate	Moderate	Immature - single simulation standards	Mature	Conceptual
Number of subcategories	8	5	4	4	0	4	0	4	3
Number of related COIs	8	3	4	5	8	4	1		2

	Geospatial data	Manmade environmental features	Unit order of battle/force structure	EOB/ Network	Platform/ weapons performance and/or characteristics	Plans/ scenarios	Behavior	Logistics	Event results
Organizational/ coordination complexity	3	1	2	2		2	3	2	2
	High	Low	Medium	Medium	Medium	Medium	High	Medium	Medium
Combined Difficulty	6	3	3	4	5	4	5	3	3
Normalized Difficulty	4	1	1	2	3	2	3	1	1
Need for Mission	69.2%	69.2%	53.8%	53.8%	61.5%	69.2%	61.5%	46.2%	76.9%
Urgency	53.8%	61.5%	46.2%	30.8%	38.5%	30.8%	30.8%	23.1%	38.5%
Average Need	61.5%	65.4%	50.0%	42.3%	50.0%	50.0%	46.2%	34.7%	57.7%
Normalized Difficulty	4	1	1	2	3	2	3	1	1
Average Need	61.5%	65.4%	50.0%	42.3%	50.0%	50.0%	46.2%	34.7%	57.7%

Figure F-1 provides the numeric values used to produce the summary recommendations illustrated in Figure 3-3. It is based on the data in the last two rows of Table F-1.

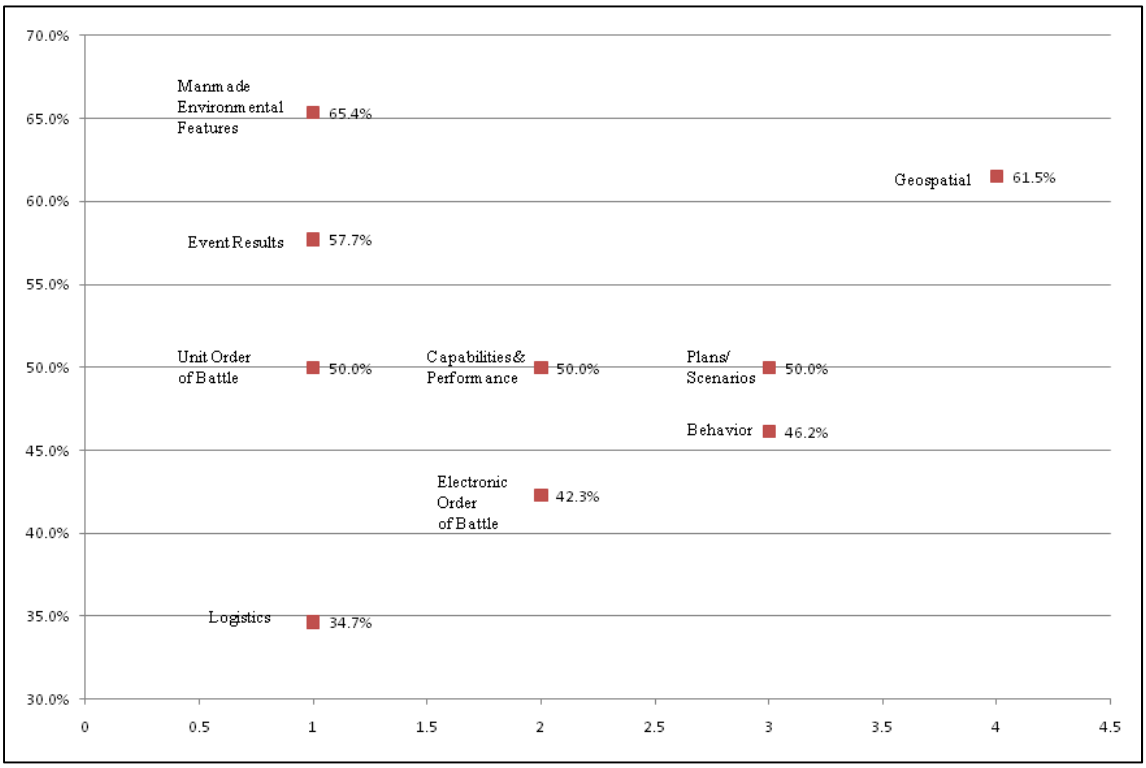

Figure F-1: Needs and Difficulty Plot

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APPENDIX G: ABBREVIATIONS AND ACRONYMS

2D	Two Dimensional
3D	Three Dimensional
3DM	Three Dimensional Model
AAR	After Action Review
ABCS	Army Battle Command Systems
ABP	Air Battle Plan
AGC	Army Geospatial Center
ACTM	Aircraft Collection Tasking Message
ACT-R	Adaptive Control of Thought-Rational
AD	Air Defense
ADRG	ARC Digitized Raster Graphic
ADS	Authoritative Data Source
AF	Air Force
AFAMS	Air Force Agency for Modeling and Simulation
AFATDS	Advanced Field Artillery Tactical Data System
AFMC	Air Force Materiel Command
AFMSTT	Air Force Modeling and Simulation Training Toolkit
AI	Artificial Intelligence
ALIS	Automatic Logistics Information Management System
ALP	Advanced Logistics Program
AMCOM	Aviation and Missile Command (US Army)
AMD	Air and Missile Defense
AMMDB	Army MARC Maintenance Data Base
AMSAA	Army Materiel Systems Analysis Activity
AMSO	Army Modeling and Simulation Office
ANSI	American National Standards Institute
AO	Air Operations
AOP	Aerospace Operations
AP-DDV	Adaptive Planning Deployment and Distribution Visibility
APEX	Adaptive Planning and Execution
ARC	Arc second Raster Chart
ASD(HA)	Assistant Secretary of Defense (Health Affairs)
ASD(NII)	Assistant Secretary of Defense (Networks and Information Integration)
ASPRS	American Society for Photogrammetry and Remote Sensing
ASSIST	Acquisition Streamlining and Standardization Information System
ASW	Anti-Submarine Warfare
ATEC	Army Test And Evaluation Command
AWARS	Advanced Warfighting Simulation
AWSIM	Air Warfare Simulation
BDFs	Behavior Definition Frames
BFT	Blue Force Tracking
BLM	Bureau of Land Management

BML	Battle Management Language
BOREAS	Boreal Ecosystem-Atmosphere Study
BTRA	Battlespace Terrain and Reasoning Awareness
BUFR	Binary Universal Form for the Representation of Meteorological Data
C&P	Characteristics and Performance
C/S/A	CINC/Service/Agency Group
C2	Command and Control
C2 SSA	Command and Control Space Situational Awareness
C2IEDM	Command and Control Information Exchange Data Model
C2IS	Command and Control Information Systems
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance
CAA	Center for Army Analysis
CACI	Consolidated Analysis Center, Incorporated
CAD	Computer-aided Design
CADRG	Compressed ARC Digitized Raster Graphic
CAE	Canadian Aviation Electronics
CAGE	Commercial and Government Entity
CAM	Computer-aided Manufacturing
CASTFOREM	Combined Arms and Support Task Force Evaluation Model
CAWG	Combat Assessment Working Group
C-BML	Coalition Battle Management Language
CBRN	Chemical, Biological, Radiological, and Nuclear
CDB	Common Database
CDED	Canadian Digital Elevation Data
CDL	Common Data Link
CDSF	Common Data Storage Format
CES	Communications Effects Server
CGF	Computer Generated Forces
CHRIS	Common Human Behavior Representation and Interchange System
CIG	C2 Interoperability Group
CIO	Chief Information Officer
CINC	Commander in Chief
CLDM	Corporate Logistic Data Model
CM2	Common Moving Models
CMIE	Civil Military Information Exchange
CND	Computer Network Defense
COAL 2	Coalition C2
COCOM	Combantant Commander
COI	Community of Interest
COLLADA	COLLAborative Design Activity
COP	Common Operating Picture
COSAGE	Combat Sample Generator

COTS	Commercial-Off-The-Shelf
Cougaar	Cognitive Agent Architecture
CRD	Common Route Definition
CREX	Character form for the Representation and EXchange of data
CSAT	Configuration Static Analysis Tool
CSS	Combat Support Services
CTC OIS	Combat Training Center Objective Instrumentation System
CTDB	Compact Terrain Database
CTIA	Common Training Instrumentation Architecture
CTTSO	Combating Terrorism Technical Support Office
CSV	Comma Separated Variable
DAFIF	Digital Aeronautical Flight Information File
DAML	DARPA Agent Markup Language
DARPA	Defense Advanced Research Projects Agency
DCIP	Defense Critical Infrastructure Program
DDCP	Distributed Debrief Control Protocol
DDMS	DoD Discovery Metadata Specification
DDRS	Defense Readiness Reporting System
DEM	Digital Elevation Model
DEV	Developers Resources
DFAD	Digital Feature Analysis Data
DFDD	DGIWG Feature Data Dictionary
DGIWG	Digital Geographic Information Working Group
DHS	Department of Homeland Security
DIA	Defense Intelligence Agency
DIAI	DIA Instruction
DIF	Data Interchange Format
DIGEST	Digital Geographic Information Exhange Standard
DIMAP	Dictionary Maintenance Programs
DIMHRS	Defense Integrated Military Human Resources System
DIS	Distributed Interactive Simulation
DISA	Defense Information Systems Agency
DISDI	Defense Installation Spatial Data Infrastructure
DISR	DoD Information Technology Standards and Profile Registry
DLA	Defense Logistics Agency
DLG	Digital Line Graph
DLGe	Digital Line Graph - Enhanced
DLMS	Defense Logistics Management System
DMA	Defense Mapping Agency
DMSO	Defense Modeling and Simulation Office
DMT	Distributed Mission Training
DoD	Department of Defense
DoDIIS	DoD Intelligence Information System
DoJ	Department of Justice
DoNC3	Department of Navy Command, Control, Communication

DoNINTEL	Department of Navy Intelligence & Cryptology
DoNINWAR	Department of Navy Information Warfare
DONLOG	Department of Navy Logistics
DONMETOC	Department of Navy Meterology & Oceanography
DONRED	Department of Navy Readiness
DPPDB	Digital Point Positioning Database
DR	Disaster Relief
DRG	Digital Raster Graphics
DRM	Data Representation Model
DRRS	Defense Readiness Reporting System
DRS	Deployment Readiness System
DSDS	DLA Shared Data Services
DSEEP	Distributed Simulation Engineering and Execution Process
DTED	Digital Terrain Elevation Data
DTRA	Defense Threat Reduction Agency
DVED	Database Virtual Environment Development
DVTE	Deployable Virtual Training Environment
DWG	AutoCAD drawing format
DXF	Desk Exchange Format
EADSIM	Extended Air Defense Simulation
ECRG	Enhanced Compressed Raster Graphic
ECW	Enhanced Compression Wavelet
EDCS	Environmental Data Coding Specification
EDCSS	Environmental Data Cube Support System
EDM	Environmental Data Model
ENVI	Environment for Visualizing Images
EOB	Electronic Order of Battle
EOD	Explosive Ordnance Disposal
EPG	Electronic Proving Ground
ERF	Entity Resolution Federation
ESG	Enterprise Sensor Grid
ESRI	Environmental Systems Research Institute
EWIDS	Enterprise Wide Identifiers
EXHORT	EXtensive Hierarchy and Object Representation for Transportation
FACC	Feature and Attribute Coding Catalog
FBX	(Autodesk) FilmBox format
FCS	Future Combat Systems
FDR	Five Dimensional Representation
FEDLOG	Federal Logistics Information System
FGDC	Federal Geographic Data Committee
FMSC	Frequency Management Sub-Committee
FP	Force Protection
FPLAN	Force Plan file
FPLN	Force Plan file

FROB	Friendly Order of Battle
FSC	Force Structure Construct
GCCS-MC	Global Combat Support System – Marine Corps
GDB	(MÄK) Geospatial Database
GEM	Global Event Management
GEOINT	Geospatial Intelligence
GFM	Global Force Management
GFMDI	Global Force Management Data Initiative
GFMXSD	Global Force Management Data Information Exchange Model
GIG	Global Information Grid
GIS	Geographic Information System
GMI	General Military Intelligence
GML	Geography Markup Language
GOP	Ground Operations
GOTS	Government Off-the-Shelf
GPAS	Geospatial Publicly Available Specifications
GPSP	Geospatial Processing Services Spatial
GRIB	Gridded Binary
GSIP	GEOINT Structure Implementation Profile
GTDS	Global Topographic Data Store
GWG	Geospatial Intelligence Standards Working Group
HA	Humanitarian Assistance
HFA	Hierarchical File Format
HIFLD	Homeland Infrastructure Feature Level Database
HITS	Homestation Instrumentation Training System
HLA	High Level Architecture
HQ	Headquarters
HRE	High Resolution Elevation
HSCB	Human, Social, Cultural, Behavioral
I&E	Installation and Environment
I&S	Interchangeability and Substitutability
I/ITSEC	Interservice/Industry Training, Simulation, and Education Conference
IA/CND	Information Assurance/Computer Network Defense
IBML	Integrated Battle Management Language
IBS	Integrated Broadcast Service
IC	Intelligence Community
ICD	Interface Control Document
IEC	International Electrotechnical Commission
IED	Improvised Explosive Device
IER	Information Exchange Requirement
IFC STEP	Industry Foundation Classes (IFC) Standard for the Exchange of Product model data (STEP)
IFDL	Intra-Flight Data Link

IGS	Integrated Gaming System
IHB	International Hydrographic Bureau
IHO	International Hydrographic Organization
IM	Installation Management
IMINT	Imagery Intelligence
INT	Intelligence
IO	Information Operations
IP	Internet Protocol
IPT	Integrated Product Team
IRIG	Inter-Range Instrumentation Group
IROF	Intended Route of Flight
IS	Instrumentation System
ISO	International Organization for Standardization
ISR	Intelligence, Surveillance, and Reconnaissance
IT	Information Technology
ITEF	Internet Engineering Task Force
ITEMS	Interactive Tactical Environment Management System
ITSC	Information Technology Standards Committee
ITT	International Telephone & Telegraph
IVE	OpenSceneGraph native binary format
J3CIEDM	Joint Consultation, Command, and Control Information Exchange Model
JAAR	Joint AAR
JAMD	Joint Air and Missile Defense
JAN-TE	Joint Airborne Networking-Tactical Edge
JANUS	Not an acronym. Sometimes rendered as “Joint Army Navy Uniform Simulation”, but that is apocryphal. “Janus” is actually the name for the two-headed Roman God of War.
JAT	Joint Air Track
JCATS	Joint Conflict and Tactical Simulation
JCS	Joint Chiefs of Staff
JCS	Joint Strike Fighter Contract Specification
JDCARS	Joint Digital Collection, Analysis, and Review System
JDDE	Joint Deployment and Distribution Environment
JFCOM	Joint Forces Command
JFM	Joint Force Management
JHU/APL	The Johns Hopkins University Applied Physics Laboratory
JICM	Joint Integrated Campaign Model
JIM	Joint, Interagency, and Multi-national
JLCCTC	Joint Land Component Constructive Training Capability
JLVC	Joint Live-Virtual-Constructive
JMBL	Joint METOC Broker Language
JMCDM	Joint METOC Conceptual Data Model
JMUL	Joint Master Unit List
JNEM	Joint Non Kinetic Effects Model
JOPES	Joint Operation Planning and Execution System

JOSGFMDI	Joint Organization Server Global Force Management Data Initiative
JPEG	Joint Photographic Experts Group
JPO	Joint Program Office
JPRA	Joint Personnel Recovery Agency
JRSG	Joint Rapid Scenario Generation
JRTC	Joint Readiness Training Center
JSAF	Joint Semi-Automated Forces
JSF	Joint Strike Fighter
JSON	JavaScript Object Notation
JTASG	Joint Targeting Automation Steering Group
JTDB	Joint Targeting Database
JTDS	Joint Training Data Services
JTF	Joint Task Force
JTF C2	Joint Task Force Command and Control
JTI	Joint Targeting Intelligence
JTID	Joint Threat Intelligence Database
JTLS	Joint Theater Level Simulation
JTT	Joint Targeting Toolbox
KML	Keyhole Markup Language
KMZ	Zipped KML Files
LAS	LASer File Format
LDAP	Lightweight Directory Access Protocol
LDIF	LDAP Interchange Format
LDM	Logical Data Model
LIBPCAP	Packet Capture Library
LIDAR	Light Detection and Ranging
LLNL	Lawrence Livermore National Laboratory
LOG	Logistics
LogCOI	Logistics Community of Interest
LT2-FTS	Live Training Transformation - Family of Training Systems
LTDS	Local Topographic Data Store
LVC	Live-Virtual-Constructive
LVCAR	LVC Architecture Roadmap
M&S	Modeling & Simulation
MADL	Multifunction Advance Data Link
MAIS	Mobile Automated Instrumentation Suite
MARC	Manpower Requirements Criteria
MASINT	Measurement and Signal Intelligence
MCGFMDI	Marine Corps Global Force Management Data Initiative
MCTINTCG	Management Interchange
MDA	Maritime Domain Awareness
MDADSCOI	Maritime Domain Awareness COI
MDB	Master Database (SECore)

MDR	Metadata Registry
MEPED	Military Equipment Parametric Engineering Database
METGM	Meteorological Message
METOC	Meteorological and Oceanographic
MIDB	Military Intelligence Database
MIIDS-IDB	Military Intelligence Integrated Data System - Intelligence Database
MIL-PRF	Military Performance Specification
MIL-STD	Military Standard
MIP	Multilateral Interoperability Program
MLSM	Modeling & Simulation (namespace)
ModIOS	General Dynamics Exercise Management and AAR System
ModSAF	Modular Semi-Automated Forces
MOSS	Map Overlay and Statistical System
MPO	Mission Planning Ops
MRF-C	Multi-Resolution Federation – Corps Battle Simulation
MRF-W	Multi-Resolution Federation – Warfighter's Simulation
MrSID	Multiresolution Seamless Image Database
MS	Multi-Sensor
MS	Microsoft
MSCO	Modeling & Simulation Coordination Office
MSDL	Military Scenario Definition Language
MSG-TDES	Messages-Tactical Data Enterprise Services
MSO	Modeling and Simulation Object
MTC	Military Targeting Committee
MUL	Master Unit List
NAMP	Naval Aviation Maintenance Program
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NBC	Nuclear, Biological, Chemical
NCDS	Net-Centric Data Strategy
NEC2IEDM	Net-Enabled Command Capability C2 Information Exchange Data Model
NECC	Net-Enabled Command Capability
NECC-AP	NECC Adaptive Planning
NECC-C2	Net-Enabled Command Capability-Command and Control
NetCDF	Network Common Data Format
NetOps	Network Operations
NetOpsT	Network Operations - Tactical
NETWARS	Network Warfare Systems
NFDD	NSG Feature Data Dictionary
NGA	National Geospatial Intelligence Agency
NGIC	National Ground Intelligence Center
NGO	Non-Government Organization
NIEM	National Information Exchange Model

NITF	National Imagery Transmission Format
NITFS	National Imagery Transmission Format Standard
NM	Nautical Mile
NPSI	Navy Portable Source Initiative
NSG	National System for Geospatial Intelligence
NSN	National Stock Numbers
NSIF	NATO Secondary Imagery Format
NTC	National Training Center
NTF	National Transfer Format
NWDC	Navy Warfare Development Command
OASD	Office of the Assistant Secretary of Defense
OBJ	Wavefront Object File Format
OBS	Order of Battle Service
ODA	Open Design Alliance
ODUSD	Office of the Deputy Under Secretary of Defense
OGC	Open Geospatial Consortium
ONA	Operational Net Assessment
OneSAF	One Semi-Automated Forces
ONIR	Overhead Non-Imaging Infrared
ONR	Office of Naval Research
OOB	Order of Battle
OOS	OneSAF Objective System
OOTW	Operations Other Than War
OPORD	Operations Order
OSD	Office of the Secretary of Defense
OUSD (ATL)	Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics)
OTF	Objective Terrain Format
OWL	Web Ontology Language
P&R	Personnel & Readiness (OSD)
PA&E	Program Analysis & Evaluation (OSD)[12]
PAIR	Parametric and Initialization
PASS	Publish and Subscribe Service
PBL	Performance-Based Logistics
PDF	Portable Document Format
PDU	Protocol Data Unit
PED	Processing, Exploitation, and Dissemination
PEO C3T	Program Executive Office, Command Control Communications - Tactical
PEO STRI	Program Executive Office, Simulation, Training and Instrumentation
PM CATT	Program Manager, Combined Arms Tactical Trainer
POC	Point of Contact
PSYOPPI	Psychological Operations Planning
PVO	Private Volunteer Organizations

[12] Now Cost Assessment and Program Evaluation (CAPE)

RDBMS	Relational Database Management System
RDECOM	Research, Development, and Engineering Command (US Army)
REPAST	Recursive Porous Agent Simulation Toolkit
RF	Radio Frequency
RPF	Raster Product Format
RTDS	Regional Topographic Data Store
RTI	Run-Time Infrastructure
S&R	Stabilization and Reconstructions
SAF	Semi-Automated Forces
SAR	Synthetic Aperture Radar
SDBF	Simulator Database Facility
SDD	System Development and Demonstration
SDO	Standards Development Organizations
SDTS	Spatial Data Transfer Standard
SE Core	Synthetic Environment Core
SEAS	Synthetic Environments for Analysis and Simulation
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SEIWG	Security Equipment Integration Working Group
SFF	Standard File Format
SIF	Standard Interchange Format
SIGACT	Significant Activity
SIGINT	Signals Intelligence
SIMCI	Simulation to Command, Control, Communications, Computers and Information (C4I) Interoperability
SISO	Simulation Interoperability Standards Organization
SIW	Simulation Interoperability Workshop
SKIWEB	Strategic Knowledge Integration WEB
SKP	Sketchup
SMEs	Subject Matter Experts
SNE	Synthetic Natural Environment
SOA	service oriented architecture
SOAR	Simulation of Adaptive Response
SOCOM	Special Operations Command
SPC	Space Control
SQL	Structured Query Language
SPIRIT	System Parametric Information Relational Intelligence Tool
SRM	Shaded Relief Model
SSA	Space Situational Awareness
SSR	Specific System Representation
SSRF	Standard Spectrum Resource Format
STANAG	Standardization Agreement (NATO)
STEP	Standard for the Exchange of Product (Model Data)
STF	SEDRIS Transmittal Format
SUP	Supply

SYM	Symbology
SYSLOG	System and Program Message Log
T3D	Tasked Target Text Data
TACSIM	TACtical SIMulation
TAR	Tracks and Reports
TBMCS	Theater Battle Management Core System
TCH	Transportation Class Hierarchy
TENA	Test and Training Enabling Architecture
TIFF	Tagged Image File Format
TIGER	Topologically Integrated Geographic Encoding and Referencing
TIS	Tasker Integration Service
TIWG	Targeting Issues Working Group
TO&E	Table of Organization and Equipment
TPFDD	Time-Phased Force Deployment Data
TRAC	TRADOC Analysis Command
TRADOC	Training and Doctrine Command
TRP	Transportation
TSG	Terrasim Tiled Scene Graph
TSGA	Terrain Scenario Generation and Archiving
TSPG	Training System Product Group
TST	Time Sensitive Targeting
TTNT	Tactical Targeting Network Technology
TWG	Technical Working Group
UCAR	University Corporation for Atmospheric Research
UCore	Universal Core
UDOP	User Defined Operational Picture
UHRB	Ultra-High Resolution Buildings
UOB	Unit Order of Battle
US	United States
USAGFMDI	United States Army Global Force Management Data Initiative
USCG	United States Coast Guard
USF&WS	United States Fish and Wildlife Service
USJFCOM	United States Joint Forces Command
USMTF	United States Message Text Format
USSOCOM	United States Special Operations Command
USW	Undersea Warfare
UTDS	Urban Topographic Data Store
VBS	Virtual Battle Space
VFP	Vector file format
VIC	Vector-in-Commander
VMF	Variable Message Format
VRF	Vector Relational Format
VRML	Virtual Reality Markup Language

VV&A	Verification, Validation, and Accreditation
W3C	World Wide Web Consortium
WARSIM	Warfighter's Simulation
WDS	WebSked Distributed Services
WMA	Warfighter Mission Area
WMO	World Meteorological Organization
WPN	Weapon Systems
WRDB	Water Resouces Database
WSDL	Web Services Description Language
WSLM	Weapon Systems Life Cycle Management
WSMR	White Sands Missile Range
X3D	Extensible Three Dimensional
XML	Extensible Markup Language

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