NATO STANDARD

AMSP-01

NATO MODELLING AND SIMULATION STANDARDS PROFILE

Edition E, Version 1

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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NATO LETTER OF PROMULGATION

6 September 2021

1. The enclosed Allied Modelling and Simulation Publication AMSP-01, Edition E, Version 1, NATO MODELLING AND SIMULATION STANDARDS PROFILE (NMSSP), which has been approved by the nations in the NATO MODELLING AND SIMULATION GROUP, is promulgated herewith. The agreement of nations to use this publication is recorded in STANREC 4815.

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4. This publication shall be handled in accordance with C-M(2002)60.

Dimitrios SIGOULAKIS
Major General, GRC (A)
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

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RECORD OF SPECIFIC RESERVATIONS

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C.	AC/323(NMSG)D(2021)004	Allied Modelling and Simulation Publications (AMSP) Policy Document (APD)
D.	IEEE 1730	Distributed Simulation Engineering and Exploitation Process (DSEEP)
E.	NATOTerm	The official NATO Terminology Database https://nso.nato.int/natoterm/

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CHAPTER 1 INTRODUCTION

1.1. BACKGROUND

1. The NATO Modelling and Simulation Standards Profile (NMSSP), is one of a number of Allied Modelling and Simulation Publications (AMSPs) aimed to provide guidance and direction to NATO members and organizations on standardization in the Modelling and Simulation (M&S) domain.

2. Alongside all AMSPs, it is subservient to the Policy and Procedures that are described in the AMSP Policy Document[1].

1.1.1. NATO Interoperability Standards and Profiles (NISP)

1. The NISP[2] prescribes the necessary technical standards and profiles to achieve interoperability of Communications and Information Systems, including M&S, in support of NATO's missions and operations. In accordance with the Alliance C3 Strategy[3] all NATO enterprise entities shall adhere to the NISP prescribed standards and profiles. Allies and Partners, in order to achieve Nation to NATO and Nation to Nation technical interoperability, are advised to adhere to these standards and profiles. These standards and profiles are mandatory for those Allies and Partners joining a federated network implemented for a NATO-led mission.

2. In order to satisfy the above NISP requirement, ANNEX A provides the direct input into that publication and will be refreshed each time that the AMSP-01 is updated. Annex A contains M&S specific standards only although other commonly used standards are referred to in the main body of this document.

1.2. PURPOSE

1. The purpose of the NMSSP is to serve as an authoritative reference and guidance product for NATO and nations on M&S standardization products and their applications.

2. In support of the main objective as described above, the NMSSP also:

   a. Informs NATO and national M&S stakeholders on new/emerging M&S standards;

   b. Details where gaps have been identified that are either being addressed or need to be addressed by specific M&S standards development activities;

[1] AC/323(NMSG)D(2021)004, the “AMSP Policy Document”
[2] ADatP-34 NATO Interoperability Standards and Profiles (NISP)
[3] C-M(2014)0016 the Alliance C3 Strategy

c. Promotes coherence of M&S standards references and descriptions;

d. Provides an introduction on M&S best practices;

e. Provides NATO directed NATO Modelling and Simulation Group (NMSG) input for M&S-specific standards into the NATO Interoperability Standards and Profiles (NISP)[4].

3. It should be noted that:

a. The NMSSP avoids duplication of references to non-M&S specific standards as these will be detailed in other NATO documentation.

b. The standardization documents included in the NMSSP have been chosen as the result of a formal selection process (see AC/323(NMSG)D(2021)004, the "AMSPs Policy Document") by the NMSG M&S Standards Subgroup (MS3) experts. These documents are aimed specifically at NATO member and partner nations, as well as national and NATO organizations, which have requirements to effectively use M&S in support of NATO, coalition and national requirements.

c. The AMSP-01 is covered by a NATO Standardization Recommendation (STANREC) document. Therefore all the standards and other products included in NMSSP can be seen as covered by the same STANREC, hence, recommended by NATO. They are not formally mandated by NATO unless they are covered by a specific NATO Standardization Agreement (STANAG).

1.3. SCOPE

1. The NMSSP maintains information on M&S standards and recommended practices relevant to achieving interoperability and re-use of components, data, models or best practices. The NMSSP provides recommendations that can be used as guidance in the selection and use of M&S standards for NATO and national activities, e.g. coalition training and experimentation.

[4] ADatP-34 NATO Interoperability Standards and Profiles (NISP)

CHAPTER 2 STANDARDS OF INTEREST

1. Standards of interest to NATO are identified in the following sections but should be noted that NMSSP only lists M&S specific standards as these fill gaps that would otherwise exist, however other key specific standards used for M&S purposes may be referenced.

2.1. DEFINITION OF THE MAIN CATEGORIES OF STANDARDS

1. In its preliminary work on this profile, the MS3 identified dozens of normative and guidance documents that could support NATO M&S activities. The documents contained very diverse standards although some were specific to M&S life cycle steps. For clarification and organizational reasons, the MS3 decided to categorize the standards. The following eight categories specific to M&S were chosen:

a. Methodology, Architecture and Processes;

b. Conceptual Modelling and Scenarios;

c. Interoperability;

d. Information Exchange Data Models;

e. Synthetic Physical Environment;

f. Analysis and Evaluation; and

g. Miscellaneous.

2. It should be noted that other non-M&S specific standards could be used but these are not covered by this publication.

3. The choice of categories was influenced by the Distributed Simulation Engineering and Execution Process (DSEEP[5]), shown diagrammatically in Figure 1, which is an approved IEEE recommended practice developed by Simulation Interoperability Standards Organization (SISO) that supports the overall M&S lifecycle.

[5] IEEE 1730 Standard “Distributed Simulation Engineering and Exploitation Process (DSEEP)”

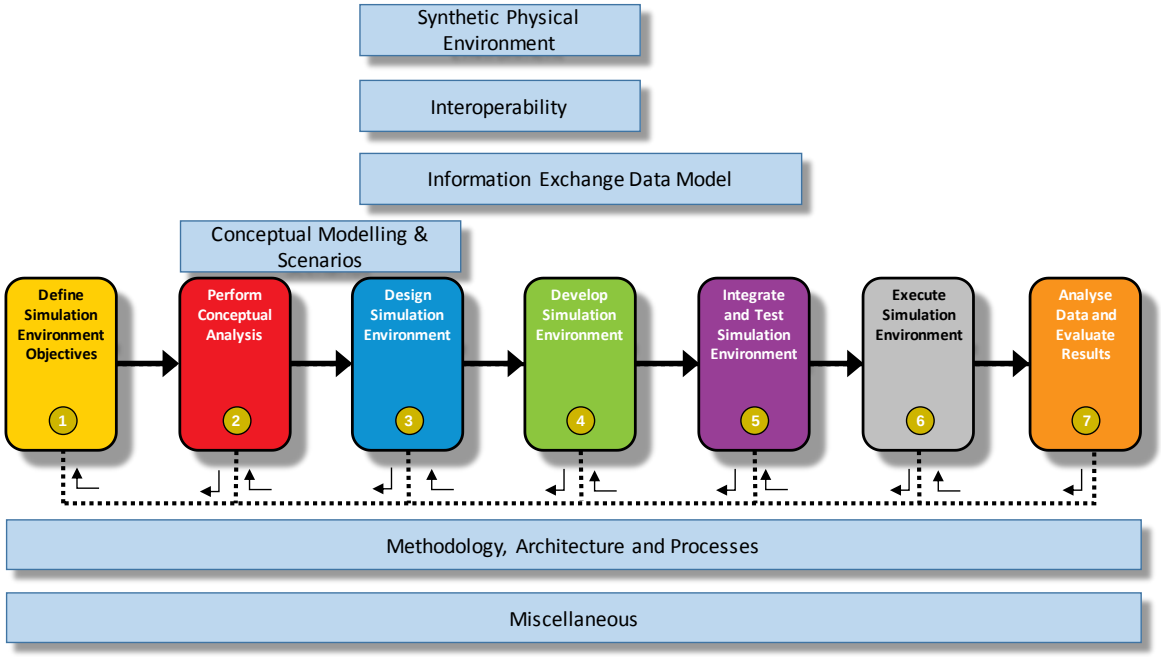

Figure 1: The 7-step DSEEP simulation engineering process and the M&S standards categories

4. Figure 1 indicates the relationships between the standards categories and the seven main DSEEP steps. The light blue shapes above and below the centre row of DSEEP steps represent the standards categories and six are linked to the DSEEP steps where the standards are most applicable. Shapes representing more general standards, such as “Architecture Framework Standards”, are not tied to any particular step. Note that the term “Simulation Environment,” which appears on the DSEEP steps, refers to any distributed simulation system - a “federation” in HLA terminology.

2.2. CATEGORISATION OF STANDARDS

1. This section proposes the allocation of existing standards onto the seven categories described in the previous subsections. Note that standards may appear in more than one category if deemed appropriate. The detailed descriptions of the M&S standards are given in Annex C.

2. An overview of the Categorization of Standards is shown in Figure 2.

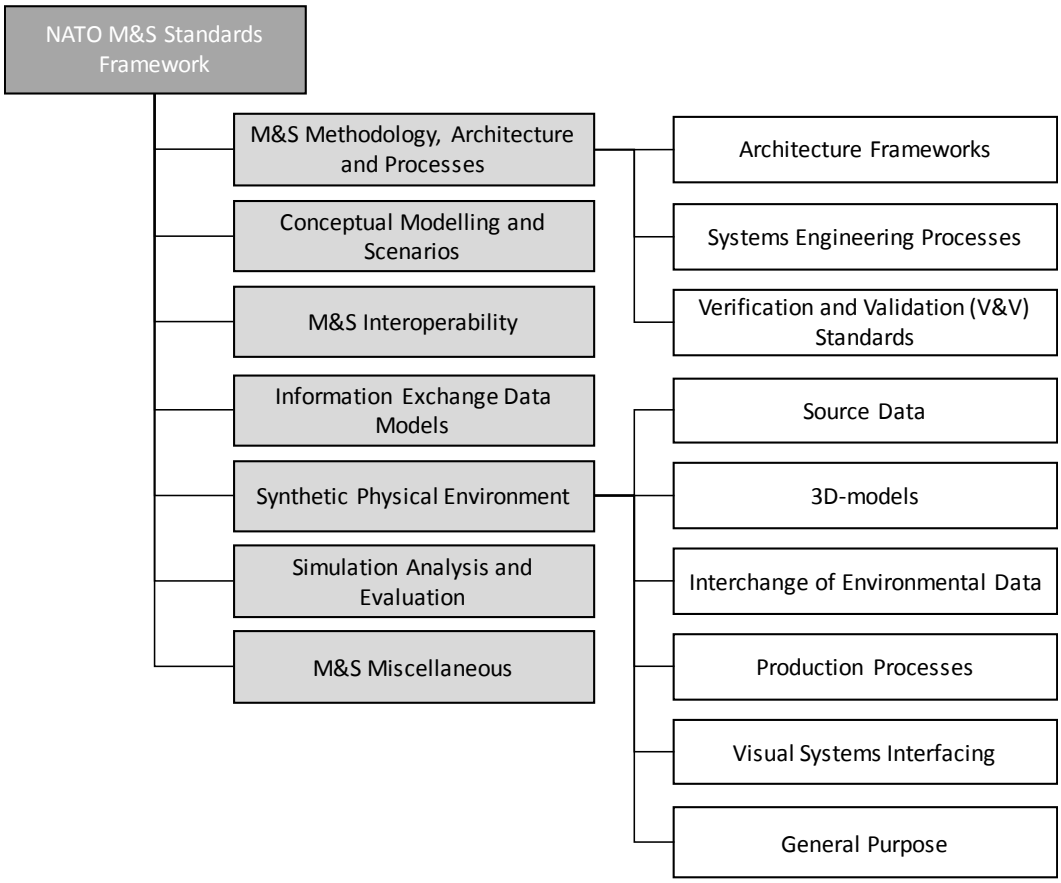

Figure 2: NATO M&S Standards Framework

2.2.1. M&S Methodology, Architecture and Processes Standards

1. This category groups general standards that cover the overall life cycle of M&S and affect all seven steps of the DSEEP. It comprises the following three subcategories:

a. **Architecture Frameworks:** This subcategory contains standards that govern high-level development of systems, typically at the enterprise level. Such standards are typically very general and not specific to M&S system development (hence not listed in the NMSSP itself), although they are still applicable. An example standard is the NATO Architecture Framework (NAF).

b. **Systems Engineering processes:** This subcategory includes both generic and M&S-specific systems engineering processes, which typically describe the steps that must be followed in order to successfully develop a system. An M&S-specific example is the above-mentioned DSEEP.

c. **Verification and Validation (V&V) standards:** V&V is a key M&S issue because they ensure that M&S systems are built according to specification, fit for their intended use, and documented accordingly. Since software engineering standards are not sufficient, the M&S community has developed M&S-specific standards such as the "VV&A overlay on the High Level Architecture (HLA) Federation Development and Execution Process (FEDEP[6]); however, more complementary standards are required. Note that V&V is not a unique acronym in this area; VV&A, which stands for Verification, Validation and Accreditation (or Acceptance[7]) is also widely used.

2. This very general category comprises three subcategories.

2.2.1.1. Architecture Frameworks

1. There are no M&S-specific standards and therefore there are no entries in the NMSSP for this subcategory. However, the NATO Architecture Framework (NAF) is a common standard in systems engineering and therefore its use is recognized and supported.

2. Architecture Frameworks are mainly used in the world of Command, Control, Communications and Information (C3I) systems, but they are also widely used for M&S and recognized as of interest by the NMSG.

2.2.1.2. Systems Engineering Processes

1. Many general systems engineering processes are applicable to M&S but this subcategory only contains those that are specific to M&S. The M&S community felt that the development of simulation systems should be supported by specific methods and processes and, as a result, developed its own. This standard subcategory includes the IEEE 1730 DSEEP.

2. Other systems engineering standards exist and are recognized by ISO and the IEEE; however, they are not included in this profile because they are redundant given the M&S-specific processes above.

2.2.1.2.1. Systems Engineering Processes – Gaps

The only gap identified in this subcategory is the lack of an engineering process dedicated to the development and exploitation of standalone simulations.

[6] Included as relevant although FEDEP has been retired. A successor based on DSEEP is planned.
[7] Note that outside of the USA, there may not be a formal accreditation process and the terms "acceptance" or "accepted for use" may be used; the term acceptance is the decision to use a simulation for a specific purpose and the term accreditation is the official certification that a model or simulation is acceptable for use for a specific purpose.

2.2.1.3. Verification and Validation (V&V)

1. This category includes the following standards:

    a. The SISO Generic Methodology for Verification and Validation and Acceptance of Models, Simulations and Data (GM-VV);

    b. The IEEE 1516.4 "VV&A Overlay on the HLA FEDEP";

    c. The US DoD "VV&A Recommended Practice Guide" (RPG); and

    d. The US DoD "VV&A Templates".

2. Many NATO and partner nations have established national V&V standards. The SISO and NMSG efforts on GM-VV have started to address the lack of internationally recognized V&V standards.

2.2.1.3.1. Verification and Validation (V&V) - Gaps

1. The number of V&V standards reflects the general consensus that the topic is very important and significant effort is needed to support it. The number of standards also suggests that V&V is adequately addressed; however, observations have been made as follows:

    a. Some of the standards are old, not evolving and/or obsolete; examples include the European REVVA1, REVVA2 and ITOP "V&V Information Exchange" standards;

    b. Many V&V efforts, such as the US DoD RPG, are national and the resulting standards are shared but not unanimously adopted by other nations. In fact, there are two internationally recognized standards that have been developed to date: the SISO GM-VV and the IEEE 1516.4 "VV&A Overlay on the HLA FEDEP" but it is recognized that work has commenced on a replacement focusing on DSEEP rather than FEDEP;

    c. No international standard exists to support the V&V and certification of simulation input data; and

    d. No methodology or process exists to support the V&V of Human Behaviour Representation (HBR) due to the unpredictable nature of humans.

2. Thus, the current set of standards is inadequate. However, the SISO and NMSG developed GM-VV standard provides a common approach.

2.2.2. Conceptual Modelling and Scenarios Standards

1. Standards in this category mainly apply to the second and third steps of the DSEEP, which translate user simulation objectives, such as “determine which tactic is best,” into the design of an appropriate system of hardware and software, including the scenario(s) to be run.

2. Conceptual modelling (CM) is the translation of the user requirements into formal statements that are understandable by both humans and machines. It is an active research area but CM-specific standards have yet to be developed; in the meantime, some software engineering standards are used.

3. The purpose of scenario standards is to enable the exchange, archiving and reuse of scenarios by describing those using standardized means. An example is the Military Scenario Description Language (MSDL), a SISO standard, which has been designed to enable different simulation programs or federates to share scenario description files, rather than having to recreate a scenario in multiple proprietary file formats, one for each (federated) application.

4. This category includes the following standards:

   a. The SISO Base Object Models (BOMs);

   b. The SISO Military Scenario Definition Language (MSDL), and its successor Standard for Command and Control Systems - Simulation Systems Interoperation (C2SIM), are standards for storing and exchanging scenarios.

   c. The SISO Guideline on Scenario Development for Simulation Environments (GSD).

5. The SISO BOMs (SISO-STD-003-2006) support conceptual modelling and are considered important for translating military requirements into simulation technical specifications and, more generally, for supporting V&V activities.

6. The three following standards - Unified Modelling Language (UML), eXtended Mark-up Language (XML) Metadata Interchange (XMI) and Systems Modelling Language (SysML) - are not specific to M&S and therefore not listed, but are considered useful for M&S.

7. It has been recognized that a generic method of describing, archiving, exchanging and reusing scenarios is of paramount interest to M&S because scenario development is very resource consuming. MSDL (SISO-STD-007-2008) was developed to address these issues. C2SIM has been designed to unify and supersede the MSDL and C-BML standards (see section 2.2.4. and ANNEX C for more information on these standards).

8. The purpose of GSD standard is to provide detailed information regarding the development of scenarios for simulation environments and the relationship of the scenario development process within the overarching simulation environment engineering process.

2.2.2.1. Conceptual Modelling and Scenarios Standards - Gaps

1. Concerning conceptual modelling, the MS3 emphasizes the importance of a standardized guidance document to support the following:

   a. The translation of M&S sponsor/user requirements into M&S technical specifications; and

   b. The lifecycle of V&V of M&S systems and model input data.

2. The Task Group MSG-058 completed its final report (see RTO-TR-MSG-058[8]), which provides a draft guide on Conceptual Modelling (CM). Past efforts of both SISO and NATO have resulted in many documents addressing this topic. Several available standards are applicable to support CM. Examples are as follows:

   a. SISO's Base Object Models (BOMs) and Real-time Platform Reference Federation Object Model (RPR FOM); and

   b. The OMG's Unified Modelling Language (UML), XML Metadata Interchange (XMI), Model Driven Architecture (MDA) and Systems Modelling Language (SysML) although these latter ones are not M&S specific.

3. These standards, many of which are data format specifications, do not address all CM issues. However, they are expected to be referenced in any guidelines or standards that are developed for CM.

4. The only known M&S scenario standard is SISO's MSDL which has its origins in the army/land-domain. With the unification of MSDL and C-BML under C2SIM, MSDL will be superseded by C2SIM-Initialize. There are also some, as yet uncoordinated, activities ongoing to extend MSDL into other domains (e.g. Crises Management).

5. The SISO GSD provides initial guidance for transitioning from operational scenarios developed by users and SMEs to conceptual scenarios refined by M&S experts and further to executable scenarios readable by computers.

[8] Publicly available at https://www.sto.nato.int/publications/

2.2.3. M&S Interoperability Standards

1. This category contains standards that support the development and execution of distributed M&S systems and support the reusability of artefacts when combined with other systems that are compliant with the same standards. Such standards mainly relate to Steps 3, 4, and 5 of the DSEEP, which address simulation system development, and support simulation execution in Step 6.

2. A very well-known example is the High Level Architecture (HLA), which is an IEEE standard and mandated by the NATO M&S Interoperability STANAG 4603.

3. This standards category includes:

   a. The IEEE 1516 and NATO STANAG 4603 High Level Architecture;

   b. The IEEE 1278 Standard Series for Distributed Interactive Simulation (DIS);

   c. The SISO Gateway Description and Filtering Languages (GDL/GFL);

   d. The Standard for UCATT Laser Engagement Interface (SISO-STD-016-00-2016) and associated reference and guidance products.

4. The purpose of GDL (SISO-STD-014.1-2018) is to specify a formal XML schema for identifying the capabilities that gateways can offer to users. GDL provides a common format and syntax for gateway developers to describe the capabilities of their products to potential users. The purpose of GFL (SISO-STD-014.2-2018) is to specify a formal XML schema for defining data filters in gateways that is independent of any gateway implementation. GDL and GFL standards, in conjunction with tools and repository capabilities, will streamline the process of gateway selection in future simulation environments.

5. The Web Live Virtual Constructive (WebLVC) is a protocol under development by SISO in order to extend traditional M&S federations (e.g. HLA and DIS) to the Web browser environment.

6. The NMSG Task Groups on “Modelling and Simulation as a Service” are investigating how to improve M&S interoperability through M&S services.

7. It is important to note that there is only one STANAG related to this category, that is, the HLA STANAG 4603. Thus, the HLA is the unique interoperability standard mandated by NATO.

2.2.3.1. M&S Interoperability Standards - Gaps

1. Many standards exist in this category. IEEE DIS and HLA and non-M&S standards like Data Distribution Service (DDS), and Web Services are just a few. So many standards exist that the USA has completed an activity to assess how to improve the current situation called LVC Architecture Roadmap (LVCAR). The LVCAR results point in the direction of merging the existing standards without formally mandating the use of a single particular standard or developing an entirely new standard. The first activities towards this goal are to develop common data interchange models and templates for federation agreements (e.g. Federation Engineering Agreements Template (FEAT) (SISO-STD-012-2013)).

2. Historically, live training systems were often proprietary, developed by individual vendors and with limited or no interoperability between different vendors or even across a vendor's product line. UCATT has established the concept of a family of standards under the governance of SISO. The first of these standards has been made publicly available: the Standard for UCATT Laser Engagement Interface, SISO-STD-016-00-2016. In addition, an overarching guidance and a reference document have been created. UCATT also provides SISO with required Product Development Group (PDG) as well as with the Product Support Group (PSG) for the existing product. The MS3 recognises, however, that still much more work is required before open M&S standards fully enable the targeted interoperability of live training systems both with other live systems and with virtual or constructive simulations.

3. The MS3 recognises, that still much more work is required before open M&S standards fully enable the targeted interoperability of live training systems both with other live systems and with virtual or constructive simulations.

2.2.4. Information Exchange Data Models Standards

1. This category is closely related to the previous one, M&S interoperability, because data need to be exchanged between components of distributed simulation systems and the structure of the data (number of fields in a message, number of bytes per value, etc.) affects system development. Thus, standards in this category also relate to Steps 3-6 of DSEEP.

2. Some of these standards are in fact a part of the main M&S interoperability standards. The HLA Object Model Template is a typical example. Some standards belonging to this category are not tied to a specific exchange mechanism or format such as the "Command and Control Systems - Simulation Systems Interoperation (C2SIM)" that facilitates data exchange between Command and Control (C2) systems and simulations.

3. This category includes standards that are typically required to support M&S interoperability:

a. The HLA OMT (Object Model Template), which is one of the three components of the HLA standard;

b. The SISO Reference for Enumerations for Simulation;

c. The Real-time Platform Reference Federation Object Model (RPR FOM);

d. NATO Education and Training Network (NETN) Federation Architecture and FOM Design (FAFD) (AMSP-04 / STANREC 4800)

e. The Link 16 Simulation standard;

f. The Link 11 Simulation standard development;

g. Command and Control Systems - Simulation Systems Interoperation (C2SIM) which supersedes the Coalition Battle Management Language (C-BML).

4. Enumerations for Simulation are unique identifiers for simulated entities that represent real-world vehicles, life forms, and other objects or phenomena that may be present in the simulation. SISO-REF-010 Reference for Enumerations for Simulation Interoperability specifies numerical values and associated definitions for fields that are identified as enumerations in SISO Standards Products and SISO-sponsored standards published by IEEE for High Level Architecture (HLA) and Distributed Interactive Simulation (DIS).

5. The RPR FOM (SISO-STD-001.1-2015) is a “reference FOM” that is widely used in the HLA community. It obviously conforms to the OMT formalism, but in addition it is consistent with the Reference Enumerations for Simulation Interoperability and facilitates data exchange between HLA and DIS-based distributed simulation systems.

6. The NATO Education and Training Network (NETN) Federation Architecture and FOM (Federation Object Model) Design (FAFD) document is a reference document intended to provide architecture and design guidance for developing distributed simulation and training systems in the context of Computer Assisted Exercises (CAX). The guidance provided by the FAFD has been developed to support the NETN vision and is applicable to NATO CAX, national CAX and to some extent to distributed modelling and simulation in general.

7. The next standards cover specific modelling needs of the military domain: Link 11 Simulation and Link 16 Simulation Tactical Data Links (SISO-STD-002-2006). They are in this category because it is deemed the most appropriate.

8. The Space Reference FOM (SISO-STD-018-00-2020) defines a collection of HLA-compliant data constructs, modelling standards, and execution control process standards that support interoperability between simulations in the space domain. It is designed to link simulations of discrete physical entities into distributed collaborative simulations of complex space related systems.

9. The C-BML (SISO-STD-011-2014) effort addresses the crucial interoperability problem between C2 systems and simulations. C2SIM (SISO-STD-019-2020), which is a unified standard based on the C-BML and MSDL standards, supersedes C-BML. A Land Operation Extension (LOX) to C2SIM (SISO-STD-020-2020) has been developed. Several MSG task groups (MSG-048, MSG-085 and MSG-145) have been supporting the operational validation of the C2SIM standards

10. STANAG 5602 SIMPLE is not M&S-specific but is often used to exchange Link 11 Simulation and Link 16 Simulation data in M&S applications. SIMPLE is also relevant in LVC simulations since the standard is widely implemented in operational tactical data link equipment.

2.2.4.1. Information Exchange Data Models Standards - Gaps

1. The HLA FOM can be thought of as an Information Exchange Data Model (IEDM). The most common being the RPR FOM mentioned earlier. MSG-106 produced the NATO Education and Training Network (NETN) FOM, which extends the RPR FOM to add capability without breaking backwards compatibility. Both the RPR and NETN FOMs are designed only for simulation interoperability and not simulation to C2.

2. This modular NETN FOM has been extended (e.g. in MSG-163 task group) and is expected to be developed and extended continuously. The current version is published and documented in the AMSP-04 standard.

3. The Logical Data Model ontology of C2SIM is extensible, but only the Core data model and the Standard Military eXtension and Land Operations eXtension are published. Further extensions need to be developed for other domains.

4. CGF Behaviours Reuse standardization is progressing slowly. The MSG-127 task group on “Reference Architecture for Human Behaviour Modelling” has concluded that the topic is still an area of much research with rapid new developments in Artificial Intelligence and the use of Machine Learning techniques. Some work is ongoing on developing Pattern-of-Life descriptive languages, but this is mostly proprietary and unpublished at the moment.

5. The medical domain is increasingly using simulations for training as well. SISO/Industry teams are discussing proposals for development of medical FOMs that define interoperability between simulated human organs. This should ultimately lead to a virtual representation of the human physiology.

6. SISO is working on a standard product for Human Performance Modelling Language. HPML is an XML schema-based language intended to cover all meaningful aspects of human performance measurement in various training and operational environments.

7. NMSG and HFM Panel should investigate how to become more involved in these efforts.

8. Representation of cyber-effects in a (distributed) simulation is becoming urgent. The efforts by MSG-170 Specialists Team on ‘’Top-Ten Cyber Effects’’ and a SISO Study Group have resulted in a recommended approach which is now in proposal phase.

9. The challenge here is to develop generic standards in a domain that has high security thresholds.

2.2.5. Synthetic Physical Environment Standards

1. This large category mainly concerns Steps 3 and 4 of the DSEEP.

2. The development, archiving and reuse of environmental data representing in M&S the natural and human-made features of the real world, are very important parts and a significant cost driver of M&S systems. Database development is a complex process and the interoperability of environmental databases is also a key issue. Some standards in use for M&S purposes are from the Geospatial community and therefore are not listed in the NMSSP as not being M&S Specific noting that they are listed in standards profiles elsewhere. Also, many “de facto” standards are in use and official standards are few or just emerging.

3. Categorising such standards appeared very important because all standards are not equal and many come from different domains such as gaming or digital geography. Thus, this category was decomposed into the following subcategories:

a. **Source Data:** for standards that define such things as elevation, bathymetry, vector, weather and imagery;

b. **3D-models:** for standards that define how three-dimensional objects are to be stored;

c. **Interchange of Environmental Data:** for standards whose primary purpose is to provide a format to exchange or archive environmental data;

d. **Production Processes:** for standards that define how environmental data is to be produced;

e. **Visual Systems Interfacing:** for standards that define how visual data is to be offered for visualization; and

f. **General Purpose:** for standards that are very flexible and do not predefine how environments are to be modelled.

4. There are many standards related to environmental data representation. They are classified in the following subsections.

2.2.5.1. General Purpose Environmental Standards

1. This subcategory contains only SEDRIS, which is a suite of 8 ISO/IEC standards published as the ISO/IEC 180xx series.

2. SEDRIS provides the concepts, the semantics, and the infrastructure for representing, modelling, and exchanging data from all environmental domains (terrain, ocean, atmosphere, and space) in an integrated manner, including urban and littoral areas, as well as 3D icons/models. While many other standards only deal with a specific subset of the environment (such as terrain surface or ocean/atmosphere volume), SEDRIS provides an object-oriented approach for representing all aspects of the natural and/or human-made environment.

3. SEDRIS provides a Data Representation Model (DRM), augmented with a rich feature/object classification and attribution standard (Environmental Data Coding Specification (EDCS)) and a unified approach for specifying positions and orientations of features/objects (Spatial Reference Model (SRM)), which in combination allow a wide range of environmental data and objects to be expressed, represented, and modelled. These three components are the major SEDRIS standards:

a. DRM, a data representation model encompassing data requirements of synthetic environments used in every type of simulation application;

b. EDCS, a mechanism to specify the environmental components that a particular data model construct is intended to represent; and

c. SRM allows the context in which coordinates, directions, and distances are defined to be known succinctly, and converted accurately into multiple definitions and representations of geo- and non-georeferenced space.

4. Each has a corresponding API specification and a language-binding standard (both of which are current). The suite of standards is rounded by two other standards that allow exchange of data expressed using the above components: the abstract transmittal format and the SEDRIS Transmittal Format (STF) (both of which are current). The EDCS and the SRM, and their associated APIs and language-binding standards, are each designed to be standalone and can be used separately from the other components.

2.2.5.1.1. General Purpose Environmental Standards - Gaps

1. Standards in this subcategory are supposed to be broadly applicable and their emphasis is the synthetic physical environment, unlike those in the previous subcategories which are much more “file-format” centric. Although SEDRIS is the most general, it has not been as widely adopted as a whole as it might have been. Its generality comes at the cost of complexity and admittedly, the success of other competing geospatial standards. Thus, the flexibility of SEDRIS is a double-edged sword. One or more standardized means of modelling common environmental features could simplify its use and subsequently increase its number of users.

2. CDB has the potential to fill some of the gaps that are currently experienced when representing the synthetic physical environment. However, the runtime constraints embarked with the CDB database structure and naming conventions is also a problem for non CDB users.

3. RIEDP is by design a compromise between various environmental database providers, leveraging some SEDRIS components together with GIS standards, while avoiding runtime constraints. All database generation initiative, including CDB, can be mapped with a RIEDP profile, fostering sharing and reuse of environmental data.

2.2.5.2. Source Data

Examples of standards commonly used by the M&S community in this category are:

1. For Elevation data: Digital Terrain Elevation Data (DTED), Geographic Tagged Image File Format (GeoTIFF)

2. For Imagery: GeoTIFF.

3. For Vector data: Keyhole Markup Language (KML), and ESRI Shapefile,

4. For Weather: GRIB and NetCDF, the most commonly used formats.

2.2.5.2.1. Source Data - Gaps

1. This category contains a significant number of formats, most of which have been in use for many years. Collectively, they address many “traditional” M&S requirements such as terrain elevation data and geospatial features but they do not cover expected future M&S requirements very well.

2. As requirements for ever more sophisticated M&S continues, the demands for more detailed environmental data will follow. For instance, time-variable data will undoubtedly be required, especially as live, virtual and constructive simulations are combined, to ensure synchronization between the real and simulated worlds. Such data is necessary to represent tidal data, river widths, snow cover, rain, clouds etc. Thus, existing standards will need to be heavily modified or new ones developed.

In addition, evolutions in source data and associated formats for the GIS, photography, and/or architecture worlds will need to be integrated. Thus, some of the existing standards will need to be heavily modified and/or new ones developed.

2.2.5.3. 3D-Models

1. The standard frequently used by the M&S community in this category is OpenFlight. It is currently a commercial “de facto” standard, a file format for describing 3D-scenes and entities. OpenFlight is currently under review for acceptance as an OGC open standard.

2. This standards subcategory also includes standards sometimes borrowed from other communities such as:

   a. X3D (XML 3-Dimensional);

   b. COLLAborative Design Activity (COLLADA).

2.2.5.3.1. 3D-Models - Gaps

1. The OpenFlight specification is owned by Presagis, and although it is not an open standard, this situation is starting to be addressed through OGC. OpenFlight also has some deficiencies particularly in the areas of animation and articulation. A leading alternative, COLLAborative Design Activity (COLLADA), is conversely too loose allowing too many margins or user defined options to be exploited around the standard without control. OGC is currently considering the adoption of OpenFlight as an OGC standard, which will then enable OpenFlight to be considered an open standard.

2. XML 3-Dimensional (X3D), the successor to Virtual Reality Modelling Language (VRML), is relatively new and is very unlikely to replace OpenFlight in popularity. X3D models can be used within HTML5 which could enable 3D through a web browser.

3. The ‘de facto’ standards such as OpenFlight are so well established that they cannot be dismissed as inappropriate for NATO purposes, either. Thus, this category would benefit from additional standards even if the de facto standards are well entrenched. Development efforts to use, adopt, and improve (as needed) international standards for 3D models should be promoted.

2.2.5.4. Production Processes

1. Some processes have existed in the community since a long time, but they were typically the result of contracted activities for large military projects such as the Synthetic Environment Core Master Terrain Database process (SE Core MTDB) of the US Army or the Naval Aviation Simulation Master Plan (NASMP) Portable Source Initiative (NPSI) of the US Navy.

2. None satisfies the selection criteria described in the AMSP Policy Document AC/323(NMSG)D(2021)004. Their commercial ties or specificity prevents them from being included in this profile.

3. Since the spring of 2010, SISO members have been developing RIEDP which fosters the reuse of environmental data. Among the various components of RIEDP, the Reference Process Model (RPM) provides a detailed description of the production process commonly used for environmental databases.

4. RIEDP was published by SISO (SISO-GUIDE-007-2018) in September 2018 and is now available as an international standard.

2.2.5.4.1. Production Processes - Gaps

1. Under SISO, the RIEDP standard is addressing issues regarding the harmonization of environmental data representations and generation processes.

2. RIEDP needs now to be maintained and updated to take into account evolutions in the way environmental data are developed in the M&S world. In particular, Procedural generation, details in high fidelity Sensor modelling, etc. need to be integrated.

2.2.5.5. Interchange and/or Sharing of Environmental Databases

1. The main purpose of the standards listed here is not to model entities or large physical spaces but to support the reuse of environmental databases. They should not be confused with those in the previous categories (relative to Source data and 3D-Models) even though they may be related.

2. Several standards are available in this category:

   a. SEDRIS Transmittal Format (STF), one of the ISO/IEC SEDRIS standards (see Section 2.2.5.1) enables the exchange of environmental data between different systems and applications by providing a standardized intermediate format. It benefits from the other SEDRIS standards (DRM, EDCS, SRM) to define and exchange a flexible model of the world.

   b. CDB is an open standard that describes the data formats, naming conventions and metadata for elevation, imagery, vector and 3D model data. A CDB dataset can be used as either a run-time database for simulations or as a data repository for that can be converted or shared to other runtime formats. CDB is not a true database; it is a collection of files that are saved with very specific naming conventions and metadata schemas. The files are all common formats that can be edited by a number of standard tools.

c. RIEDP is an open standard from the SISO (SISO-GUIDE-007-2018) to enable environmental data sharing, based on a Reference Abstract Data Model (RADM), using explicit data modelling techniques, robust metadata and user-focused conformance profiles. RIEDP reuses high level concepts and standards from SEDRIS, and unlike SEDRIS relies on the same principles and data formats of the GIS community that CDB references. Since RIEDP does not use runtime specific constraints (such as those used in CDB), RIEDP provides a broader and more neutral data sharing capability before the runtime stage.

3. In addition, Geographic Markup Language (GML) and City Geography Markup Language (CityGML) are used for M&S purposes.

2.2.5.5.1. Interchange and/or Sharing of Environmental Databases - Gaps

1. For interchange, the use of STF (an ISO/IEC standard) is limited to SEDRIS-based concepts and some situations may only involve environmental data in other formats. Therefore, it could be argued that additional standards are required. However, this situation is exactly what the suite of SEDRIS standards was designed to address, that is, how best to interchange geospatial data from one format into another given that there are a huge number of possible conversion combinations. Thus, until such time that the SEDRIS suite is shown to be inadequate for interchanging environmental data between some combinations of formats, this category is considered to have an adequate standard for addressing the integrated combination of environmental data (Ocean, Terrain, Atmosphere …). Considering other data formats that could be used to exchange environmental data, it should be noticed that they mainly cover terrain data (the traditional “geospatial/GIS data) and not the full geospatial environment and not general requirements for exchanging environment representation.

2. With the introduction of CDB and RIEDP standards, the gap for addressing data interchange for static terrain using common terrain/GIS formats is being closed.

3. There is work in progress with various NMSG Groups, and from OGC looking to address the gaps in dynamic terrain.

2.2.5.6. Visual System Interfacing

1. The Common Image Generator Interface (CIGI) standard details an interface designed to promote a common way for a host device to communicate with an image generator.

2. CIGI is defined by SISO-STD-013-2014 approved 22 Aug 2014.

2.2.5.6.1. Visual System Interfacing - Gaps

This category is not specific to M&S and, except for CIGI, no other visualisation standard is included in this version of the NMSSP. CIGI 4.1 is currently in development by SISO however this is a minor version update and does not address Extended Reality (xR) technologies. There are a variety of xR standards in development (e.g. OpenXR, WebXR) identified by the MSG-ET-050 group, and the SISO CIGI group of experts are in the early stages of development of a next generation interface specification which will address recent developments in xR technologies and so extend standardization efforts beyond visualisation alone. Cyber-sickness caused by xR technologies is an ongoing issue which is being addressed by the HFM-MSG-323 specialist team.

2.2.6. Analysis and Evaluation Standards

1. This category covers Steps 6 and 7 of the DSEEP. It is intended to include standards that define how simulation data is captured at run-time and processed afterwards for analysis purposes. An example standard for this category is the Distributed Debrief Control Architecture (DDCA) developed by SISO (SISO-STD-015-2016).

2. This category has been recognized as important but, unfortunately, no official or “de facto” standard could be identified for this domain.

2.2.6.1. Analysis and Evaluation Standards - Gaps

1. On one hand, the lack of standards in this category is understandable. Simulations can be used for an endless number of purposes and a matching-that is, endless-number of analysis standards is required in principle. Fortunately, simulation results may often be analysed using a combination of general purpose statistical methods, subject matter expertise, and application-specific standards, such as knowledge of emergency aircraft landing procedures. Thus, analysis techniques are already well defined in M&S application areas and such techniques do not need to be “recreated” as M&S related.

2. The above suggests that standards for simulation analysis and evaluation should be independent of any particular application area. They should address issues related to M&S technology, such as how to structure and replay simulation data using open-source viewers, and documentation standards that are broadly applicable. The latter might be very useful when documentation standards that do not exist for an application area of concern.

2.2.7. Miscellaneous Standards

1. This large category mainly concerns Steps 3 and 4 of the DSEEP. This category covers standards that generally concern all DSEEP steps, some or none.

2. This category contains those standards that do not readily fall into any of the other categories. As yet, there are no M&S specific standards available identified under the miscellaneous banner.

2.2.7.1. Miscellaneous Standards - Gaps

1. There are two gaps identified in this category, the lack of a standard to support the integration of simulation in distant learning courses and the issue of addressing security in distributed simulation.

2. Education and training have a high priority in NATO and some successful prototypes have been developed in the USA to demonstrate simulation and e-learning interoperability. While the IEEE Sharable Content Object Reference Model (SCORM) is a well-known standard that enables the sharing of course materiel between different platforms, a SCORM extension to support on-line integration of simulations in course content does not exist. The impact on the M&S domain regarding technology to trace and monitor student performance (xAPI) should be considered.

3. Information exchange between nations and organizations is often restricted due to the classification levels of data. Distributed simulation is obviously affected by these restrictions also. Information such as weapons or sensor performance may need to be protected without invalidating the Joint or Combined simulation or training objectives. This simulation exercise is in a sense ‘different’ from the real-world due to the often used principle of exchanging ‘ground-truth’ between simulations. The difficult issue of addressing security challenges for M&S is currently not covered by any standards. The Task Group MSG-080 has investigated this problem and made recommendations for the way-ahead. The MSG-165 MTDS is working on concepts for Cross-Domain Security solutions.

2.2.8. Software Engineering - Gaps

1. Gaps related to software engineering are difficult to assess because so many issues are involved. However, considering the size of the software development industry and plethora of software engineering standards available, many gaps may be considered filled and any remaining are likely to be addressed in standards under development by the OMG, the World Wide Web Consortium (W3C), etc.

2. Even if the M&S community identifies gaps in software engineering standards, the M&S community is not likely to have a significant influence on the development of new standards because software engineering standards usually address the concerns of all possible users, not just those of a special interest group. This lack of influence might be considered a concern, but in practice, it has not been a significant issue; the M&S community has long been very successful in adopting state-of-the-art software engineering tools and techniques to its needs, whether or not they were specifically developed for M&S. The MS3 expects this trend to continue.

2.3. SUMMARY

The table in ANNEX A summarizes the grouping of M&S standards in categories and sub-categories. Note that this includes standards identified as being “Emerging”. Note also that some standards in the table can be relevant to one or two categories/sub-categories (overlapping standards – see also Table 2 in ANNEX C).

CHAPTER 3 CONCLUSIONS AND RECOMMENDATIONS

3.1. OBSERVATIONS

1. Considering the large number of M&S standards and guidance documents identified in this AMSP, it is tempting to declare that the situation is rather satisfactory. Unfortunately, there are some observations that temper this conclusion. A quick assessment shows that there are overlapping standards in some specific areas and some obvious gaps in other areas. Where there are too many "standards" in support of a particular domain it means there is "no real standard", but sometimes many competing technologies or methodologies.

2. A second observation is that even where standards do exist, they must be maintained and endorsed by NATO and national organizations. The AMSP-01 is a suitable guideline document for the relevant M&S standards that should be used in development projects and procurement projects. The AMSP-01 needs to be widely disseminated by NMSG and nations and the recommendations regarding standards should be strongly considered by the NATO organizations and nations.

3.2. CONCLUSIONS

1. The objective of this publication is to provide guidance regarding modelling and simulation (M&S) standards and processes to NATO and partner nations, as well as national and NATO organizations that have to effectively use M&S in support of NATO and national requirements.

2. In support of this objective it was concluded that:

   a. Given the continuously evolving nature of M&S standards and processes, timely updates and review of the NMSSP guidance document are required to maintain currency of the information;

   b. A framework structure was required, taking into account categories or functional areas of M&S standards as well as maturity levels of the various standards and processes;

   c. There are benefits to identifying and using common open standards, recognizing that due to breadth of application of M&S there is no "one size fits all";

   d. There are many standards in existence that have or may have an indirect impact on M&S activities, such as, for example, system engineering standards. However only those standards directly applicable to M&S development, integration, and employment are considered for inclusion in NMSSP; this document is not intended to be an encyclopaedia of standards;

e. A specific procedure for submission and subsequent evaluation of a candidate standard should be utilized to ensure consistency of acceptance for standards into the document;

f. Gaps exist within current standards development regarding certain functional areas of M&S and some gaps exist within current standards regarding breadth of application in a functional area; and

g. Specific efforts should be made by the NMSG and nations to encourage focus on identified gap areas.

3.3. RECOMMENDATIONS ON M&S STANDARDS DEVELOPMENT

1. Standardization trends in the development of engineering processes dedicated to simulation are generally satisfactory considering current harmonization efforts taking place in SISO; nevertheless there is a need to integrate, in the DSEEP Multi Architecture Overlay (DMAO), main concepts developed in Architecture Framework efforts which are currently too diverse;

2. Efforts on standards for describing, archiving and reusing scenarios, orders and reports need to be continued and even reinforced in cooperation with the C2 community based on its current reference standards like Multilateral Interoperability Programme (MIP) Information Model (MIM). The M&S community should carefully follow MIM development and contribute elements that support C2-Simulation interoperability;

3. The service oriented approach which is addressed by M&S as a Service (MSaaS) should continue so that it will in the near future contribute to the M&S interoperability standards.

4. Efforts on standards for describing, archiving and reusing simulated Human Behaviour Representation (HBR) need to be continued and even reinforced in cooperation with the Human Factors and Medicine community. In particular, the non-kinetic aspects need attention. The M&S community should contribute its expertise in suitable architectures for behaviour models and interoperability between computer generated elements and live players. The medical domain is also showing increased interest in M&S and several initiatives are ongoing related to medical data models. The M&S community should contribute to standardization efforts in this domain;

5. Considering modelling aspects, requirements are sometimes specific to a particular community of interest, such as Tactical Data Links, weather, cyber effects; those communities are encouraged to work with NMSG to submit existing standards or jointly draft their specific standards as required and publish them as AMSPs to contribute to the M&S body of knowledge;

6. Immersive simulation (Augmented Reality, Mixed Reality, Virtual Reality), generically known as ‘xR’, are developing at significant pace and should be addressed from a standardization viewpoint as well. Note that this concerns technical interoperability as well as human-factor aspects and guidelines (e.g. cyber sickness);

7. The M&S community cannot influence software engineering evolutions, but shall monitor this domain to take profit of emerging technologies as it was successfully done in the past;

8. M&S interoperability is a primary concern of NATO; efforts have to be maintained to improve the current situation of overlapping standards and make progress in direction to substantive interoperability; and

9. Data standards and (big) data sharing standards are a weak area of the overall standardization activity; there is a need to start a general reflection about the data issue in NATO, all the more important as NATO is initiating large simulation programs in support of education and training.

10. Standardization efforts targeted to representation and visualization of simulated natural and human-made environment are even more critical realizing that “de facto” standards, commercial products and SEDRIS are competing; there is a lack of coordinated effort and of a general policy in this domain and the idea of a collective reflection should be promoted and better specified.

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ANNEX A NATO M&S STANDARDS PROFILE (NMSSP) – M&S STANDARDS SUBMITTED TO THE NISP

Table 1: M&S STANDARDS SUBMITTED TO THE NISP

Categories	Sub-categories	Standards attached to the category
M&S methodology, architectures and processes	**Architecture Frameworks**	*None M&S Specific*
	System Engineering Processes	***Mandated*** DSEEP ***Current*** DMAO
	V&V	***Current*** GM-VV VV&A RPG (US DoD) VV&A Templates (US DoD) ***Obsolete*** V&V Overlay on HLA FEDEP
Conceptual Modelling and Scenarios		***Current*** BOM GSD MSDL Link 16 Simulation ***Emerging*** Link 11 Simulation
M&S Interoperability		***Mandated*** HLA ***Current*** DIS FEAT GDL/GFL HLA UCATT ***Emerging*** WebLVC ***Obsolete*** DLC API

Categories	Sub-categories	Standards attached to the category
Information Exchange Data Model		***Mandated*** Enumerations for Simulation ***Current*** HLA OMT BOM Link 16 Simulation RPR FOM NETN FAFD C-BML C2SIM ***Emerging*** Link 11 Simulation
Synthetic Physical Environment	**Sources Data**	***Current*** Terrain: DTED, GeoTIFF, Shapefile, KML Weather: To be Added
	3D Models	***Current*** OpenFlight
	Interchange of environmental data	***Current*** SEDRIS STF CDB RIEDP
	Production processes	***Emerging*** RIEDP
	Visual Systems Interfacing	***Current*** CIGI
	General Purpose	***Current*** SEDRIS
Simulation Analysis and Evaluation		***Current*** *DDCA*
M&S Miscellaneous		*None M&S Specific*
Software Engineering		*None M&S Specific*

ANNEX B STANDARD DESCRIPTION TEMPLATE

[Enter Standard Name]

Standard Title: *[Full title of the standard]*

Standard Identifier: *[Unique identifier, could be the one provided by an SDO]*

Version Identifier: *[Alpha indicators designating Editions and Amendments]*

SDO: *[Standards Development Organisation that developed/maintains the standard]*

STANAG/STANREC identifier: *[Enter STANAG/STANREC details]*

STANAG/STANREC status: *[Enter status - delete rest of wording]* *(Promulgated, Approval/Ratification Draft, Study, Cancelled, Superseded, Withdrawn)*

Abstract: *[Description of the standard]*

Technical Maturity [*Standard Status - e.g. Current/Obsolete*]: *[Description of how mature the standard is - delete rest of wording]* *e.g., how long it has been in evolution or existence, have implementations been developed, etc.*

Applicability: *[The intended uses of the standard]*

Information on implementation: *[Example of standards use - delete rest of wording]* *Specific examples of how the standard has been used in programs and products within individual Nations and in NATO*

Limitations of this Standard: *[List any known limitiations]*

Standard Type: *[Enter Standards Type - delete rest of wording]* *e.g. Conceptual Modelling & Scenarios, M&S Interoperability, etc.*

Public Availability: *[How the standard can be accessed by the general public]*

URL or instructions to Access or Acquire: *[Normally website information]*

Input Date: *[Date the standard was included in the AMSP-01]*

Last Updated: *[Date of last update for the standard metadata]*

Keywords: *[List keywords associated with standard]*

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ANNEX C STANDARDS WITH APPLICABILITY TO NATO M&S DOMAIN

Table 2: Standards with Applicability to NATO M&S Domain

STANDARD	CATEGORIES													
	M&S Methodology, Architectures and Processes			Conceptual Modelling & Scenarios	M&S Interoperability	Information Exchange Data Model	Synthetic Physical Environment						Analysis & Evaluation	Miscellaneous
	Architecture Frameworks	System Engineering Processes	V&V				Source Data	3D Models	Interchange of Environmental Data	Production Process	Visualisation Systems Interfacing	General Purpose		
BOMs				**X**		x								
C2SIM						**X**								
C-BML						**X**								
CDB									**X**					
CIGI											**X**			
DDCA													**X**	
DIS					**X**									
DMAO		**X**												
DSEEP		**X**												
Dynamic Link Compatible (DLC) HLA API					**X**									
Enumerations for Sim						**X**								
FEAT					**X**									
GDL/GFL					**X**									
GM-VV			**X**											
GSD				**X**										
HLA					**X**									
HLA - OMT						**X**								
Link 11 Simulations				x		**X**								
Link 16 Simulations				x		**X**								
MSDL				**X**		x								
NETN FAFD						**X**								
OpenFlight								**X**						
RIEDP									**X**	**X**				
RPR FOM						**X**								
SEDRIS DRM												**X**		
SEDRIS EDCS												**X**		
SEDRIS SRM												**X**		
SEDRIS STF									**X**			x		
UCATT					**X**									
VV&A RPG			**X**											
VV&A Templates			**X**											
Web LVC					**X**									

Note: Some standards in the above table can be relevant to one or two categories. In this case a capital ‘X’ indicates its main category while a low case ‘x’ indicates the secondary one (see ANNEX A above).

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Base Object Model (BOM)

Standard Title: Base Object Model (BOM)

Standard Identifier: This standard is comprised of two documents:

1. "BOM Template Specification", SISO-STD-003-2006,
2. "Guide for Base Object Model (BOM) Use and Implementation", SISO-STD-003.1-2006

Version Identifier: SISO-STD-003, year of publication: 2006

SDO: Simulation Interoperability Standard Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: Base Object Models (BOMs) provide a component framework for facilitating interoperability, reuse, and composability. The BOM concept is based on the assumption that piece-parts of models, simulations, and federations can be extracted and reused as modelling building-blocks or components. The interplay within a simulation or federation can be captured and characterized in the form of reusable patterns. These patterns of interplay are sequences of events between simulation elements. The representation of the pattern of interplay is captured in the first BOM document. [Reference SISO-STD-003-2006]. The second document, the “Guide for Base Object Model (BOM) Use and Implementation”, introduces methodologies for creating BOMs and implementing them in the context of a larger simulation environment. The document is a means of familiarizing the reader with the concept of BOMs and providing guidance for BOM development, integration, and use in supporting simulation development. [Reference SISO-STD-003.1-2006]

Technical Maturity [Current]: The BOM specification and guide were published by SISO in 2006. First uses of BOMs were known to be successful.

Applicability: The BOM template has constructs that allow the expression of 1) a conceptual model (in terms of events and states), 2) a data exchange model based on the HLA OMT, and 3) the relationships between 1 and 2. Parts 1 and 2 can be use independently or together in combination with part 3. BOMs are intended to improve the reusability and composability of models, simulations and federations.

Information on implementation: Some evidence of successful initial use in FR/US.

Limitations of this Standard: A more concise, but less rich in semantics, as compared with other generalized modelling standards such as UML. Specifically targeted to, but not limited to M&S.

Standard Type: Conceptual Modelling and Scenarios

Public Availability: The standard’s specification and guide can be accessed on the SISO website under the "products" heading.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 8 April 2008

Last Updated: 15 September 2020

Keywords: Automation, Behaviour, BOM, Components, Composability, Conceptual Model, FEDEP, Interoperability, Metadata, Patterns, Requirements, Reuse

C2SIM

Standard Title: Standard for Command and Control Systems - Simulation Systems Interoperation (C2SIM)

Standard Identifier: SISO-STD-019-2020

Version Identifier: 1.0

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: STANAG 4856

STANAG/STANREC status: Study

Abstract: C2SIM is a standard for expressing and exchanging information, including initialization information, tasking and reporting, among C2 systems, simulation systems, and robotic and autonomous systems. C2SIM is a unified standard based on the body of knowledge from the existing C-BML and MSDL standards. The C2SIM covers engineering guidelines (creating C2SIM models), data structure mechanisms (format and syntax for C2SIM models) and rules for execution. The latter includes systems initialization (C2SIM Initialize) and exchange of messages among the systems (C2SIM Tasking and Reporting). C2SIM Initialization supersedes the MSDL standard, while C2SIM Tasking and Reporting supersede the C-BML standard. C2SIM defines a logical data model, in the form of a Web Ontology Language (OWL) ontology, and a standard way of generating an XML Schema representation of the ontology. In addition to the Core, a Standard Military Extension (SMX) is also part of the C2SIM standard. A generic Core and extension mechanisms allow for applications outside military. A Land Operations Extension (LOX) has been issued as a separate standard (SISO-STD-020-2020).

Technical Maturity [Current]: C2SIM is based on the C-BML and MSDL standards. MSG-145 “Operationalization of Standardized C2-Simulation Interoperability” supported SISO with technical and operational validation of the PDG draft products.

Applicability: C2SIM provides the foundation to exchange orders, requests and reports between C2 systems, simulation systems, and robotic and autonomous systems. Different application areas can develop extensions to the C2SIM Core Ontology to meet their needs. An extension for Land Operations (LOX) has been developed. Extensions associated with various domains (e.g. Tactical Data Links; Autonomous Systems) are under development.

Information on implementation: Experiments in different Nations and a series of MSG technical activities have contributed to the current draft standard. Experiences from implementation are limited to developmental activities and MSG-145 technical and operational validation activities.

Limitations of this Standard: Experiences from implementation is limited.

Standard Type: Information Exchange Data Model

Public Availability: Via SISO web site

URL or instructions to Access or Acquire: www.sisostds.org

Input Date: 27 November 2019

Last Updated: 3 May 2021

Keywords: C2, Simulation, MSDL, C-BML

C-BML

Standard Title: Standard for Coalition Battle Management Language (C-BML)

Standard Identifier: SISO-STD-011-2014

Version Identifier: 1.0

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: A Battle Management Language (BML) is an unambiguous language used to (a) Command and control forces and equipment conducting military operations and to (b) Provide situational awareness and a shared, common operational picture.

BML is particularly relevant in a network centric environment for enabling mutual understanding. A Coalition BML developed and applied by the all Services and by coalition members would not only allow interoperability among their C2 systems and simulations, but also among themselves. As it is almost impossible to imagine a situation in the future when a single Service will be unilaterally employed, these efforts must be embedded into international standards. Because future military operations, and a significant amount of training, will be Joint in nature, it is critical that a Joint Service approach be taken to the BML development effort.

The C-BML is a standard language for expressing and exchanging plans, orders, requests, and reports across C2 systems, live, virtual and constructive (LVC) modelling and simulation (M&S) systems, and autonomous systems participating in coalition operations. C-BML task representation is organized according to the 5Ws (Who, What, When, Where, Why). C-BML describes a sufficient data model to unambiguously define a set of military orders that can be interpreted by C2, M&S, and ultimately autonomous systems. The standard describes the data model as a subset of JC3IEDM and specifies the information exchange content and structure in the form of an XML schema. The C-BML standard is superseded by the SISO C2SIM standard.

Technical Maturity [Current]: Version 1.0 of the C-BML was approved 14 Apr 2014. Different experimentations were completed which prove the validity of this concept.

Applicability: Leverage interoperability between C2 systems and simulations.

Information on implementation: Many experiences in different nations and MSG-activities with predecessor activities that have led to the current standard.

Limitations of this Standard: The first version of C-BML is based on an XML schema; later versions will include a standardized approach to extensibility.

Standard Type: Information Exchange Data Model

Public Availability: Via SISO web site

URL or instructions to Access or Acquire: www.sisostds.org

Input Date: 19 March 2008

Last Updated: 3 May 2021

Keywords: C2, Simulation, MSDL

CDB

Standard Title: CDB

Standard Identifier: CDB

Version Identifier: 1.2

SDO: Open Geospatial Consortium (OGC)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: The CDB standard defines a standardized model and structure for a single, “versionable”, virtual representation of the earth. A CDB structured data store provides for a geospatial content and model definition repository that is plug-and-play interoperable between database authoring workstations. Moreover, a CDB structured data store can be used as a common online (or runtime) repository from which various simulator client-devices can simultaneously retrieve and modify, in real-time, relevant information to perform their respective runtime simulation tasks. In this case, a CDB is plug-and-play interoperable between CDB-compliant simulators. A CDB can be readily used by existing simulation client-devices (legacy Image Generators, Radar simulator, Computer Generated Forces, etc.) through a data publishing process that is performed on-demand in real-time.

The application of CDB to future simulation architectures will significantly reduce runtime-source level and algorithmic correlation errors, while reducing development, update and configuration management timelines. With the addition of the High Level Architecture - -Federation Object Model (HLA/FOM) and DIS protocols, the application of the CDB standard provides a Common Environment to which inter-connected simulators share a common view of the simulated environment.

The CDB standard defines an open format for the storage, access and modification of a synthetic environment database. A synthetic environment is a computer simulation that represents activities at a high level of realism, from simulation of theatres of war to factories and manufacturing processes. These environments may be created within a single computer or a vast distributed network connected by local and wide area networks and augmented by super-realistic special effects and accurate behavioural models. SE allows visualization of and immersion into the environment being simulated. This standard defines the organization and storage structure of a worldwide synthetic representation of the earth as well as the conventions necessary to support all of the subsystems of a full-mission simulator. The standard makes use of several commercial and simulation data formats endorsed by leaders of the database tools industry.

A series of associated OGC Best Practice documents define rules and guidelines for data representation of real world features.

Version	Document Title (click to download)	Document #	Type
1.2	OGC CDB Version 1.2 Release Notes	20-006	NOTE
1.2	**Volume 0:** Primer for the OGC CDB Standard: Model and Physical Data Store Structure	15-120r6	BP
1.2	**Volume 1:** OGC CDB Core Standard: Model and Physical Data Store Structure	15-113r6	IS
1.2	**Volume 2:** OGC CDB Core: Model and Physical Structure: Informative Annexes	16-005r4	BP
1.2	**Volume 3:** OGC CDB Terms and Definitions	15-112r4	IS
1.2	**Volume 4:** OGC CDB Best Practice use of Shapefiles for Vector Data Storage	16-070r4	BP
1.2	**Volume 5:** OGC CDB Radar Cross Section (RCS) Models	16-004r5	BP
1.2	**Volume 6:** OGC CDB Rules for Encoding Data using OpenFlight	16-009r5	BP
1.2	**Volume 7:** OGC CDB Data Model Guidance Formerly Annex A Volume Part 2	16-010r5	BP
1.2	**Volume 8:** CDB Spatial and Coordinate Reference Systems Guidance	16-011r5	BP
1.2	**Volume 10:** OGC CDB Implementation Guidance	16-006r5	BP
1.2	**Volume 11:** OGC CDB Core Standard Conceptual Model	16-007r5	IS
1.2	**Volume 12:** OGC CDB Navaids Attribution and Navaids Attribution Enumeration Values	16-003r4	BP
1.2	**Volume 13:** OGC CDB Rules for Encoding CDB Vector Data using GeoPackage (Normative, Optional Extension).	20-050	IS
1.2	**Volume 14:** OGC CDB Guidance on Conversion of CDB Shapefiles into CDB GeoPackages (Best Practice)	19-066	BP
1.1	**Volume 0:** Primer for the OGC CDB Standard: Model and Physical Data Store Structure	15-120r5	BP
1.1	**Volume 1:** OGC CDB Core Standard: Model and Physical Data Store Structure	15-113r5	IS
1.1	**Volume 2:** OGC CDB Core: Model and Physical Structure: Informative Annexes	16-005r3	BP
1.1	**Volume 3:** OGC CDB Terms and Definitions	15-112r3	IS
1.1	**Volume 4:** OGC CDB Best Practice use of Shapefiles for Vector Data Storage	16-070r3	BP

Version	Document Title (click to download)	Document #	Type
1.1	**Volume 5:** OGC CDB Radar Cross Section (RCS) Models	16-004r4	**BP**
1.1	**Volume 6:** OGC CDB Rules for Encoding Data using OpenFlight	16-009r4	**BP**
1.1	**Volume 7:** OGC CDB Data Model Guidance Formerly Annex A Volume Part 2	16-010r4	**BP**
1.1	**Volume 8:** CDB Spatial and Coordinate Reference Systems Guidance	16-011r4	**BP**
1.1	**Volume 9:** OGC CDB Schema Package: provides the normative schemas for key features types required in the synthetic modelling environment. Essentially, these schemas are designed to enable semantic interoperability within the simulation context. (Normative)		**Schema**
1.1	**Volume 10:** OGC CDB Implementation Guidance	16-006r4	**BP**
1.1	**Volume 11:** OGC CDB Core Standard Conceptual Model	16-007r4	**IS**
1.1	**Volume 12:** OGC CDB Navaids Attribution and Navaids Attribution Enumeration Values	16-003r3	**BP**
1.1	OGC CDB Version 1.1 Release Notes	18-016r1	**notes**
1.0	**Volume 0:** Primer for the OGC CDB Standard: Model and Physical Data Store Structure	15-120r4	**BP**
1.0	**Volume 1:** OGC CDB Core Standard: Model and Physical Data Store Structure	15-113r3	**IS**
1.0	**Volume 2:** OGC CDB Core: Model and Physical Structure: Informative Annexes	16-005r2	**BP**
1.0	**Volume 3:** OGC CDB Terms and Definitions	15-112r2	**IS**
1.0	**Volume 4:** OGC CDB Best Practice use of Shapefiles for Vector Data Storage	16-070r2	**BP**
1.0	**Volume 5:** OGC CDB Radar Cross Section (RCS) Models	16-004r3	**BP**
1.0	**Volume 6:** OGC CDB Rules for Encoding Data using OpenFlight	16-009r3	**BP**
1.0	**Volume 7:** OGC CDB Data Model Guidance Formerly Annex A Volume Part 2	16-010r3	**BP**
1.0	**Volume 8:** CDB Spatial and Coordinate Reference Systems Guidance	16-011r3	**BP**
1.0	**Volume 9:** OGC CDB Schema Package: provides the normative schemas for key features types required in the synthetic modelling environment. Essentially, these schemas are		**Schema**

Version	Document Title (click to download)	Document #	Type
	designed to enable semantic interoperability within the simulation context. (Normative)		
1.0	**Volume 10:** OGC CDB Implementation Guidance	16-006r3	**BP**
1.0	**Volume 11:** OGC CDB Core Standard Conceptual Model	16-007r3	**IS**
1.0	**Volume 12:** OGC CDB Navaids Attribution and Navaids Attribution Enumeration Values	16-003r2	**BP**
1.0	CDB Multi-Spectral Imagery Extension	17-080r2	**IS**

** where Type stands for:*

- *BP: OGC Best Practice*
- *IS: OGC Implementation Specification*
- *Schema: OGC Schema Package*

Warning: OGC's Best Practices are subject to change without notice.

Technical Maturity [Current]: Version 1.2 of the standard was approved 24 August 2020 by the OGC. Consequences of further aligning CDB and other OGC standards (like GML, CityGML, and GeoPackage) cannot be anticipated yet.

Applicability: Best suited for native CDB-compliant client-applications including image generators, radar simulations, Computer Generated Forces, etc. (missing "CDB-aware" tools, data extraction complexity and costs increase for non-native CDB-compliant client-applications). Use of a CDB data store as an on-line database repository imposes runtime publishers to be developed for client-applications.

Information on implementation: CAE originally designed and developed the Common Database Specification for the United States Special Operations Command (USSOCOM). It was followed by several known implementations of the Common Database Specification, up to the version 3.2 (released by Presagis in March 2014), to which the US Government has unrestricted rights. The structure of a CDB data store composed of tiles, layers, and levels of detail (up to 34 LODs) has been influenced by CAE runtime publishing requirements.

Limitations of this Standard: Missing at present "CDB-aware" tools to understand and access the overall construction / structure of a CDB data store (API and Starter Kit only exist for the Common Database version 3.2, released by Presagis). The number of files in a CDB data store representing a large-sized terrain database may result in a challenging deployment operation. Best practices (e.g. for use of OpenFlight and Shape files, Spatial and Coordinate Reference Systems) leave place for sufficient variations that interoperability and exchange results can vary significantly. The standard does not provide implementation details for developing specific off-line data store editors or runtime publishers.

Standard Type: Synthetic Physical Environment/Interchange of environmental data

Public Availability: The standard is available to the public at no cost (no login required); it can be found on the OGC website under the "Standards and Supporting Documents" heading.

URL or instructions to Access or Acquire: https://www.ogc.org/standards/cdb
Input Date: 19 May 2017
Last Updated: 3 May 2021
Keywords: geospatial data repository, geospatial formats, GEOINT

CIGI

Standard Title: Common Image Generator Interface

Standard Identifier: SISO-STD-013-2014

Version Identifier: Version 4

SDO: CIGI development began in 2000 by The Boeing Company. Over the years CIGI matured under supervision of SISO culminating in an approved open version in August 2014.

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: CIGI is an interface designed to promote a standard way for a host device to communicate with an image generator. As this interface is designed to be a real-time interface; bandwidth requirements have been minimized. CIGI is not to be associated with any particular hardware interface. With CIGI, it is possible to connect a host with an arbitrary number of image generators. The communications can be performed during either synchronous (the host's frame rate matches the image generator's frame rate) or asynchronous operation.

To construct complex simulations, a high level of abstraction is provided by CIGI, using so-called building blocks. Each of these building blocks is generic in nature and represents a related group of data. With these building blocks, things such as high-level image generator commands, out-the-window view portals, entities, special effects, articulated parts, atmospheric effects, mission functions and sensor simulation objects can be specified.

Technical Maturity [Current]: In use and supported by several commercially available image generators.

The SISO Product Support Group (CIGI-PSG) provides support to the generation of registered extension packet IDs as defined in section 6.3 of the CIGI standard.

Applicability: Specifically designed to support the communication between host devices and image generators.

Information on implementation: Supported by several commercially available image generators.

Limitations of this Standard: The first open version of the standard (v4) concentrated on organizing content rather than adding functionality. Future work on the standard will examine how functionality can be expanded.

Standard Type: Synthetic Natural Environment / Visual Systems Interfacing

Public Availability: CIGI is available a C++ class library or a C language SDK/API. Both are freely available at http://cigi.sourceforge.net as open source software under the GNU Lesser General Public License.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 28 September 2009

Last Updated: 21 April 2020

Keywords: Image Generator, Interoperability, CIGI

DDCA

Standard Title: Standard for Distributed Debrief Control Architecture

Standard Identifier: SISO-STD-015-2016

Version Identifier: 1.0

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: DDCA is an object model that is designed to specify the states and behaviours required for multiple discrete debrief systems to interoperate during a distributed debrief (DD) event. Interoperability between different implementations shall be enabled through consistent use of these messages, states and behaviours

Technical Maturity [Current]: The DDCA standard was developed over many years, with the prototype developed by Boeing in 2007. The standard was published in November 2016.

Applicability: This standard is intended for the portion of the Modelling and Simulation (M&S) community who conduct distributed debrief activities, including instructor operator station developers and others who are interested in or are involved in distributed debrief. Other communities of interest, although not the intended primary audience, are encouraged to leverage the standard described here for use in their domains.

Information on implementation: Lacking a reference implementation for either DIS or HLA simulation interoperability standards this standard has nevertheless been implemented in several training devices and has been in use by Boeing since 2007.

Limitations of this Standard: The standard does not include standards for the actual playback of data.

Standard Type: Simulation Analysis and Evaluation

Public Availability: Via SISO web site

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 28 April 2020

Last Updated: 28 April 2020

Keywords: Debrief, Architecture

DIS

Standard Title: “IEEE Standard for Distributed Interactive Simulation” (DIS)

Standard Identifier: DIS (IEEE 1278 series)

Version Identifier: Current official versions:

- IEEE 1278.1-2012 –Standard for Distributed Interactive Simulation – Application Protocols
- IEEE-1278.2-2015 - Standard for Distributed Interactive Simulation - Communication Services and Profiles
- IEEE 1278.3-1996 (R2010) - Recommended Practice for Distributed Interactive Simulation - Exercise Management and Feedback.
- ANSI/IEEE 1278.4-2003 (R2010) - Recommended Practice for Distributed Interactive Simulation - Verification Validation & Accreditation

  1278.3 is planned to be reaffirmed and eventually should be replaced by a new IEEE standard (Annex B to the IEEE Standard “IEEE 1730™ Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP))”

SDO: “DIS workshops” organization until 1997, presently SISO, as a Standards Sponsor of The Institute of Electrical and Electronics Engineers, Inc. (IEEE)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4482; “Standardized Information Technology Protocols for Distributed Interactive Simulation (DIS)”, was promulgated in 1995. An updated version of STANAG 4482 was not ratified in 1999. STANAG 4482 was cancelled in 2010 -- superseded by the STANAG 4603 on HLA.

STANAG/STANREC status: Cancelled

Abstract: DIS is an interoperability standard based on exchanges of formatted messages between simulation applications/ simulators. Simulation state information and interactions are encoded in messages known as Protocol Data Units (PDUs) and exchanged between hosts using existing transport layer protocols, though normally broadcast User Datagram Protocol (UDP) is used.

Technical Maturity [Current]: More than 20 years of use in many NATO countries; very mature technology.

Applicability: Distributed Interactive Simulation (DIS) is a protocol for linking simulations of various types at multiple locations to create realistic, complex, virtual worlds for the simulation of highly interactive activities. This protocol can be used to bring together systems built for separate purposes, technologies from different eras, products from various vendors, and platforms from various services, and permits them to interoperate. DIS exercises are intended to support a mixture of virtual entities with computer controlled behaviour (computer generated forces), virtual entities with live operators (human-in-the-loop simulators), live entities (operational platforms and test and evaluation systems), and constructive entities (wargames and other automated simulations).

Information on implementation: Many operational implementations in various nations. Best example is the US Air Force Distributed Mission Operation (DMO) programme

Limitations of this Standard: The primary limitation of this standard is that it is applicable to only real time (simulated time = wall clock time) simulation and has a fixed object model defined at the platform level.

Standard Type: M&S Interoperability

Public Availability: Available to the public with an IEEE copyright and a fee

URL or instructions to Access or Acquire: www.ieee.org

Input Date: 28 February 2008

Last Updated: 31 March 2020

Keywords: protocol Data Unit, PDU, DIS, Distributed Interactive Simulation, simulation, exercises, distributed, interoperability, verification, validation, certification

DMAO

Standard Title: Distributed Simulation Engineering and Execution Process (DSEEP) Multi-Architecture Overlay (DMAO)

Standard Identifier: IEEE DMAO

Version Identifier: IEEE 1730.1-2013

SDO: Simulation Interoperability Standards Organization (SISO) on behalf of IEEE

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: Many special issues must be addressed when building a distributed simulation environment that involves multiple simulation architectures (e.g., HLA, DIS, TENA). Issues like time management, interest management, and object model reconciliation are all more difficult to resolve when multiple simulation architectures are in play. While the DSEEP provides an architecture-neutral description of the process required to build distributed simulation environments, it does not address the unique issues/solutions associated with the development and execution of multi architecture simulation environments, leaving developers with little or no sources of practical guidance.

Technical Maturity [Current]: The Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP) Multi-Architecture Overlay (DMAO) was approved as an IEEE Recommended Practice (IEEE 1730) in January 2011.

Applicability: The DMAO extends the process described in the DSEEP to address multi-architecture development and execution. It is designed as an overlay, associating issues and solutions relevant to multi-architecture development to existing DSEEP activities.

Information on implementation: No known implementation yet.

Limitations of this Standard: Needs to be tailored for specific uses and interoperability standards selected.

Standard Type: M&S Methodology, Architecture and Processes: Systems Engineering Processes

Public Availability: Copies of this standard may be purchased from IEEE. The first version is freely available only to members.

URL or instructions to Access or Acquire: www.ieee.org. or www.sisostds.org for SISO members only.

Input Date: 25 October 2012.

Last Updated: 02 April 2020.

Keywords: DSEEP, Architecture

DSEEP

Standard Title: IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)

Standard Identifier: IEEE DSEEP

Version Identifier: IEEE Std 1730™-2010

SDO: Simulation Interoperability Standards Organization (SISO) on behalf of IEEE

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: The DSEEP is the successor of former guides based on DIS and HLA. The most known is the FEDEP (Federation Development and Execution Process, whose full name is HLA FEDEP) which was a process of engineering in support of the development of federations of simulations based on the HLA architecture. The FEDEP evolved in two successive versions: the first one was based on HLA 1.3 and was published by the US DoD (1998); the second was an IEEE standard (IEEE Std 1516.3™-2003). Both versions of the FEDEP are now obsolete and are not any more accessible on the IEEE website: they have been replaced by the DSEEP and the DMAO (IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process Multi-Architecture Overlay).
The DSEEP is generic and does not make a reference to any architecture or specific protocol; however, it proposes implementation details in dedicated appendices for the IEEE DIS, HLA standards, and the US DoD Test and Training Enabling Architecture (TENA). The DSEEP is therefore applicable to the distributed systems of simulations which use one interoperability standard DIS, HLA, or TENA.

Technical Maturity [Current]: The DSEEP was approved as an IEEE Recommended Practice (IEEE Std 1730™) in January 2011.

Applicability: Distributed systems of simulations.

Information on implementation: Many experiences in different nations. Extensions are being drafted to cover the development of ‘M&S as a Service’ (MSaaS) solutions, as a follow-up of recent NMSG activities.

Limitations of this Standard: Appendices made available only for IEEE DIS, HLA standards, and TENA.

Standard Type: M&S Methodology, Architecture and Processes: Systems Engineering Processes

Public Availability: Copies of this standard may be purchased from IEEE.

URL or instructions to Access or Acquire: www.ieee.org or www.sisostds.org for SISO members only.

Input Date: 23 April 2003

Last Updated: 16 September 2020

Keywords: Distributed Simulation, Engineering Process, Architecture

Dynamic Link Compatible (DLC) HLA API

Standard Title: Dynamic Link Compatible HLA API Standard for the HLA Interface Specification

Standard Identifier: Dynamic Link Compatible HLA API Standard for the HLA Interface Specification (IEEE 1516.1 Version) [SISO-STD-004.1-2004]

Version Identifier: 2014

SDO: Simulation Interoperability Standard Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: This standard defines link compatible C++ and Java Application Programmer Interfaces (API) consistent with the High Level Architecture Interface Specification and is applicable to HLA Runtime Infrastructures and federates developed in compliance with that specification. The primary objective of this standard is to provide a mechanism to permit federates to utilize RTIs developed in compliance with the High Level Architecture and this specification, without recompiling or relinking federate code.

Technical Maturity [Obsolete]: In use for 4 years and incorporated into the 2010 version of the core IEEE HLA specification. However, it was not declared obsolete by SISO as it can be still in use by people working with the 1516-2000 version.

Applicability: Applicable to the HLA federates using the C++ and Java interfaces to implement the IEEE 1516-2000 series of HLA specifications.

Information on implementation: Unknown within NATO applications.

Limitations of this Standard: This standard is intended to establish the C++ and Java API specifications but it is not intended to facilitate functional compatibility.

Standard Type: M&S Interoperability

Public Availability: Freely downloadable from the SISO web site.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 21 August 2008

Last Updated: 15 September 2020

Keywords: HLA, High Level Architecture, API, Application Programmer Interface, RTI, Run Time Interface, interoperability, architecture, simulation

Enumerations for Simulation Interoperability

Standard Title: Reference for Enumerations for Simulation Interoperability

Standard Identifier: SISO-REF-010-2019

Version Identifier: Version 27, **year of publication**: 2019

SDO: Simulation Interoperability Standards Organization (SISO) as per the Standards Activity Committee Special Working Group (SAC SWG) Enumerations. The process and organization to capture, review, and approve enumerations is defined separately in reference document Enumerations for Simulation Operations Manual (SISO-REF-010.1-2019).

STANAG/STANREC identifier: STANAG 4855

STANAG/STANREC status: Study

Abstract: This reference product is essentially a data dictionary for distributed simulation. It specifies the numerical values and associated definitions for those fields that are identified as enumerations in SISO standards and in SISO-sponsored standards published by IEEE.

The reference product is made available in archive form; as such, it comprises the following files:

- README file
- Enumerations data file (XML) and related schema (XSD);
- Enumerations in a RPR FOM “RPR-Enumerations” module (XML);
- C99 Makefile;
- Enumerations document in Word format, PDF, and HTML format; and
- Translators (XSL) to: Microsoft Excel and C99 Header.

Technical Maturity [Current]: Version 27 of the reference product was approved 14 October 2019.

Applicability: Any distributed simulation architecture, not limited to DIS, HLA, and TENA.

Information on implementation: Many operational implementations in various nations, all over the world. **NOTE**: The Enumeration SWG aims to produce 2 updates to the Enumerations document per year, to ensure latest version refer to the website.

Limitations of this Standard: None

Standard Type: Information Exchange Data Model

Public Availability: The reference product is available to the public at no cost (no login required); it can be found on the SISO website under the "Products & Publications" heading.

URL or instructions to Access or Acquire:
https://www.sisostds.org/ProductsPublications/ReferenceDocuments.aspx

Input Date: 09 May 2017

Last Updated: 30 March 2019

Keywords: Enumerations, Interoperability, DIS, HLA, Link, CIGI

FEAT

Standard Title: Federation Engineering Agreements Template

Standard Identifier: FEAT [SISO-STD-012-2013]

Version Identifier: SISO FEAT standard (approved 2 Aug 2013)

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: The Federation Engineering Agreements Template (FEAT) provides a standardized format for recording federation agreements to increase their usability and reuse. The template is an eXtensible Markup Language (XML) schema from which compliant XML-based federation agreement documents can be created. Creating the template as an XML schema allows XML-enabled tools to both validate conformant documents, and edit and exchange agreements documents without introducing incompatibilities.

Technical Maturity [Current]: The standard is based on lessons learned from experimentation (e.g. US LVCAR Implementation program, MSG-052) and was further evaluated in MSG-106 (2012-2013).

Applicability: Capture and unambiguously document federation agreements for the benefit of all stakeholders in a simulation.

Information on implementation: Used only in experimentation so far. JHU/APL has developed a FEAT Editor, a Java-based tool to simplify development of federation agreements conformant with the XML schema.

See http://sourceforge.net/projects/feateditor/,

The SISO PDG has also developed the FEAT User's Guide [SISO-REF-067-2017].

Limitations of this Standard: The SISO PSG is collecting information regarding example agreements.

Standard Type: M&S Interoperability.

Public Availability: The data files associated with SISO-STD-012-2013 may be downloaded from the SISO Product Data Files webpage.

URL or instructions to Access or Acquire:
https://www.sisostds.org/featprogrammersreference/index.htm

Input Date: 15 May 2014

Last Updated: 21 April 2020

Keywords: Federation Agreements

Gateway Description and Filtering Languages (GDL/GFL)

It consists of a series of 2 SISO standards addressing the selection, integration and usage of gateways in a multi-architecture simulation environment. A gateway can be seen as an “intelligent translator” designed to link simulation enclaves when e.g. middleware incompatibilities, dissimilar models for data exchange, or differences in the nature of the services that are provided by the architectures must be reconciled for such environments to operate properly.

GDL – Gateway Description Language

Standard Title: Standard for Gateway Description Language

Standard Identifier: SISO-STD-014.1-2018

Version Identifier: 1.0 published 12 September 2018

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: Provides a common language for capturing both gateway user requirements and the (translation and performance) capabilities that individual gateways can offer to users. Thus, GDL supports direct mappings between gateway requirements and capabilities, facilitating more informed user gateway selections.

GFL – Gateway Filtering Language

Standard Title: Standard for Gateway Filtering Language

Standard Identifier: SISO-STD-014.2-2018

Version Identifier: 1.0 published 12 September 2018

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: Filtering stands for the elimination of simulation data from one architecture to another architecture, based on criteria. The purpose of data filters is to reduce unneeded or unwanted data communication between architecture pairs. GFL provides a common language for capturing gateway filters independently of the implementation.

SDO: Simulation Interoperability Standard Organization (SISO)

Technical Maturity [Current]: Both GDL and GFL were originally developed in response to US DoD needs expressed in the Live-Virtual-Constructive Architecture Roadmap (LVCAR) effort.

Applicability: GDL and GFL provide support to gateway developers to record gateway capabilities and filtering settings, and further to users in a multi-architecture simulation environment to better select and use a gateway based on its characteristics.

Additionally, resource developers may use GDL and GFL specifications to create tools to facilitate gateway selection, integration and usage in support of simulation event planning, preparation, and execution.

Information on implementation: GDL and GFL specifications are supplemented with a full eXtensible Markup Language (XML) schema and examples (provided as annexes).

Limitations of this Standard: Simulation Data Exchange Model mapping between architectures is outside the scope of current GDL/GFL standards series.

Standard Type: M&S Interoperability

Public Availability: Both products are publicly available on the SISO website under the "Product & Publications" heading.

URL or instructions to Access or Acquire:
https://www.sisostds.org/ProductsPublications/Standards/SISOStandards.aspx

Input Date: 22 November 2019

Last Updated: 19 April 2020

Keywords: Gateway, Translation Capabilities, Filtering Capabilities.

GM-VV

Standard Title: Guidance for a "Generic Methodology for Verification and Validation and Acceptance[9] of Models, Simulations, and Data" (GM-VV).

Standard Identifier: GM-VV. The methodology consists of three documents:

- GM-VV Volume 1 "Introduction and Overview"
- GM-VV Volume 2 "Implementation Guide"
- GM-VV Volume 3 "Reference Manual"

Version Identifier: Current status of the GM-VV documents:

- GM-VV Volume 1 "Introduction and Overview", SISO-GUIDE-001.1-2012 (approved 5 October 2012)
- GM-VV Volume 2 "Implementation Guide", SISO-GUIDE-001.2-2013 (approved 6 June 2013)
- GM-VV Volume 3 "Reference Manual", SISO-REF-039-2013 (approved 9 December)

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: This product provides the international community with guidance for a generic V&V and Acceptance methodology for models, simulations, and data. The product leverages and harmonizes with the contributions from other national and international V&V and Acceptance initiatives such as the current IEEE Std 1516.4™-2007 "IEEE Recommended Practice for Verification, Validation, and Accreditation of a Federation—An Overlay to the High Level Architecture Federation Development and Execution Process", IEEE Std 1278.4™-1997 "IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation—Verification, Validation, and Accreditation", the REVVA projects, the V&V International Test Operations Procedures (ITOP) Working Group, and the US DoD VV&A Recommended Practices Guide. The initial GM-VV draft documents have been produced by the REVVA consortium. The GM-VV document set includes the following:

- GM-VV Vol. 1 "Introduction and Overview". This document provides an overall description of the methodology. It presents the core concepts of the methodology as well as how its architecture binds them together to establish the foundations of the tailorable implementation.
- GM-VV Vol. 2 "Implementation Guide". This document extends Volume 1 by providing guidance on how to apply the methodology. It unfolds the methodology's architecture by elaborating on the processes, products, interactions among the roles, and how to tailor the methodology.

[9] Note that outside of the United States there may not be a formal accreditation process and the terms "acceptance" or "accepted for use" may be used; the term acceptance is the decision to use a simulation for a specific purpose and the term accreditation is the official certification that a model or simulation is acceptable for use for a specific purpose. The GM V&V standard should not treat accreditation aspects.

- GM-VV Vol. 3 “Reference Manual”: This document presents the foundations of the concepts, their dependencies and rationale. This document is meant to be referenced whenever a deeper technical understanding of the methodology is required.

Vol. 1 and 2 are balloted SISO Guidance Products. Vol. 3 is a non-balloted SISO Reference Product.

Technical Maturity [Current]: The GM-VV products are building upon the contributions of mature national and international V&V projects. All three documents have been reviewed and commented within SISO. In addition, there have been case studies conducted (9 use cases introduced in Volume 3).

Applicability: GM-VV methodology was experienced in some benchmarking cases in Canada and Europe. One operational use has been announced (NLD).

Information on implementation: Use cases have been introduced in past SISO workshops.

Limitations of this Standard: A lack of maturity and limited tool support.

Standard Type: M&S Methodology, Architectures and Processes, Verification and Validation (V&V)

Public Availability: Via SISO website.

URL or instructions to Access or Acquire: www.sisostds.org

Input Date: 26 February 2008

Last Updated: 08 Apr 2020

Keywords: Verification, Validation, Acceptance

GSD

Standard Title: Guideline on Scenario Development for Simulation Environments

Standard Identifier: SISO-GUIDE-006-2018

Version Identifier: 1.0 published 25 May 2018

SDO: Simulation Interoperability Standard Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: Scenarios are used to specify situations and conditions to be represented in a simulation environment for the intended purpose of a simulation application. Therefore, scenarios defined by the user of a simulation environment are important sources of requirements for the engineers that are planning and setting up a simulation environment. As such, well-specified scenarios are of utmost importance to ensure that the conceptual model (and the subsequently developed simulation environment) reflects what the user originally wanted.

A scenario specification should be complete, consistent and understandable. Completeness means that a scenario specification has to contain sufficient information to enable persons in the subsequent process (especially during development of the conceptual model) to use the scenario in a meaningful way and to extract all information required for their activities. Consistency refers to the internal correctness of a scenario specification (e.g. no unit belongs to more than one party, initial positions of all units are within the specified geographic area). Understandability requires that a scenario specification has to be written and structured in a way that it is easily accessible by future users.

The Guideline on Scenario Development (GSD) provides detailed information regarding the development of scenarios for (distributed) simulation environments and the relationship of the scenario development process with the overarching simulation environment engineering process. The SISO Guidance Product is based on the IEEE Std 1730™-2010, IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP) and as such it augments the DSEEP with additional information specific to scenario development.

Technical Maturity [Current]: GSD is based on the results of NATO MSG-086 “Simulation Interoperability” and national guidelines of similar nature. The NMSG has recently set up Technical Course (MSG-162) on “Guideline for Scenario Development”; three sessions were held in 2018, in Germany, France, and Canada.

Applicability: GSD provides initial support to SMEs, M&S experts, and system operators including which standards and tools may be used to specify scenarios in the context of distributed and non-distributed simulation environments. It is not restricted to a specific domain (e.g. military scenarios), but may be applied in various different domains (e.g. crisis management scenarios).

Information on implementation: GSD has been used at several occasions so far:

- Germany recommends that all new CD&E activities follow GSD guidance, especially defining operational scenarios as a first step to define the operational context and operational requirements;

- Several experiences were performed by the French MoD since 2015 in order to move ahead the transition from system engineering to simulation;
- MSG-145 “Operationalization of Standardized C2-Simulation Interoperability”, decided to experiment GSD guidance in order to master systems interoperability with the goal to provide suitable C2SIM extensions.

Limitations of this Standard: GSD recommends specific standards for the individual phases of the scenario development process. The focus is on aspects of scenario development relevant for setting up and running simulation environments. It thereby augments other well-known guidelines, which address the operational aspects of scenario development or focus on special application areas of simulation (e.g. Computer Assisted eXercises or CAX).

Standard Type: Conceptual Modelling and Scenarios

Public Availability: The Guidance Product is available to the public at no cost (no login required); it can be found on the SISO website under the "Product & Publications” heading.

URL or instructions to Access or Acquire:
https://www.sisostds.org/ProductsPublications/GuidanceProducts.aspx

Input Date: 22 November 2019

Last Updated: 19 April 2020

Keywords: Scenario, Conceptual Scenario, Scenario Description, Scenario Development

High Level Architecture (HLA) for M&S

Standard Title: IEEE Standard for Modelling and Simulation (M&S): High Level Architecture (HLA)

Standard Identifier: Three documents: IEEE 1516-2010 (Framework and Rules), IEEE 1516.1-2010 (Federation Interface Specification), IEEE 1516.2-2010 (Object Model Template)

Version Identifier: 2010 (year of publication), nickname: “HLA Evolved”

SDO: The IEEE 1516 series of standards are sponsored by the Simulation Interoperability Standards Organization (SISO) Standard Activities Committee, serving as the IEEE Computer/Simulation Interoperability (C/SI) Standards Committee.

STANAG/STANREC identifier: STANAG 4603

STANAG/STANREC status: Promulgated 17 February 2015 (Ed. 02)

Abstract: The High Level Architecture for M&S (HLA) is defined by 3 technical documents. The standards contained in this architecture are interrelated and need to be considered as a product set, as a change in one is likely to have an impact on the others. As such, the HLA is an integrated approach that has been developed to provide a common architecture for simulation.

The Framework and Rules is the capstone document for a family of related HLA standards. It defines the HLA, its components, and the rules that outline the responsibilities of HLA federates and federations to ensure a consistent implementation. The Federate Interface Specification defines the standard services of and interfaces to the HLA Runtime Infrastructure (RTI). These services are used by the interacting simulations to achieve a coordinated exchange of information when they participate in a distributed federation. The Object Model Template provides a specification for describing object models that define the information produced or required by a simulation application, and for reconciling definitions among simulations to produce a common data model for mutual interoperation.

Technical Maturity [Current]: The initial IEEE standard was published and copyrighted in 2000. HLA is considered a mature standard and is in use in numerous countries. The current version (published in 2010) is already in use even in NATO (Snow Leopard project).

Applicability: The High Level Architecture is a technical architecture developed to facilitate the reuse and interoperation of simulation systems and assets. The HLA provides a general framework within which developers can structure and describe their simulation systems and/or assets and interoperate with other simulation systems and assets. The HLA consists of three main components. The first component specifies the Framework and Rules. The second component provides the interface specifications. The third component describes the Federation Object Model requirements in the Object Model Template (OMT) Specification.

Information on implementation: Widely implemented within NATO and PfP nations; limited implementation of HLA in NATO federations. There are a wide variety of commercial, open source and government support tools. Many support the more recent and current version of the standard.

Limitations of this Standard: HLA is not “plug and play”. Some parts of the standards are left open to the RTI implementer, thus different RTIs are not guaranteed to interoperate but this situation is improving thanks to the more recent version of HLA.

Standard Type: M&S Interoperability

Public Availability: Copies of this document may be purchased from the Institute of Electrical and Electronics Engineers at the IEEE Customer Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, U.S.A. or via the IEEE website. SISO members may download one copy free via the SISO website.

URL or instructions to Access or Acquire: https://www.ieee.org and https://www.sisostds.org (SISO members only)

Input Date: 08 April 2008

Last Updated: 15 September 2020

Keywords: architecture, class attribute, federate, federation, federation execution, federation object model, framework, High Level Architecture, instance attribute, interaction class, joined federate, object class, object model template, rules, runtime infrastructure, simulation object model

Link 11 Simulations

Standard Title: Standard for LINK 11/11B Simulation

Standard Identifier: SISO-STD-005-202x

Version Identifier: Version 1.0 (draft version date 14 Mar 2021)

SDO: Simulation Interoperability Standards Organization (SISO).

STANAG/STANREC identifier: No specific STANAG, but should be consistent with and in support of STANAG 5602

STANAG/STANREC status: N/A

Abstract: A SISO standard that defines methods to simulate a Link 11/11B tactical data link network within a Distributed Interactive Simulation (DIS) or High Level Architecture (HLA) federation. The standard defines 3 levels of fidelity ranging from pure message exchange (level LOW) to sophisticated Link 11/11B network modelling (level MEDIUM). The three parts of the standard describe Link 11/11B network simulation using DIS (including some extensions), Link 11/11B network simulation using HLA, and a Base Object Model (BOM) as a general modelling approach to Link 11/11B network modelling. The DIS specific part of the Link 11/11B standard in more detail explains the usage of DIS Transmitter and Signal Protocol Data Units (PDUs). HLA/Real-time Platform Reference (RPR)-FOM based simulations also will be able to simulate Link 11/11B networks by incorporating the corresponding FOM extensions described by the Link 11/11B standard into their FOM/SOM. This is easily accomplished using the BOM defined in the appendix of the Link 11/11B standard.

Technical Maturity [Emerging]: Prior to 2019, each SISO tactical datalink simulation standard had its own development group and there was a separate support group mostly associated with the Link 16 Simulation Standard. These groups all merged into the TADIL TALES PDG & PSG. In May 2021 this group lists the Standard for LINK 11/11B Simulation as “in development”.

Applicability: There are immediate and overdue operational requirements for existing military simulations to exchange Link 11/11B data using a single interoperability method (i.e. DIS or HLA) instead of implementing additional protocols like SIMPLE. The HLA “rule set” requires all data to be exchanged only via the RTI, thus rendering any simulation application federations using “bypass channels” like e.g. SIMPLE as not HLA compliant.

Information on implementation: There will be a draft implementation from the Canadian Defense Ministry, as well as the U.K. E-3D training program.

Limitations of this Standard: This standard should only apply to Link 11/11B network simulation via DIS or HLA.

Standard Type: Information Exchange Data Model

Public Availability: via SISO TADIL TALES PDG & PSG website.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 07 July 2008

Last Updated: 3 May 2021

Keywords: Tactical Data Link, LINK 11, LINK 11B

Link 16 Simulations

Standard Title: Standard for LINK 16 Simulation

Standard Identifier: SISO-STD-002-2006

Version Identifier: 10 July 2006 (released version, a draft version 2.0 SISO-STD-002-2019 dated 31 May 2019 is available on the SISO website)

SDO: Simulation Interoperability Standards Organization (SISO).

STANAG/STANREC identifier: No specific STANAG, but consistent with and in support of STANAG 5602 (edition 1)

STANAG/STANREC status: N/A

Abstract: There are immediate operational requirements for military simulation applications to simulate the exchange of Link 16 data messages during a simulation execution. This standard provides means to incorporate the Link 16 message exchange into DIS or HLA simulation networks thus eliminating the need for additional transport protocols (e. g. SIMPLE). The Link 16 standard defines 5 fidelity levels ranging from pure message exchange only (level LOW) to sophisticated Link 16 network modelling including Return Trip Timing messages, Net Entry and Exit, Actual versus Perceived location and encryption methods (level HIGH). The three parts of the standard describe Link 16 network simulation using DIS (including some extensions), Link 16 network simulation using HLA, and a Base Object Model (BOM) as a general modelling approach to Link 16 network modelling. The DIS specific part of the Link 16 standard in more detail explains the usage of DIS Transmitter and Signal Protocol Data Units (PDUs). HLA/Real-time Platform Reference (RPR)-FOM based simulations also will be able to simulate Link 16 networks by incorporating the corresponding FOM extensions described by the Link 16.

Technical Maturity [Current]: Aside from the approved version SISO-STD-002-2006 of the standard, a follow-on version is emerging under the label SISO-STD-002-20XX Link 16 Simulation Standard as “in development”.

Applicability: There are immediate and overdue operational requirements for existing military simulations to exchange Link 16 data using a single interoperability method (i.e. DIS or HLA) instead of implementing additional protocols like SIMPLE. The HLA “rule set” requires all data to be exchanged only via the RTI, thus rendering any simulation application federations using “bypass channels” like e. g. SIMPLE as not HLA compliant.

Information on implementation: In use in NATO and partner countries.

Limitations of this Standard: This standard applies only to Link 16/JTIDS/MIDS. It does not address Link 16 over SATCOM.

Standard Type: Information Exchange Data Model

Public Availability: via SISO TADIL TALES PDG & PSG website.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 20 March 2008.

Last Updated: 3 May 2021

Keywords: Tactical Data Link, LINK 16

MSDL

Standard Title: Military Scenario Definition Language (MSDL).

Standard Identifier: SISO-STD-007-2008.

Version Identifier: Version 1 (approved 14 Oct 2008)

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: The Military Scenario Definition Language (MSDL) is intended to provide a standard initialization mechanism for loading Military Scenarios independent of the application generating or using the scenario. Standard MSDL is defined utilizing an XML schema thus enabling exchange of all or part of scenarios between (e.g.) C2 planning applications, simulations, and scenario development applications. XML based scenario representations can readily be checked for conformance against the standard's schema. The scope of MSDL is bounded by the situation, defined at one instant in time, combined with the course of action about to be taken in context to that situation. The intent is for MSDL to include that information which is either core or common to the situation and course of action (COA) of a military scenario. Definition of COA falls under the scope of the Coalition Battle Management Language (C-BML). The MSDL standard is superseded by the SISO C2SIM standard (C2SIM Initialize).

Technical Maturity [Current]: The MSDL Standard evolved from a common scenario format definition initiated by the USA OneSAF Program in 2001. The initial scenario format as proposed by OneSAF was matured and enhanced through additional US and international involvement as part of the SISO standards development process that resulted in a ratified MSDL standard in Oct 2008.

MSDL version 1 is an official SISO standard – approved 14 Oct 2008 and reaffirmed 11 May 2015. MSDL version 2 (C2SIM Initialize) is being developed under the auspices of the C2SIM PDG.

Applicability: MSDL provides the M&S community with the ability to create military scenarios that can be shared and reused among a variety of simulations. Furthermore MSDL provides a mechanism for reusing military scenarios between independent simulations and federated simulations.

- Facilitation of interoperability for multiple military simulation products.
- Real-world scenario data capture (e.g. C4I) can easily be ported to military simulation systems.
- Easier comparison of military simulation products using the same initial conditions.
- Enables third party products for military scenario design.

Information on implementation: User experience across NATO MSG activities and participating nations in support of standards-based C2 and simulation interoperation as well as the USA OneSAF community.

Limitations of this Standard: Mainly targeted to land operations; needs to be generalized to joint operations.

Standard Type: Conceptual Modelling and Scenarios.
Public Availability: Via SISO web site.
URL or instructions to Access or Acquire: https://www.sisostds.org/
Input Date: 19 March 2008
Last Updated: 3 May 2021
Keywords: Scenario, Simulation, C-BML

NETN FAFD

Standard Title: NATO Education and Training Network (NETN) Federation Architecture and FOM Design (FAFD)

Standard Identifier: AMSP-04

Version Identifier: v3.0

SDO: N/A

STANAG/STANREC identifier: STANREC 4800

STANAG/STANREC status: Promulgated 26 Mar 2021 (Ed. B)

Abstract: The purpose of NETN Federation Architecture and FOM Design Document (FAFD) is to provide a common reference federation agreements document (FAD) for all federations supporting the NATO Education and Training Network (NETN). Agreements that are common to all NETN based federations are specified in this document. Principles and format for information exchange between federates in a NETN based federation is defined in the FAFD. STANAG 4603 (HLA) is used and part of the federation agreements are provided as HLA Federation Object Model (FOM) modules.

The NETN FAFD is intended to be used as a template and/or reference when developing federation specific agreements. In any specific federation more detailed and other types of agreements are almost always required. This reference agreement document is not intended to replace the need for developing federation specific agreements.

All updates and versioning of AMSP-04 is coordinated by the NATO Modelling and Simulation Coordination Office (MSCO), managed by the NATO Modelling and Simulation Group (NMSG) and performed as NATO Science and Technology Organization (STO) technical activities in support of the NMSG Modelling and Simulation Standards Subgroup (MS3). AMSP-04 was originally developed by NATO Modelling and Simulation Group (NMSG) Task Group, MSG-068. The current version (3.0) was updated by MSG-163 Task Group.

AMSP-04 is currently maintained by MSG-191 and a new release (v4.0) is being prepared. All documentation and related Federation Object Models (FOM Modules) are Not Classified and both current and development versions are freely available to the community via GitHub (https://github.com/AMSP-04/). Feedback on the use of AMSP-04, suggestions for improvements and identified issues are welcome and can be provided using GitHub issue tracking. However, development and update of AMSP-04 requires participation in NMSG technical activities with a delegated maintenance responsibility.

The content and scope of AMSP-04 is developed with representatives from the participating NATO and partner nations representing a broad community of practice with respect to federation architecture and design. Requirements from major systems, federations and training networks are provided as input to the development and harmonization of this standard.

Key modules included in the NETN FAFD v3.0 are:

- RPR FOM v2.0 (AMSP-04 Extends and complements RPR-FOM v2.0)

- Extensions for representing platforms and aggregates
- Enhanced Logistics modelling using Service Consumer-Provider Patterns
- CBRN modelling
- Multi-Resolution-Modelling (Aggregation/Disaggregation)
- Transfer of Modelling Responsibilities (TMR)
- Entity Tasking and Reporting (ETR)
- Representation of Organizations and Extensions of MSDL to support initial allocation of modelling responsibilities

Technical Maturity [Current]: The NETN FAFD has been used in experimentation (MSG-068 Final Experiment, SEESIM 12 NTF Experiment) and in exercises (Viking 11, 14 and 18). The technical maturity is strong and proven. Maintenance of NETN FAFD v3.0 is currently conducted by MSG-191 on behalf of MS3. User feedback and proposals for new modules are received through CSO and GitHub issue tracking and managed by MSG-191. AMSP-04 is in the process of being updated to v4.0 and released as Ed C.

Applicability: The NETN FAFD is intended as a reference document for creating federation specific agreements on information exchange and simulation interoperability. The FOM modules described in the FAFD can be extended and complemented with additional modules.

Information on implementation: The NETN FAFD has been used in experimentation (MSG-068 Final Experiment, SEESIM 12 NTF Experiment) and in exercises (Viking 11, Viking 14 and Viking 18). Extensive use of NETN FAFD is planned for exercise Viking 22 to federate simulation and C2 systems and services originating from NATO and Partner nations. It has also been used extensively in various research activities in e.g. SWE and NLD. The technical maturity is strong and proven.

Limitations of this Standard: The standard does not cover all aspects of federated simulation interoperability and the set of modules represent the prioritization made by the task groups when developing this version. The standard is extensible and will incrementally include additional modules.

Standard Type: Information Exchange Data Model

Public Availability: The NETN FAFD v3.0 is under custodianship of NATO Modelling and Simulation Group M&S Standards Subgroup (NMSG MS3) and is currently released as AMSP-04 Edition B covered by STANREC 4800 Edition 2. An updated version is planned for release in 2024.

URL or instructions to Access or Acquire: Current version to be published on CSO website.

Input Date: 02 Sep 2013

Last Updated: 28 Apr 2021

Keywords: Federation, Federate, Simulation, Interface, Interoperability

OpenFlight

Standard Title: OpenFlight Scene Description Database Specification ®

Standard Identifier: OpenFlight ®

Version Identifier: 16.0

SDO: Open Geospatial Consortium (OGC)

STANAG/STANREC identifier: None

Abstract: OpenFlight is a 3D scene description file format used in the high-end real-time visual simulation industry. It is also used as a standard interchange format between different image generation systems. OpenFlight is intended for use in real-time systems and supports: variable levels of detail, degrees of freedom, sound, instancing (both within a file and to external files), replication, animation sequences, bounding volumes for real-time culling, scene lighting features, light points and light point strings, transparency, texture mapping, material properties, and many other features. Military visual simulation includes battle simulation, fighter jet flight simulation and tank simulation while visual simulation also includes geo-specific terrain for accurate fly through of regions. As part of the CDB standard, OpenFlight v16.0 was approved as an open community standard by OGC. OpenFlight v16.7 (latest version) has been submitted to OGC as a community standard in its own right.

Technical Maturity [Current]: Mature standard/minor revisions occur periodically.

Applicability: The actual specification is of most use to software developers but it is also of interest to model developers (visual artists) as it determines what visual effects can be modelled (e.g. transparency) and how they are represented.

Information on implementation: The standard is used in a very large number of end-user applications and in software development tools from Presagis and other companies. Many businesses have incorporated OpenFlight in their products.

Limitations of this Standard: As a community standard, OpenFlight has been endorsed by OGC but OpenFlight is technically owned and controlled by Presagis and the standard or its open source availability may change at any time. Although the OpenFlight file format allows for vendor specific data field additions, some modelling and simulation tools may not fully support vendor specific additions to the file format. It is protected under the copyright and trademark laws of the United States of America.

Standard Type: Synthetic Physical Environment / 3D Models

Public Availability: Freely available.

URL or instructions to Access or Acquire: The standard specification http://www.presagis.com/files/standards/OpenFlight16.7.pdf OpenFlight API http://www.presagis.com/products_services/products/modeling-simulation/free_tools/openflight_api/

Input Date: 29 April 2008

Last Updated: 16 February 2021

Keywords: 3D visualization format, Presagis, real-time visualization, OpenFlight, visualization database, 3D geometry model, interchange format.

RIEDP

Standard Title: Reuse and Interoperation of Environmental Data and Processes

Standard Identifier: SISO-GUIDE-007-2018

Version Identifier: 1.0 (published standard)

SDO: Simulation Interoperability Standard Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: RIEDP promotes reusability of environmental database generation efforts and fosters interoperability between simulation systems through a standardized understanding of both their environmental data products and generation processes. The focus is on the harmonization of environmental database generation processes, and includes a uniform method for the representation of such data, as well as the means to exchange the generated data, at various points in the process, after the source data collection stage but before the runtime/proprietary database creation stage. Added to this is the desire to not introduce specific target application constraints prior to that point in the process (such constraints should be addressed separately by each target application during or just prior to creating the runtime database). In addition, it is desirable and valuable to retain the data form (or format) as close to the source data as possible throughout the data generation process in order to benefit from GIS tools and any intrinsic correlation factor they may provide.

Two complementary RIEDP specification products address this.

Document Title	Document #
RIEDP Data Model Foundations	SISO-GUIDE-007
RIEDP Detailed Feature Description	SISO-STD - TBD

Technical Maturity [Current]: Version 1.0 of the RIEDP Data Model Foundations document was published by SISO on 12th September 2018. The RIEDP Detailed Feature Description document is under development and should be available by the end of 2020.

Applicability: Allows sharing and reuse of various types of environmental data products, from a single layer terrain (identified as Profile 1 in the RIEDP Data Model Foundations) to a comprehensive Full Flight Simulator database (identified as Profile 12), as well as including reusable elements such as 3D models.

Deliberately does not cover the last stage of the data generation process (publishing), which shall be performed by the user in accordance with its target application run time constraints.

Information on implementation: The RIEDP approach takes benefit of the lessons learnt from all related initiatives and standards. These include the US Army/SE Core, US Navy/NPSI, USAF/AFCD, USSOCOM/CDB, DBMS, and EDS initiatives, ISO/IEC PNG and JPEG standards, and the SEDRIS family of ISO/IEC standards, as well as formats commonly used by the M&S and GIS community.

The RIEDP approach represents a common denominator for the database generation process by providing a Reference Process Model (RPM), and includes a formal Reference Abstract Data Model (RADM), relying on use of existing formats, specifying unique profiles, and focusing on metadata and attribution semantics. As such, it is referred to as a production related standard in the AMSP-01.

This allows the best sharing and reuse of environmental data, independently from any target application implementation, with a current scope addressing static terrain from single terrain layer to high-end visual system database. As such, it is referred to as an interchange related standard in the AMSP-01.

The RIEDP approach does not impose internal solutions on environmental data producers. It provides a common data sharing approach at various stages of the data generation process and relies on a formal abstract data model (RADM), along with specific metadata and attribution.

The RIEDP Data Model Foundations specification relies on the RIEDP Detailed Feature Description specification for defining the semantics of the attribution of the environmental objects/features. Conversely, the RIEDP Detailed Feature Description specification assumes the use of RIEDP Data Model Foundations for defining the geometric and organizational relationships between environmental data.

Limitations of this Standard: The specification addresses the static terrain only, but can be used as a base for, and subsequently to integrate results from, dynamic terrain development efforts (see NATO MSG-156).

Standard Type: Synthetic Physical Environment

Public Availability: The standard is available to the public at no cost on the SISO website under the "Product" heading.

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 16 April 2018

Last Updated: 19 April 2020

Keywords: Database, Sharing, Reuse, Process, Terrain, Data Model, Format, Metadata, Profile, Semantics.

RPR FOM

Standard Title: Standard for Real-time Platform-level Reference Federation Object Model (RPR FOM).

Standard Identifier: SISO-STD-001-2015.

Version Identifier: 2.0

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

Abstract: While the HLA dictates how federates exchange data, it is a Federation Object Model (FOM) that dictates what data is being exchanged in a particular federation. HLA does not mandate the use of any particular FOM, however, several "reference FOMs" have been developed to promote a-priori interoperability. That is, in order to communicate, a set of federates must agree on a common FOM (among other things), and reference FOMs provide ready-made FOMs that are supported by a wide variety of tools and federates. Reference FOMs can be used as is, or can be extended to add new simulation concepts that are specific to a particular federation or simulation domain. The goal of SISO's RPR FOM was not to just implement the DIS Protocol Data Unit structures within HLA object and interaction classes, but rather to provide an intelligent translation of the concepts used in DIS to an HLA environment. The Real-time Platform Reference Federation Object Model 2.0 (RPR FOM 2.0) defines a hierarchy of object and interaction classes for the High Level Architecture (HLA) that provides the capabilities defined in IEEE 1278.1™-1995, IEEE Standard for Distributed Interactive Simulation — Application Protocols, and its supplement, IEEE Std 1278.1a™-1998, IEEE Standard for Distributed Interactive Simulation — Application Protocols. SISO-STD-001-2015, Standard for Guidance, Rationale, and Interoperability Modalities for the RPR-FOM encapsulates guidance in the use of RPR FOM 2.0. It provides descriptions of FOM classes and datatypes and the relationship between the DIS and the HLA-based RPR FOM, as well as rules for accomplishing specific distributed simulation tasks.

Technical Maturity [Current]: RPR FOM 2.0 is based on the IEEE 1278.1-1995 version of the DIS and became a SISO standard in 1999. It corresponds to US DoD 1.3 version of HLA. RPR FOM 2.0 corresponds to the IEEE 1516 version of HLA.

Applicability: Enables federations of real-time, platform-based simulations, typically allowing DIS users achieve HLA compliance.

Information on implementation: In use in many HLA federations.

Limitations of this Standard: Mainly targeted to entity-level simulations. Not suitable to be used at operation level.

Standard Type: Information Exchange Data Model

Public Availability: Via SISO web site

URL or instructions to Access or Acquire: https://www.sisostds.org/

Input Date: 19 March 2008

Last Updated: 02 April 2020

Keywords: Distributed, Simulation, HLA

Synthetic Environment Data Representation and Interchange Specification (SEDRIS)

SEDRIS is a series of 8 ISO standards addressing:

- the representation of environmental data, and,
- the interchange of environmental data sets.

To achieve the first, SEDRIS offers a data representation model (DRM), augmented with its environmental data coding specification (EDCS) and spatial reference model (SRM), so that one can articulate one's environmental data clearly, while also using the same representation model to understand others' data unambiguously. Therefore, the data representation aspect of SEDRIS is about capturing and communicating meaning and semantics. While a data representation model is a necessary component of a standard, it is not sufficient to allow effective use. Thus the second aspect of SEDRIS addresses data interchange. In SEDRIS, data interchange is standardized through a SEDRIS Application Programming Interface (API) and a transmittal format (SEDRIS Transmittal Format or STF). The transmittal format and API are semantically coupled with the data representation model.

SEDRIS is introduced in the order of 3 corresponding STANAGs (4662 to 4664) that are promulgated.

Standard Title: Part 1: Functional Specification (DRM, APIs, and STF)

Standard Identifier: ISO/IEC 18023-1:2006(E), Amd: 1:2012

Version Identifier: 2006 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4664 - SEDRIS Functional Specifications and Abstract Transmittal Format

STANAG/STANREC status: Withdrawn

Abstract: This part of ISO/IEC 18023 addresses the concepts, syntax and semantics for the representation and interchange of environmental data. It specifies:

- data representation model for expressing environmental data,
- the data types and classes that together constitute the data representation model, and
- (c) an API that supports the storage and retrieval of environmental data using the data representation model.

ISO/IEC 18023-1 also specifies topological, rule-based, and other constraints that ensure appropriate data can be available for applications that rely on automatically generated behaviours when interacting with environmental data.

Standard Title: Part 2: Abstract Transmittal Format (ATF)

Standard Identifier: ISO/IEC 18023-2:2006(E)

Version Identifier: 2006 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4664 - SEDRIS Functional Specifications and Abstract Transmittal Format

STANAG/STANREC status: Withdrawn

Abstract: ISO/IEC 18023-2 specifies the abstract syntax of a SEDRIS transmittal. Actual encodings (e.g. binary encoding) are specified in other parts of ISO/IEC 18023.

Standard Title: Part 3: Transmittal Format Binary Encoding

Standard Identifier: ISO/IEC 18023-3:2006(E), Amd: 1:2012

Version Identifier: 2006 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4664 - SEDRIS Functional Specifications and Abstract Transmittal Format

STANAG/STANREC status: Withdrawn

Abstract: SEDRIS Transmittal Binary Encoding defines a binary encoding technique that allows encoding DRM objects specified in ISO/IEC 18023-1 according to the abstract syntax specified in ISO/IEC 18023-2. The name of this binary encoding is SEDRIS Transmittal Format (STF).

Standard Title: Part 4: Language Bindings: C

Standard Identifier: ISO/IEC 18041-4:2016

Version Identifier: 2016 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4664 - SEDRIS Functional Specifications and Abstract Transmittal Format

STANAG/STANREC status: Withdrawn

Abstract: The SEDRIS language binding standard specifies the binding of the application program interface (API) defined in SIO/IEC 18025 to the C program language

Standard Title: Environmental Data Coding Specification (EDCS)

Standard Identifier: ISO/IEC 18025:2014

Version Identifier: 2014 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4662 -- SEDRIS — Environmental Data Coding Specification (EDCS)

STANAG/STANREC status: Withdrawn

Abstract: EDCS specifies objects used to model environmental concept. EDCS includes a collection of nine dictionaries that define environmental concepts, objects, attributes, and quantitative measures of objects. EDCS supports the encoding and communication of qualitative and quantitative information associated with physical environments, both real and virtual. This is accomplished by specifying nine EDCS dictionaries of environmental concepts and the EDCS application program interface. EDCS specifies labels and codes and environmental phenomenon to provide a standard way of identifying concepts.

Standard Title: EDCS Language Bindings Part 4: C

Standard Identifier: ISO/IEC 18041-4:2016

Version Identifier: 2016 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4662 -- SEDRIS — Environmental Data Coding Specification (EDCS)

STANAG/STANREC status: Withdrawn

Abstract: EDCS language binding specifies the binding of the Application Program Interface (API) defined in ISO 18023-6 to the C Programming language.

Standard Title: Spatial Reference Model

Standard Identifier: ISO/IEC 18026:2009(E)

Version Identifier: 2009 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4663 -- SEDRIS —Spatial Reference Model (SRM)

STANAG/STANREC status: Withdrawn

Abstract: SRM provides aspects of spatial positioning of location, direction, distance, mapping, charting, geodesy, imagery, topography, etc. SRM provides for the description, and transformation or conversion, of geometric properties within or among spatial reference frames. SRM also supports specification of the positions, directions, distances, and times associated with spatial information. The SRM may be, and has been, used independently of the other components of SEDRIS standards.

Standard Title: Part 4: SRM Language Bindings: C

Standard Identifier: ISO/IEC 18042-4:2006(E), Amd 1:2011

Version Identifier: 2006 (year of publication)

STANAG/STANREC identifier: no current STANAG/STANREC: former STANAG 4663 -- SEDRIS —Spatial Reference Model (SRM)

STANAG/STANREC status: Withdrawn

Abstract: This part of ISO/IEC 18041-4 specifies a language-independent application program interface (API). For integration into a programming language, the Spatial Reference Model (SRM) API is embedded in a language-dependent layer obeying the particular conventions of that language. ISO/IEC 18042-4 specifies such a language-dependent layer for the C language.

SDO: International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) Joint Technical Committee 1 (ISO/IECJTC 1) Sub-Committee 24. (SC 24)

Technical Maturity [Current]:

Applicability: SEDRIS (ISO/IEC 18023) may be applied to the representation of any environmental data including: (a) terrain, (b) ocean, (c) atmosphere, and (d) space.

Information on implementation: Used widely in the USA, most frequently by ground forces. Some use in other nations (France, for example).

Limitations of this Standard: None identified

Standard Type: Synthetic Physical Environment: General, Interchange of Environmental Data

Public Availability: The standard can be accessed on the website at http://iso.org

URL or instructions to Access or Acquire: http://standards.sedris.org

Input Date: 9 April 2008

Last Updated: 31 March 2020

Keywords: Data Interchange, Environmental Data, Geospatial Data, M&S, Modelling, Representations, SEDRIS, Simulation, Synthetic Environment Data Representation Interchange Specification, Virtual Environment

UCATT Laser Engagement Interface Standard U-LEIS

Standard Title: Standard for Urban Combat Advanced Training Technology (UCATT) Laser Engagement Interface (U-LEIS)

Standard Identifier: SISO-STD-016-00-2016

Version Identifier: Version 1.0, 9 May 2016

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: STANREC 4816

STANAG/STANREC status: Promulgated

Abstract: This standard applies to the optical interface primarily used to communicate a simulated weapon engagement from a weapon simulator platform to a target simulator platform. Additionally, the Laser Engagement interface has a secondary use to communicate administrative and other kind of information (i.e., umpire control-gun commands, indoor positioning and player association).

The Laser engagement Standard is the first physical implementation of an external interface defined in the UCATT functional Architecture for Live Simulation Training Systems

Technical Maturity [Current]: UCATT Laser engagement Standard is based on the optical code OSAG 2.0 standard which is widely used throughout various nations.

Applicability: Contributes to live simulation interoperability by providing a common Laser standard.

Information on implementation: Used in combat training centres in BEL, CZE, DEU, FIN, FRA, GBR, NLD, NOR, POL, SWE, SVN, USA (potentially some under the name “OSAG 2.0 Standard”)

Limitations of this Standard: Not known

Standard Type: M&S Interoperability

Public Availability: Via SISO web site

URL or instructions to Access or Acquire:
https://www.sisostds.org/ProductsPublications/Standards/SISOStandards.aspx

Input Date: 09 May 2016

Last Updated: 11 May 2021

Keywords: Live Simulation & Training, TES, TESS, Laser engagement, Optical Codeset, UCATT, OSAG, AGDUS, STC, SAT

VV&A Recommended Practices Guide (RPG) US DoD

Standard Title: Verification, Validation & Accreditation (VV&A) Recommended Practices Guide (VV&A RPG)

Standard Identifier: VV&A RPG

Version Identifier: RPG 2012

SDO: U.S. Department of Defense

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: The VV&A RPG provides general instructions on how, when, and under what circumstances formal VV&A procedures should be employed. In particular it:

- describes the interrelated processes that make up VV&A
- defines roles and responsibilities of the participants
- identifies special topics associated with VV&A
- identifies tools and techniques
- provides reference material on related areas.

This set of documents also includes an informal discussion of the key concepts of VV&A – the principles, rationale, terminology, and general approach to conducting VV&A for models and simulations. It provides an analogy from everyday life intended to demonstrate the practicality of VV&A, and concludes with a summary of the costs and benefits and an introduction to the remainder of the RPG.

Technical Maturity [Current]: Used on dozens of applications in the USA. Date of latest revision – 18 May 2011.

Applicability: This guide is applicable to the planning, conduction and documentation of all verification, validation and accreditation of models and simulations. Its recommendations should be tailored to the requirements of the specific M&S application.

Information on implementation: Use of the RPG is voluntary but recommended.

Limitations of this Standard: None

Standard Type: M&S Methodology, architectures and Processes: Verification & Validation

Public Availability: May be accessed freely from the Websites below.

URL or instructions to Access or Acquire: https://vva.msco.mil/

Input Date: 27 August 2008

Last Updated: 29 April 2020

Keywords: Verification, Validation, Accreditation, Recommended Practices Guide, RPG

U.S. Department of Defense Standard Practice, Documentation of Verification, Validation, and Accreditation (VV&A) For Models And Simulations

Standard Title: U.S. Department of Defense Standard Practice, Documentation Of Verification, Validation, and Accreditation (VV&A) For Models And Simulations

Standard Identifier: [U.S. Dept. of Defense], number: MIL-STD-3022.

Supporting Data Item Descriptions (DIDs):

- Number: DI-MSSM-81750, Accreditation Plan
- Number: DI-MSSM-81751, Verification and Validation (V&V) Plan
- Number: DI-MSSM-81752, Verification and Validation (V&V) Report
- Number: DI-MSSM-81753, Accreditation Report

Version Identifier: U.S. Dept. of Defense MIL-STD-3022, Change 1, 05 April 2012

SDO: U.S. Department of Defense

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: This standard was developed by the US DoD Modeling and Simulation Coordination Office in coordination with the Military Departments. It establishes templates for the four core products of the Modelling and Simulation Verification, Validation, and Accreditation processes. The intent of this standard is to provide consistent documentation that minimizes redundancy and maximizes reuse of information. This promotes a common framework and interfacing capability that can be shared across all Modelling and Simulation programs within the US Department of Defense, other government agencies and allied nations.

Technical Maturity [Current]: Approved by the US DoD in January 2008.

Applicability: This standard is approved for use by all Departments and Agencies of the US Department of Defense.

Information on implementation: Not Known

Limitations of this Standard: Not Known

Standard Type: M&S Methodology, architectures and Processes: Verification & Validation

Public Availability: Yes, from US Dept. of Defense MIL-STD-3022

URL or instructions to Access or Acquire: https://vva.msco.mil/

Input Date: 27 August 2008

Last Updated: 29 April 2020

Keywords: Verification, Validation, Accreditation, VV&A, Accreditation Plan, Accreditation Report, V&V Plan, V&V Report

WebLVC

Standard Title: Standard for WebLVC Protocol

Standard Identifier: SISO-STD-017

Version Identifier: Version 0.8 - January 2020 (emerging standard, currently undergoing ballot comment resolution)

SDO: Simulation Interoperability Standards Organization (SISO)

STANAG/STANREC identifier: None

STANAG/STANREC status: N/A

Abstract: WebLVC is an interoperability protocol that allows integrating web-based applications (typically JavaScript applications running in a web browser) in traditional M&S federations (which may be using Distributed Interactive Simulation (DIS), High Level Architecture (HLA), Test and Training Enabling Architecture (TENA), or related protocols and architectures). Essentially, WebLVC takes the semantics of DIS or HLA Federation Object Models (FOMs), and represents them using messages in the JSON (JavaScript Object Notation) format, which are typically passed between server and client using WebSockets. The WebLVC protocol defines a standard way of passing simulation data between a web-based client application and a WebLVC server - independent of the protocols used in other distributed simulations. Thus, a WebLVC client can participate in a DIS exercise, an HLA federation, a TENA execution, or other distributed simulation environment.

Technical Maturity [Emerging]: The WebLVC Protocol is used by numerous M&S organizations around the world. Currently, SISO has a Product Development Group (PDG) working on the WebLVC standard. Balloting was successfully completed in November 2020. Prior to publication, the PDG will resolve the ballot comments.

Applicability: Applies to anyone who wants to develop web-based applications, and achieve interoperability with traditional M&S applications and federations – whether those applications are used for training, experimentation, analysis, or other purposes. The Standard will allow web and mobile applications developed by different organizations to interoperate with each other, and with existing native M&S assets. Also, WebLVC may be a natural choice for users of web technologies (e.g., web-based M&S services as part of MSaaS environments).

Information on implementation: Commercial products available and successfully used.

Limitations of this Standard: Unknown

Standard Type: M&S Interoperability

Public Availability: Via SISO web site

URL or instructions to Access or Acquire: www.sisostds.org

Input Date: April 2013

Last Updated: 17 February 2021

Keywords: Web technologies, JSON, web applications, mobile applications.

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ANNEX D ACRONYMS

A

ADatP	Allied Data Publication
ADL	Advanced Distributed Learning
AMSP	Allied Modelling and Simulation Publication
AP	Allied Publication
APD	AMSP Policy Document
API	Application Programming Interface
AVT	Applied Vehicle Technology (an STO Panel)

B

BOM	Base Object Model

C

C-BML	Coalition Battle Management Language
C2	Command and Control
C2SIM	Command and Control - Simulation
C3	Command Control and Communication
C3I	Command Control Communication and Information
CAX	Computer Assisted Exercise
CDB	Common Database (OGC)
CGF	Computer Generated Forces
CIGI	Common Image Generator Interface
CityGML	City Geography Markup Language
CM	Conceptual Modelling
COLLADA	COLLAborative Design Activity
CSO	Collaboration Support Office

D

DDCA	Distributed Debrief Control Architecture
DDS	Data Distribution Service
DIS	Distributed Interactive Simulation
DLC	Dynamic Link Compatible (DLC) HLA API
DoD	Department of Defense
DRM	Data Representation Model (SEDRIS)
DMAO	DSEEP Multi Architecture Overlay
DSEEP	Distributed Simulation Engineering and Execution Process
DTED	Digital Terrain Elevation Data

E

EDCS	Environmental Data Coding Specification (SEDRIS)
ESRI	Environmental Systems Research Institute

F

FAFD	Federation Architecture and FOM Design
FEAT	Federation Engineering Agreements Template
FEDEP	Federation Development and Execution Process
FOM	Federation Object Model (HLA)

G

GDL	Gateway Description Language (SISO)
GFL	Gateway Filtering Language (SISO)
GeoTIFF	Geographic Tagged Image File Format
GEOINT	Geospatial Intelligence
GIS	Geographic Information System
GM-VV	Generic Methodology for Verification and Validation
GML	Geographic Markup Language
GRIB	GRIdded Binary
GSD	Guideline on Scenario Development

H

HFM	Human Factors and Medicine (an STO Panel)
HBR	Human Behaviour Representation
HLA	High Level Architecture
HPML	Human Performance Modelling Language
HTML	Hyper Text Mark-up Language

I

IEC	International Electrotechnical Commission (of ISO)
IEDM	Information Exchange Data Model
IEEE	Institute of Electrical and Electronics Engineers, Inc.
ISO	International Organization for Standardization
ITOP	International Test Operations Procedures
IST	Information Systems Technology (an STO Panel)

J

JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model

K

KML	Keyhole Markup Language

L

LOX	Land Operation Extension (to C2SIM standard)
LVC	Live Virtual Constructive
LVCAR	Live Virtual Constructive Architecture Roadmap

M

M&S	Modelling and Simulation
MDA	Model Driven Architecture
MIM	MIP Information Model
MIP	Multinational Interoperability Programme
MSaaS	Modelling and Simulation as a Service

MSDL	Military Scenario Definition Language
MSG	Modelling and Simulation Group (NATO STO)
MS3	Modelling and Simulation Standards Subgroup (subgroup of NMSG)
MTDB	Master Terrain Database
MTDS	Mission Training through Distributed Simulation

N

NAF	NATO Architecture Framework
NASMP	Naval Aviation Simulation Master Plan
NATO	North Atlantic Treaty Organization
NATOTerm	The NATO Official Terminology Database (https://nso.nato.int/natoterm)
NAVAIR	Naval Air Systems Command
NCIA	NATO Communications and Information Agency
NCS	NATO Committee for Standardization
NetCDF	Network Common Data Form
NETN	NATO Education and Training Network
NISP	NATO Interoperability and Standards Profile
NMSG	NATO Modelling and Simulation Group
NMSSP	NATO Modelling and Simulation Standards Profile
NPSI	NAVAIR Portable Source Initiative
NSO	NATO Standardization Office

O

OGC	Open Geospatial Consortium
OMG	Object Management Group
OMT	Object Model Template
OTAN	Organisation du Traité de l'Atlantique Nord
OWL	Web Ontology Language

P

PDG	Product Development Group (in SISO)
PfP	Partnership for Peace (NATO)
PSG	Product Support Group (in SISO)

R

RADM	Reference Abstract Data Model (RIEDP)
REVVA	Reference for VV&A
RIEDP	Reuse and Interoperation of Environment Database Development Process
RPG	Recommended Practice Guide
RPM	Reference Process Model (RIEDP)
RPR FOM	Realtime Platform Reference (RPR) FOM
RTI	Run Time Infrastructure (HLA)
RTO	Research and Technology Organization (now, STO)

S

SAS	Systems, Analysis and Studies (an STO Panel)
SCI	Systems, Concepts and Integration (an STO Panel)
SCORM	Shareable Content Object Reference Model (ADL standard)
SE	Synthetic Environment
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SET	Sensors and Electronics Technology (an STO Panel)
SISO	Simulation Interoperability Standards Organization
SIMPLE	Standard Interface for Multiple Platform Link Evaluation
SPE	Synthetic Physical Environment
SRM	Spatial Reference Model (SEDRIS)
SME	Subject Matter Expert
SMX	Standard Military Extension (to C2SIM standard)
STANAG	Standardization Agreement (NATO)
STANREC	Standardization Recommendation (NATO)
STF	SEDRIS Transmittal Format
STO	Science and Technology Organization (NATO)
SysML	Systems Modelling Language

T

TDL	Tactical Data Link
TG	Task Group
TR	Technical Report

U

UCATT	Urban Combat Advanced Training Technology
UDP	User Datagram Protocol
UML	Unified Modelling Language

V

V&V	Verification and Validation
VRML	Virtual Reality Modelling Language
VV&A	Verification, Validation and Accreditation (or Acceptation)

W

W3C	World Wide Web Consortium
WebLVC	Web Live Virtual Constructive
WG	Working Group

X

xR	eXtended Reality
X3D	XML 3-Dimensional
XMI	XML Metadata Interchange
XML	eXtended Mark-up Language

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