AMSP-01(A)

NATO MODELLING AND SIMULATION STANDARDS PROFILE

December 2009

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NORTH ATLANTIC TREATY ORGANIZATION

NATO STANDARDIZATION AGENCY (NSA)

NATO LETTER OF PROMULGATION

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1. AMSP-01(A) – NATO MODELLING AND SIMULATION STANDARDS PROFILE is a non classified publication.

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Juan A. MORENO
Vice Admiral, ESP(N)
Director, NATO Standardization Agency

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS

RECORD OF CHANGES

Change Date	Date Entered	Effective Date	By whom Entered

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CHAPTER 1

INTRODUCTION

0101 Purpose

The NATO Modelling and Simulation Standards Profile (NMSSP) aims to provide guidance to NATO and partner nations, as well as national and NATO organisations who have requirements to effectively use modelling and simulation (M&S) in support of NATO coalition and national requirements. **No standard is mandated or endorsed by NATO unless there is a related STANAG.**

0102 Scope of Standards Profile

1. The NMSSP maintains information on M&S standards and recommended practices relevant to achieving M&S interoperability and re-use of M&S components, e.g. data, models. The NMSSP provides a set of standards descriptions for decision making on options for the use of M&S standards for NATO activities, e.g. coalition training and experimentation.

2. Functional areas are classified as:

   a. M&S process standards, e.g. simulation validation and verification, systems engineering.

   b. M&S scenarios.

   c. M&S modelling.

   d. M&S interoperability standards, e.g. technical interoperability, portability standards.

   e. M&S data representation and interchange.

   f. M&S miscellaneous standards, e.g. visualisation, learning management systems.

3. As part of the profile standards and guidance documents are classified as either ‘obsolete’, ‘old’, ‘current’, or ‘emerging’:

   a. ‘Obsolete’ standards are identified as those which are not being maintained and have been superseded. Users should plan replacement activities. For new projects these standards should not be applied.

   b. ’Old’ standards are identified as those which are mature and in wide use, but may have limited capability. In these cases the use of ‘current’ or ‘emerging’ standards may need to be considered in the context of future developments.

   c. ‘Current’ standards are identified as those which are in use and are currently being maintained and developed.

   d. ’Emerging’ standards are identified as those which are being developed (e.g. to meet gaps in capability), but are not yet widely accepted.

0103 Background on NATO Standardisation

1. NATO STANDARDIZATION AGENCY (NSA). Shortly after the establishment of NATO, it was recognized that the co-ordinated development of policies, procedures and equipment of the member nations held great potential for enhancing the military effectiveness and efficiency of the fledgling Alliance. As a result, the Military Agency for Standardization (MAS) was established in January 1951. MAS was combined with the Office of NATO Standardization in 2001. The Charter of the resultant NATO Standardization Agency (NSA), approved in August 2001, gave the NSA expanded responsibilities for the co-ordination of standardization activities within NATO. Today NSA is an independent NATO Agency that reports to the NATO Committee for Standardization (NCS) for general oversight and direction. For issues relating to operational standardization, the NSA reports directly to the Military Committee. The Agency's mission is to foster NATO standardization with the goal of enhancing the combined operational effectiveness of Alliance military forces. As a key part of the NATO Standardization Organization (NSO), the NSA takes an active interest in all standardization related activities in NATO. Standardization is defined within NATO as the process of developing concepts, doctrines, procedures and designs to achieve and maintain the most effective levels of "compatibility, interchangeability and commonality" in the operational, procedural, materiel, technical and administrative fields. The primary products of this process and NATO's tools for the enhancement of interoperability are Standardization Agreements (STANAGs) and Allied Publications (Aps). APs are official NATO standardization documents which NATO nations and commands normally use as a common implementing document. The NSA, as the focal point for NATO standardization efforts, accomplishes its mission through the promotion of co-ordination among all NATO Committees/Working Groups dealing with standardization. Furthermore, it provides support to the operationally oriented working groups that have been established by the Service Boards (Joint, Maritime, Land, Air and Medical) pursuant to authority delegated by the Military Committee. A small staff co-ordinates Agency activities and supports the Director of the NSA. The NSA is functionally organized into five branches (Policy and Co-ordination, Joint, Maritime, Land and Air) and an administrative support element. Following the approval of the NATO Framework for Civil Standards in January 2004 and its notation by the North Atlantic Council (NAC) on 4th March 2004, the NATO Standardization Agency (NSA) has started to implement the necessary measures to enhance co-operation and co-ordination with international and regional standards organizations of interest to NATO. In particular co-operation and co-ordination has been enhanced with international civil standards organisations chiefly ISO, IEC, ITU, CEN, CENELEC and ETSI, but also with national standardization organisations like ANSI, DIN or AFNOR. The first technical cooperation agreements have been signed in November 2004 with CEN, CENELEC and ETSI. They were followed by signatures with ANSI, SAE and ASTM in March 2005. Others will follow in the near future. First in line will be here ISO, SISO (Simulation Interoperability Standards Organization) and IEC. There is a Technical Cooperation Agreement between NATO and SISO signed in July 2007 by the NMSG.

2. NATO MODELLING AND SIMULATION GROUP (NMSG). The NMSG is part of the NATO Research and Technology Organization (RTO). It is assigned responsibility for coordinating and providing technical guidance for NATO M&S activities undertaken by NATO and partner nations. The administration of M&S activities is the responsibility of the Modelling and Simulation Coordination Office (MSCO) of the Research and Technology Agency (RTA) which is the permanent body supporting the RTO. The mission of the NATO Modelling and Simulation Group (NMSG) is to promote cooperation among Alliance bodies, NATO and partner nations to maximise the effective utilisation of M&S. Primary mission areas include: M&S standardisation, education, and associated science and technology. The activities of the Group are governed by the NATO M&S Master Plan. The Group provides M&S expertise in support of the tasks and projects within the RTO and from other NATO bodies. NMSG was officially named as the Delegated Tasking Authority for NATO M&S standards by CNAD (letter DI(2003)243, dated 29 August 2003). In that role the NMSG is responsible for the development of STANAGs and other standardisation documents, such as this guide, in support of NATO Modelling and Simulation activities.

3. MODELLING AND SIMULATION STANDARDS SUBGROUP (MS3). To achieve the standardisation mission of the NMSG the MS3 was formed as an NMSG subgroup. Specifically the MS3 was tasked with producing this NMSSP and administering its development and evolution. Creation of the MS3 and its Terms of Reference (TOR) were officially approved by the NMSG in October 2007.

0104 Scope

This document covers the conduct of NATO M&S activities and supports the following NATO M&S Master Plan objectives:

a. Establish a Common Technical Framework to foster Interoperability and Reuse.

b. Provide Common Services to increase Cost-Effectiveness in NATO M&S.

c. Develop and Employ Simulations.

d. Incorporate Technological Advances.

0105 Proprietary Rights

1. The NATO Policy on Intellectual Property Rights (IPR) for NATO Standards is stated in the C-M(2008)0017 document and is available on the NSA protected website. The document outlines procedures to ensure the protection of intellectual property rights of NATO standardization community from the civilian standardization community.
2. These procedures will resolve potential conflicts between the objective of standardization (the widespread diffusion of a common technology) and the principles of protecting intellectual property rights (the securing of private monopoly rights over a technology as an incentive to develop new products and processes).

3. The NSA owns the NATO copyrights in all NATO standardization documents and retains the right to exploit such copyrights.

5. The rights provided above do not extend to commercial sales of the NATO standardization documents.

6. Concerning referenced standards developed by civil organizations, they have specific copyrights requirements which can be different from one organization to another one. It is the responsibility of standards users to check these restrictions and comply with them. No responsibility will be assumed by the NSA or the NMSG.

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CHAPTER 2

MODELLING AND SIMULATION STANDARDS

0201 NATO Definition of a Standard[1]

1. A standard is a normative document, established by common consent and approved by a recognized body, that describes an exact value, a physical entity or an abstract concept related to a specific subject, to serve as a reference, model, or rule in measuring quantities or qualities, establishing practices or procedures, or evaluating results.

2. **Notes**:

a. A standard provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. [Derived from: ISO/IEC Guide 2:1996].

b. In NATO, a standard may be operational, procedural or technical.

3. In this document the listed standards are mainly procedural or technical.

0202 Rationale for the Establishment and the Use of M&S Standards

1. Historically the need for establishing M&S standards became apparent with the emergence of the distributed simulation concept and the associated technology (end-80s, early-90s). Reuse of different simulators/simulation applications developed under different technological approaches and implemented on different platforms became possible: a requirement for developing interoperability protocols and/or architecture standards emerged. While simulation interoperability spurred the development of many standards, there are other types of M&S and M&S-related standards, e.g., engineering practices.

2. After some years of standards development, it appears than existing standards were only partial solutions to the overall interoperability problem. The current situation is improving but a lot has still to be done. Standards development and maintenance is an evolutionary process. Existing standards must mature to meet changing requirements. When new requirements emerge, new standards will likely be needed.

a. Interoperability between simulations. According to the NATO definition, interoperability is "The ability to operate in synergy in the execution of assigned tasks". When speaking about M&S, interoperability is defined as the "…capability for simulations to physically interconnect, to provide (and receive) services to (and from) other simulations, to use these exchanged services in order to effectively work together …" This definition was given in the NATO M&S Master Plan (1998). It suggests an additional comment: it refers mainly to "technical interoperability" that means the possibility to physically interconnect then communicate. A lot of additional work has to be done after interconnection is ensured, to reach higher levels of interoperability (semantic or substantive interoperability).

Why interoperability is so important:

1 AAP-42 (Edition 1, 2007) - NATO Glossary of Standardization Terms and Definitions

(1) We have moved from individual/team training to collective training (combined, joint, multi-national), multi-level training.

(2) M&S industry tends to become a new and recognized branch, but is still diverse in solutions and general approach.

(3) Nobody wants to depend on unique/proprietary solutions: standards are part of the solution.

b. Good reasons to develop and use M&S standards:

(1) To share investments and access the best of the technology (standards are supposed to represent the state-of-the-art; they are built on experience and are generally based on more recent technological developments).

(2) Standards require a large consensus and are developed in open organizations (SDOs).

(3) They protect investment in M&S: for example, scenario descriptions, models and data bases may be reused in a variety of applications.

From an industry perspective, use of standards facilitates co-operation among traditional competitors on large multinational programmes:

(1) No one feels in a dominant position.

(2) This avoids lengthy negotiations.

(3) They are neither an unacceptable constraint nor a performance overhead: on the contrary, they are an enabler for asset protection and industrial co-operation (standards allow everybody to speak the same language and understand each other).

Overall, there are many benefits to standards. Standards can improve operational capabilities by supporting higher reliability and facilitating new technology insertion. Further, standards reduce costs, including development, lifecycle, and implementer training costs. Finally, standards can reduce complexity and produce more modular and reconfigurable implementations thus reducing development risk.

c. In conclusion: According to recent workshop/conference discussions, 3 phases of the standard development activity are generally identified:

(1) The “age of heroes”: earlier technology development (Distributed Interactive Simulation - DIS), the early days of collective training.

(2) The maturity phase: from technology to engineering process (High Level Architecture - HLA, Federation Development and Execution Process - FEDEP), development of large collective training applications.

(3) Non-training applications: development of operational support, simulation in support of acquisition.

There is a general consensus to declare that the standardization activity is now in phases (2) and (3). M&S standardization is now recognized as indispensable for a mature simulation activity and is a recognized part of the M&S body of knowledge.

0203 Development of Standards

1. The process of developing standards varies depending on the standards development organization (SDO) involved, but most of the steps are common, especially across SDOs developing open standards. Main steps in this process are:

a. A need is identified and described, along with identification of key individuals and organizations that will participate in the standards development. In the parlance of the Simulation Interoperability Standards Organization (SISO) this is known as a product nomination. If the SDO approves, a working group is formed to develop the standard.

b. The majority of the effort and time in the standards development process is the development of a draft specification for balloting. This is true for both open standards development processes as well as closed processes such as the development of a proprietary standard. Typically a series of drafts are developed, reviewed, commented upon, and comments resolved until the working group agrees that sufficient consensus has been achieved to proceed to balloting.

c. The balloting process is typically a more formal process than the draft development described in step ‘b’ above. Typically, all objections require the specification of alternate text to satisfy the commenter (where during the drafting process, less precise comments and identification of concerns are permitted). Balloting processes have a threshold in terms of a percentage of votes who must agree to pass the ballot. If that threshold is not reached, then a recirculation of the ballot is required, after making modifications to the balloted specification to address comments.

d. Once the ballot is passed, the SDO publishes the specification and a maintenance period is started. During the maintenance period, any errors and problems are reported to a maintenance group. For SISO, this group is known as a Product Support Group.

e. At the end of a specified period (typically 5 years) the SDO requires that the standard be revised, renewed without changes, or retired.

2. For open standards processes, steps ‘a’ to ‘d’ above typically take 2-3 years. Controlled standards (those that do not through open balloting), typically have much shorter revision cycles.

0204 Policy

1. The scope of standards that are considered for inclusion:

a. M&S development, integration and employment standards that have been widely adopted and commonly used, and standards that have the potential to be used by and available to NATO.

b. Standards that are specific to M&S and general purpose standards for systems and software engineering (e.g. programming language standards) that have specific implications for M&S.

c. Technical interoperability standards (e.g. the High level Architecture, HLA), data standards (e.g. Synthetic Environment Data Representation and Interchange Specification, SEDRIS) and best practices (e.g. the HLA FEDEP, Federation Development and Execution Process).

2. In terms of maturity the following will be considered for inclusion in the NMSSP:

a. Existing standards applicable to M&S development, integration and employment.

b. Emerging standards, i.e. standards that are under development.

c. Standards which are expected to be produced where a group has been established with that mission (e.g. NATO MSG-058 on Conceptual Modelling).

3. The NMSSP will not include:

a. Standards that will require a fee to implement. For example, if those implementing the standard must pay a royalty fee to the publisher of the standard, it will not be considered. This does not imply that a standard will be precluded just because products based on the standard are sold or licensed.

b. General information technology and software standards (e.g. programming languages as C++) unless they have a specific implication for M&S.

4. The NMSSP will contain only 'open' standards as defined as those standards upon which government and commercial organisations may develop products freely. Candidate standards can be developed by internationally recognised SDOs, industry consortiums, governmental organizations/agencies or vendors.

0205 Procedures

1. The NMSSP will be developed and maintained using the following NMSG process.

a. Any member of the NATO MSG MS3 may propose standards for inclusion in or removal from the NMSSP based on the policy listed above. Proposals will be submitted in the form of a completed profile consistent with Annex A. Submissions shall be sent to the Secretary of MS3.

b. Task Group Chairpersons and NMSG members may also submit standards for consideration via the process described in step 'a' above.

c. The MS3 will vote on inclusion of standards in the NMSSP by an audio or video teleconference, face-to-face meeting, or email. The quorum for a vote shall be 5 members. If a standard receives a 75% vote for inclusion, it will be included.

d. If the 75% threshold is not met, a discussion period of two working weeks (with the exclusion of holidays) shall be observed, followed by an email vote. If a simple majority (above 50%) is reached for inclusion, the standard shall be included. Abstentions do not count in the percentage.

e. All email votes in steps 'c' and 'd' shall be held for a period of two calendar weeks.

f. All standards must be reviewed at least once every three years, and the MS3 membership shall vote for continued inclusion or modification using the voting procedures described in 'c' and 'd' above.

g. The process in steps 'a' to 'f' occurs on a continuing basis. The NMSSP product of these evolutions will be internal to the MS3.

h. On a yearly basis, the NMSSP shall be provided to the NMSG for approval. Upon the NMSG approval, the NMSSP shall be posted to the NMSG Web site and provided to NSA for publication.

2. The same rules shall apply for modifying or deleting items from the profile. Abstentions do not count in the percentage.

3. Any other comments or proposals regarding NMSSP may be addressed via the points of contact or directly to the secretary of MS3 (see Annex C for details).

0206 Standards Development Organisations (SDO) of Interest to the M&S Activity

1. International Organization for Standardization (ISO). The International Organization for Standardization, widely known as ISO, is an international-standard-setting body that promulgates world-wide proprietary industrial and commercial standards. ISO is composed of representatives from various national standards organizations, and acts as a consortium with strong links to member governments. Founded on 23 February 1947, the organization, headquartered in Geneva, Switzerland, has 157 national members out of the 195 total countries in the world. While ISO defines itself as a non-governmental organization, its ability to set standards that often become law, either through treaties or national standards, makes it more powerful than most non-governmental organizations. ISO standards are developed by technical committees comprising experts from the industrial, technical and business sectors which have asked for the standards, and which subsequently put them to use. Many groups wish to contribute to the process of the development of International Standards, because they are affected by those standards. They participate in the technical work of ISO through national delegations appointed by the member bodies of ISO or through liaison organizations of international or broadly-based groups. Since 1947, the ISO has published more than 16 000 International Standards. The ISO's work program ranges from standards for traditional activities, such as agriculture and construction, through mechanical engineering, to medical devices, to the newest information technology developments, such as the digital coding of audio-visual signals for multimedia applications. ISO is officially recognized by NATO as an SDO, under a Technical Cooperation Agreement (TCA) signed by NSA. With the exception of a small number of isolated standards, ISO standards are normally not available free of charge, but for a purchase fee. The official URL for access to ISO Standards is www.iso.org.

2. The Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA). The IEEE is one of the leading standards development organizations in the world. IEEE performs its standards development and maintenance functions through the IEEE Standards Association (IEEE-SA). IEEE standards affect modelling and simulation as well as a wide range of industries including: power and energy, biomedical and healthcare, Information Technology (IT), telecommunications, transportation, nanotechnology, information assurance, and many more. Individuals, including IEEE members of any grade, IEEE Society affiliates, or non-IEEE members are eligible for IEEE-SA membership. Corporate Membership is designed for corporations, government agencies, trade associations, user groups, universities and other standards developing organizations that want to actively participate in standards development. All IEEE members (individual or corporate) are entitled to ballot on an unlimited number of proposed standards projects. Non-members of the IEEE can participate in the balloting process by paying

a “balloting fee”. Currently, IEEE collection of standards consists of more than 2,100 IEEE standards, including drafts. At the present time, the IEEE is not officially recognized by NATO. IEEE Standards Association ("IEEE-SA") offers copyright permission, on a non-discriminatory basis, for any and all uses. IEEE-SA associated materials include IEEE standards and drafts, IEEE-SA policies, procedures, by-laws and publications associated with the IEEE Standards Information Network ("IEEE-SIN"). The payment of royalty may be required, depending on the amount of material to be utilized and/or the intended use of those materials. The official URL for access to IEEE Standards is http://standards.ieee.org/.

3. The World Wide Web Consortium (W3C). The W3C is an international consortium where member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is to lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web. W3C develops Web Standards and Guidelines. W3C primarily pursues its mission through the creation of Web standards and guidelines. W3C also engages in education and outreach, develops software, and serves as an open forum for discussion about the Web. There are many other organizations developing standards for the Internet or the Web in general, and in some cases, their activities may overlap with W3C activities. To help coordinate the development of the Web, W3C engages in liaisons with numerous organizations after careful consideration of the costs and benefits. The Consortium is governed by its membership, which comprises about 400 organizations. Members include only businesses, non-profit organizations, universities, and governmental entities. There is no provision for individual membership. Since 1994, the W3C has published more than ninety such standards, called W3C Recommendations. The W3C is not officially recognized by NATO. Access to W3C Recommendations is under a royalty-free patent license, allowing anyone to implement them. The URL for W3C recommendations is www.w3.org.

4. The Simulation Interoperability Standards Organization (SISO). SISO is an international organization dedicated to the promotion of modelling and simulation interoperability and reuse for the benefit of a broad range of M&S communities. SISO's Standards Activity Committee develops and supports simulation interoperability standards, both independently and in conjunction with other organizations. SISO is a Category C Liaison Organization with ISO/IEC (JTC 1) for the development of standards for the representation and interchange of data regarding Synthetic Environment Data Representation and Interchange Specification (SEDRIS). Each person who registers for and attends a Simulation Interoperability Workshop (SIW) is considered a member of SISO, effective as of the date of such registration. SISO membership automatically expires at the end of any calendar year in which a member fails to attend at least one SISO Workshop. SISO membership exceeds 1400 individuals from 28 countries, representing over 400 organizations. Currently, more than 35 SISO Standards and Reference products have been developed and approved. SISO is officially recognized by NATO as an SDO, under a TCA signed by the NMSG in 2007. SISO standards are normally free of charge. The official website for SISO standards is www.sisostds.org.

5. The Object Management Group (OMG). OMG has been an international, open membership, not-for-profit computer industry consortium since 1989. OMG produces and distributes only specifications – not software. Software products implementing OMG specifications – e.g. MDA (Model Driven Architecture), UML (Unified Modelling Language) or CORBA (Common Object Requesting Broker Architecture) – are available from hundreds of sources including vendor companies and sources of freeware and open-source software, including both OMG members and non-members. Dozens of standards organizations and other consortia maintain liaison relationships with OMG. OMG is an ISO Publicly Available Specifications submitter, able to submit specifications directly into ISO’s fast-track adoption process. Any organization may join OMG and participate in standards-setting process. Membership includes over 800 companies from both the computer industry and software-using companies. Half of the OMG member companies are software end-users in over two dozen vertical markets, and the other half represent virtually every large organization in the computer industry and many smaller ones. Most of the organizations that shape enterprise and Internet computing today are represented

on the Board of Directors. More than 170 specifications have been formally published. There is no official OMG recognition by NATO so far. All of OMG specifications may be downloaded without charge from OMG website: www.omg.org.

6. The US National Institute of Standards and Technology (NIST). The National Institute of Standards and Technology (NIST) was known as the National Bureau of Standards (NBS) between 1901 and 1988. It is a non-regulatory agency of the United States Department of Commerce. The mission of NIST is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life. Two standards published and promoted by NIST are included in the AMSP-01: Integration Definition for Information Modeling (IDEF1X) and Integration Definition for Function Modeling (IDEF0). Standards promoted by NIST are available at their website: http://ts.nist.gov/Standards/ssd.cfm..

7. The US National Geospatial-Intelligence Agency (NGA). The NGA and the National System for Geospatial-Intelligence (NSG) are responsible for establishing geospatial intelligence (GEOINT) standards for the United States defence and intelligence communities. GEOINT standards ensure the timely access to relevant and accurate GEOINT data, services, and products regardless of source, exploitation process, or production element. The National Center for Geospatial Intelligence Standards (NCGIS) at NGA and the Geospatial Intelligence Standards Working Group (GWG) provide critical support to this mission. The NGA has issued a new document that provides guidance and direction to develop an overall baseline for common geospatial standards used to share, manipulate, and exploit digital geospatial data. The document, “Geospatial Intelligence Standards: Enabling a Common Vision," (http://www.nga.mil/NGASiteContent/StaticFiles/OCR/ncgis-eb.pdf) outlines the standards that will be used in the National System for Geospatial-Intelligence (NSG).

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CHAPTER 3

STANDARDS OF INTEREST

1. In its preliminary work to the drafting of this profile, the MS3 has identified dozens of normative documents or guidance documents which could be of interest for the support of NATO M&S activity within. They are very diverse and specific to some steps of the M&S development and exploitation. For clarification reasons, it has been decided to classify them in 9 different categories of standards which are:

a. **Verification and Validation** (V&V).

b. **Simulation Systems Engineering** (including M&S-specific Processes and generic Systems Engineering processes).

c. **M&S Scenarios**.

d. **Modelling** (including Conceptual Modelling and M&S Representation).

e. **Software Engineering** standards (only those applicable to M&S).

f. **M&S Interoperability** standards.

g. **Data Standards** (including data production, data mediation and exchange, data engineering).

h. **Visualization.**

i. **M&S Miscellaneous** (covering those standards that are difficult to insert in previous categories).

2. In some cases, standards could appear in more than one category: for example, the "eXtended Mark-up Language", XML, is clearly a Software Engineering standard but it is also largely in use in the M&S world as a data format; as a matter of fact, XML is the basic format supporting other M&S standards like HLA (High Level Architecture) or C-BML (the Coalition Battle Management Language). In such cases, this should be reflected in the standard description and also commented in the following paragraphs.

3. The emerging/current/old/obsolete attributes, as specified in the article 0102 above, were also assigned to the standards listed below.

Note: The standards listed below are not necessarily eligible for inclusion in the NMSSP (see article 0205 for the procedures for inclusion). References are made only for a more clear definition of the standards categories

0301 Verification and Validation (V&V)

1. V&V was selected as the first category because it concerns the full life-cycle of M&S and it has the first priority for the credibility of the M&S activity. V&V is not the unique acronym used in this area:

VV&A standing for Verification and Validation and Accreditation (or Acceptance[2]) is also largely used by experts of the domain.

2. This standard category includes:

a. The SISO **GM V&V** (Generic Methodology (GM) for Verification and Validation (V&V) and Acceptance of Models, Simulations and Data) – emerging.

b. The European **REVVA1** ("Referential for VV&A") – old.

c. The "**V&V Information Exchange**" (from the ITOP - International Test Operations Procedures consortium) – old.

d. The IEEE 1516.4 "**VV&A Overlay on the HLA FEDEP**" – current.

e. The US DoD "**VV&A Recommended Practice Guide**" (RPG) – emerging.

f. The US DoD "**VV&A Templates**" – emerging.

3. All these standards are documented in Annex B, section B.1. REVVA1 should be superseded by the SISO GM V&V standard and the V&V Information Exchange should not evolve further. Many NATO and partners nations have established national standards. There is some lack of internationally recognized standards that can be filled by current SISO efforts.

0302 Simulation System Engineering (including M&S Processes and Systems Engineering Standards)

1. Few standards listed and described in this profile are specific of the M&S domain. Nevertheless there is a general feeling that the development of simulation systems should be supported by general methods and processes. The failure or limitations of some past simulation projects was sometimes attributed to the lack of good engineering practices supporting their development.

2. This standard category includes:

a. The IEEE 1516.3 **HLA FEDEP** (Federation Development and Execution Process) – current.

b. The European **SEDEP** (Synthetic Environment Development and Exploitation Process) – obsolete.

c. The IEEE 1710 **DSEEP** (Distributed Simulation Engineering and Execution Process) – emerging.

d. **DODAF** (The US DoD Architecture Framework) – current.

e. **IDEF0** (Integration Definition for Function Modelling) developed by the US National Institute of Standards and Technology (NIST) – old.

[2] 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

f. **NAF** (The NATO Architecture Framework) – emerging.

3. The three first standards are specific to the M&S domain. The DSEEP (in development by SISO in support of IEEE) is intended to supersede both FEDEP and SEDEP. The two listed Architecture Frameworks are mainly popular in the C3I systems world but they are well in use in the M&S domain and are recognized of interest by the NMSG. IDEF0 has been used in the Operational View level 5 description within DODAF activities. There are a number of System Engineering standards mainly derived from ISO and IEEE. This profile is not intended to be an encyclopaedia of System Engineering practices.

0303 M&S Scenarios

1. For a long time it was recognized that a way of describing scenarios, archiving, exchanging and re-using them was of paramount interest in the M&S activity: building scenarios is a very time-consuming and resource-consuming activity.

2. There is only one standard known relevant to this topic: the SISO **MSDL** (Military Scenario Definition Language) – emerging.

3. This unique standard is derived from previous US Army efforts. It should evolve for more generality while staying consistent with JC3IEDM (Joint C3 Interface and Exchange Data Model) and C-BML further developments (see article 0307 and Annex B.7 for more information on these standards).

0304 Modelling (Including Conceptual Modelling and M&S Representation)

1. In this categories are listed standards in support of modelling activities: some are very general and useful in describing the requirements and design of simulation (the general conceptual modelling activity). Some others are more specific and support particular aspects of the military activity.

2. This standard category includes:

a. The SISO **BOMs**, (Base Object Models) – current.

b. **UML** (the Unified Modelling Language) from the OMG – current.

c. **XMI** (XML Metadata Interchange) from the OMG – emerging.

d. **SysML** (Systems Modelling Language) from the OMG – emerging,

e. The SISO **RPR FOM** (Realtime Platform Reference Federation Object Model) – current.

f. The NATO STANAG 5602 "**SIMPLE**" (Standard Interface for Multiple Platform Link Evaluation) – current.

g. The **Link 11** Simulation standard development of SISO – emerging.

h. The **Link 16** Simulation standard of SISO – current.

3. The SISO BOMs support the conceptual modelling activity and are considered important for the translation of military requirements into simulation technical specification and, more generally, in support of V&V activity. The three following standards (UML, XMI and SysML) are not specific to M&S but

considered as useful for the modelling activity and are actually used. UML could be listed in the Software Engineering section, such as XMI which in addition could be referenced in the Data Standards section.

4. The RPR FOM is a reference FOM which is widely used in the HLA community. It could also be referenced in the Data Standards section.

5. The last three standards cover more specific modelling needs of the military domain: *Tactical Data* Links simulation. SIMPLE is not specific to M&S but was included for clarification reasons with respect to Link 11 and Link 16 efforts.

0305 Software Engineering

1. The following are general-purpose standards which are very attractive to the M&S community and sometimes considered as part of the methodologies and tools of the M&S domain.

2. This standard category includes:

a. **MDA** (Model Driven Architecture) from the OMG – emerging.

b. **CORBA** (the Common Object Request Broker Architecture) also developed by the OMG – old.

3. MDA and its supporting process (Model Driven Engineering, MDE) are clearly adapted to the M&S activity and in use in simulation system developments. CORBA was sometimes used as an M&S interoperability standard (even in NATO) but appeared as very limited when compared to dedicated standards like DIS or HLA (see next sections).

4. As previously mentioned, many standards listed in the preceding section could be listed here (like UML, SysML or XMI); some could be put in the Data Standards section (0307).

0306 M&S Interoperability

1. The following standards are typical products developed to support distributed simulations developments which began as early as the late 80s or the early 90s. They are mainly supporting interconnection of simulation applications, simulators, live systems and supporting tools. Currently they are all clearly limited to support semantic interoperability and should be superseded or completed by additional standards or technologies in the future.

2. This standard category includes:

a. The IEEE 1516 and NATO STANAG 4603 High **Level Architecture (HLA)** – current.

b. The SISO **Dynamic Link Compatible (DLC) HLA API** – current.

c. The IEEE 1278 Standard Series for **Distributed Interactive Simulation (DIS)** – current.

d. The US Army **TENA** (Test and Training Enabling Architecture) – current.

3. DIS, HLA and TENA are competing standards even if they have different purposes, qualities and inherent limitations. There is currently an US DoD effort investigating what could be done to leverage this

situation. This effort is named LVC (Live Virtual Constructive) Architecture Roadmap and could lead to the development of a new standardization effort. The DLC HLA API standard was developed to complement the HLA standard and compensates for lack of compatibility between HLA commercial supporting software.

0307 Data Standards (Including Data Engineering and Production, Data Mediation and Exchange, Data Engineering)

1. This is a very general category for the interoperability of simulation systems. The creation, certification, archiving and exchange of data are recognized to be important in every M&S policy document. Data standards include the representation of natural and human environment. There are many standards related to this domain of simulated environment and a clear need to clarify their respective role for M&S. Some other related standards can be found in the Visualization section (0308).

2. This standard category includes:

a. **IDEF1X** (Integrated Computer-Aided Manufacturing (ICAM) DEFinition language) – old.

b. **XML** (eXtensible Markup Language) – current.

c. **JC3IEDM** (Joint Common Command and Control Information Exchange Data Model) – current.

d. **C-BML** (Coalition Battle Management Language) – emerging.

e. **SEDRIS – EDCS** (Environmental Data Coding Specification) – current.

f. **SEDRIS – SRM** (Spatial Reference Model) – current.

g. **SEDRIS – STF** (SEDRIS Transmittal Format) – current.

f. **VMAP** (Vector MAP) – old.

g. **DTED** (Digital Terrain Elevation Data) – current.

h. **DFAD** (Digital Feature Analysis Data) – obsolete.

3. Both IDEFX1 and XML are in common use for data engineering and production and are general standards not specific to M&S. JC3IEDM is a STANAG developed by the Multinational Interoperability Programme. The JC3IEDM models the information that allied component commanders need to exchange and is recognized in the M&S community as the reference standard for data description and exchange. For example, the C-BML is developed in consistency with the JC3IEDM: this C-BML effort addresses the crucial interoperability problem between C3I systems and simulation.

4. The next standards are related to the representation of natural and artificial environment in simulation. SEDRIS provides the concepts to represent all environmental domains (terrain, ocean, atmosphere, and space) in an integrated manner, to include urban and littoral areas and is related to three draft STANAGs. SEDRIS is also a very general paradigm covering data modelling and exchange in this domain.

5. SEDRIS EDCS provides mechanisms to unambiguously specify objects used to model environmental concept. SEDRIS SRM provides the binding mechanisms to bind the environmental objects to terrain locations. SEDRIS EDCS and SEDRIS SRM could be used as standalone. The third one, SEDRIS - STF is dependent on the use of the others. Nevertheless, SEDRIS is an integrated approach that has been developed to provide a common architecture for simulation.

6. VMAP is a data format derived from the DIGEST standard (DIgital Geographic information Exchange STandard) which identifies terrain relief and physical manmade terrain features such as roads. It conforms rigorously to a US military standard to ensure interoperability. Although still produced its use is being superseded by DTED.

7. DTED is a data format for representing terrain relief which is in wide use in the M&S world, usually overlaid on imagery to produce 3D data. DFAD is also a data format but is largely used to represent natural entities such as forests or rivers and also artificial entities like roads or buildings. Support maintenance for DFAD ended in November 2001.

0308 Visualization

1. This category is not specific to the M&S world and it is not surprising to find here standards not developed for specific simulation purposes. Nevertheless the importance of visualisation for M&S application is so big that it was decided to include this category into this document.

2. This standard category includes:

   a. **X3D** (XML 3-Dimensional) – emerging.

   b. **VRML** (Virtual Reality Modelling Language) – current.

   c. **OpenFlight** – current.

3. X3D is a standard file format and run-time architecture for defining and communicating real-time, interactive 3D scenes and objects using XML for visual effects and behavioural modelling. The Virtual Reality Modelling Language (VRML) is a file format for describing interactive 3D objects and worlds. OpenFlight is a commercial standard file format for describing 3D scenes and entities.

0309 M&S Miscellaneous

1. In this category can be found those standards which are either very specific or have some connexion with simulation.

2. This standard category includes:

   a. **SCORM** (Sharable Content Object Reference Model).

   b. **SCORM Sim** (SCORM Simulation Interface Standards).

3. SCORM is not a simulation standard but a standard for describing and exchanging contents of learning courses developed under the Advanced Distributed Learning (ADL) concept. It was included in the profile to facilitate the understanding of the follow-on SISO effort named SCORM-Sim which intents to standardize the integration and use of simulation in distant learning systems.

CHAPTER 4

GAPS

1. Many M&S standards are listed in Chapter 3 of this NMSSP and briefly described in Annex B of this document. When considering their number, the reader of the NMSSP may feel that the M&S standardization effort is relatively satisfactory. However, there is a general consensus in the MS3 that the current developments are not sufficient to achieve the important goals of M&S re-use and interoperability. This feeling is shared by partners outside of NATO, such as members of the SISO leadership.

2. Before reviewing the gaps related to each standard category (according to the categorization introduced in chapter 3), two important gaps which were unanimously agreed by MS3 participants should be mentioned:

a. The lack of standards supporting Human Behaviour Modelling (HBM).

b. The lack of standards related to Live simulations.

3. Human behaviour representation in simulation has seen significant progress recently, partly due to the methods and tools developed in the gaming industry. However, the current modelling techniques are difficult to analyze since they are mainly proprietary. Standardisation of behaviour modelling methods and/or languages has not been achieved. Nevertheless, there is an urgent need to address this gap today and it should be dealt with.

4. Concerning the Live training systems, there are some NATO working groups addressing the topic, but it is clear that systems developed by individual nations are in general not interoperable. Within the NMSG, the MSG-063 Task Group (Urban Combat Advanced Training Technology - UCATT 2) is addressing this issue.

0401 Verification and Validation (V&V)

1. The situation in this area seems relatively satisfactory with respect to the number of existing standards. This large figure reflects the general consensus that V&V is a very important topic and that a strong effort is needed to support it.

2. Looking at the described standards it can be observed that:

a. Some standards are old or soon obsolete (such as the European REVVA1 and the ITOP "V&V Information Exchange").

b. A lot of efforts are national and resulting standards are either not shared or not unanimously adopted by other nations (e.g. the US DoD RPG); there is currently only one internationally recognized standard: the IEEE 1516.4 "VV&A Overlay on the HLA FEDEP".

c. There is no international standard supporting the V&V and certification of simulation input data.

d. There is no methodology/process supporting the V&V of human behaviour modelling.

3. In conclusion, international cooperation on this topic is not sufficient enough and NATO has to realize that this effort should be better supported and coordinated to achieve commonly accepted standards in the future.

0402 Simulation System Engineering (Including M&S Processes and Systems Engineering Standards)

1. This is a category where many standards are available. Systems Engineering standards are mature and numerous and may be adapted or tailored to Simulation System engineering.

2. Engineering processes tailored for distributed simulation systems are also satisfactory and the current DSEEP development should provide the M&S Community with an even more general and adaptable process. The only gap to be mentioned is the lack of engineering process dedicated to the development and exploitation of stand-alone simulations. This situation is amazing and could be easily filled.

3. Concerning Architecture Frameworks (AF), there is no gap. Several national standards are available and even an open source version (i.e. The Open Group AF (TOGAF)). The US DoDAF is used by some other nations also. There is also a NATO version of DoDAF available and it was included in this profile (NATO Architecture Framework - NAF). Although the identified AFs are generally well appreciated at "System" level, there is however a recognized weakness related to the "System of Systems" level.

0403 M&S Scenarios

There is only one known standard which is relevant to this topic: the SISO MSDL (Military Scenario Definition Language). Unfortunately, the MSDL is currently very Army/land domain specific. There is a need to develop a 'joint' version of MSDL which is better adapted to the needs of the other services, while staying consistent with JC3IEDM and further developments in C-BML.

0404 Modelling (Including Conceptual Modelling and M&S Representation)

1. Concerning the Conceptual Modelling activity, the MS3 has emphasized the importance of a standardized **guidance** document to:

   a. Support the translation process from M&S sponsor/user requirements into M&S technical specifications.

   b. Support the life-cycle of V&V of M&S and V&V of model input data.

2. Unfortunately, there is currently not even a draft guide available for supporting conceptual modelling, despite the efforts of both SISO and NATO. Nevertheless, there are a lot of documents addressing this topic and many standards that can be used to support this activity. Examples of such standards are: the SISO BOMs (Base Object Models) and RPR FOM (Real Platform Reference FOM), the UML (Unified Modelling Language), XMI (XML Metadata Interchange), MDA (the Model Driven Architecture) and SysML (Systems Modelling Language), all developed by the OMG. All previous standards do not solve the conceptual modelling issue (many of them being just data formats) but are probably a part of the future solution. The OWL (Web Ontology Language) was not included in this profile as a supporting standard because its real impact on the modelling activity was judged as premature and impossible to be assessed.

3. There are some standards available (or under development) to cover modelling of specific military domains. Three of them are related to Tactical Data Links. It is difficult to say if there are gaps related to the modelling of the military domain except the Human Behaviour representation as previously mentioned.

0405 Software Engineering

It is difficult to assess the gaps that are related to this category. Historically the M&S community has been very successful to adopt and use software engineering tools and techniques, standardized or not, when adapted to its needs. M&S is unable to steer software engineering developments and should continue to profit from the state-of-the-art in the software engineering domain.

0406 M&S Interoperability

1. There are probably too many standards in this category such as the IEEE DIS and HLA, the US DoD TENA and the civil OMG CORBA. There is a US initiated effort to try to improve this situation. This activity is largely open to the international community and is known as LVC AR (Live, Virtual, Constructive Architecture Roadmap). Unfortunately, the results of this study were not yet known when drafting the current version of this profile. Even if there seems to be some redundancy between the above-mentioned standards, it should be underlined that:

a. They address different interests and show different capabilities and are not all targeting the same type of applications (e.g. real-time simulations versus non real-time simulations).

b. They all address "technical" interoperability rather than "substantive" interoperability.

c. Only HLA is a promulgated (STANAG 4603).

2. The MS3 group identified a real gap in addressing higher levels of interoperability between simulations and also between the simulated world and the real world.

3. Another gap is related to event-driven simulations, which are widely used in the military M&S domain:

a. There is only academic work and early-bird SISO work to clarify this concept (DEVS, SRML and Open M&S Architecture).

b. There is a lack of interoperability of the numerous COTS products available (this gap should be probably covered by the emerging SISO CSPI standard (COTS Discrete Event Simulation Package Interoperability)).

c. Interoperability between event-driven simulations and real-time applications is already addressed by the HLA but there is room for improvement.

0407 Data Standards (Including Data Engineering and Production, Data Mediation and Exchange, Data Engineering)

1. Many standards are available in this domain, but this situation is not really satisfactory. The JC3IEDM STANAG is hopefully recognized as the basic standard within NATO and nations, but it is not sufficient for the M&S activity. In the data domain, there are many national efforts but they are not always shared between nations. As an example, there is a lack of Reference FOMs for the HLA within NATO,

the RPR FOM being the only well-recognized standard in the category. The only real and promising effort is the SISO C-BML effort supported by NATO.

2. What is lacking so far is a "roadmap" to develop common standards and preliminary talks on this topic have not even been initiated.

3. Concerning more specific standards related to the representation of natural and man-made environment in simulation, there are many so-called de-facto standards. Unfortunately, many are derived from commercial products, are not controlled by independent organizations and there are some concerns about their long-term availability. Some other commonly used standards (such as DFAD or VMAP) are judged as ‘old’ or even ‘obsolete’. Many recent standards are grouped under SEDRIS which could produce three complementary STANAGs (still under a draft ratification format). Unless a general consensus about SEDRIS in NATO appears, it seems important to discuss a roadmap for the modelling of the natural environment in NATO.

0408 Visualization

This category is not specific to the M&S world and there is no standard included in this version of the NATO M&S Standard Profile. Some existing standards were identified, but they were only partially assessed by the MS3. Nevertheless there is no evidence that there are M&S-related gaps in this area so far.

0409 M&S Miscellaneous

1. There is only one gap identified in this category: the lack of standard to support the integration of simulation in distant learning courses.
2. Education and training have a high priority in NATO. Some prototypes have been developed in the US to demonstrate the possibility to interoperate simulations and learning courses: they were successful. While there is a well known standard allowing sharing courses between different platforms (the IEEE SCORM, Sharable Content Object Reference Model), there is not yet a SCORM extension supporting on-line integration of simulations in course contents. This is clearly a gap to be filled and SISO is addressing this issue in the recently started SCORMsim initiative.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

0501 Preliminary Observation

1. Considering the large number of standards and guidance documents mentioned in this profile it is tempting to declare that the situation is rather satisfactory. Unfortunately, there are 2 observations that temper this opinion. First, many listed standards are not coming from the M&S community like MDA or SIMPLE. Second, a quick assessment shows that there are overlapping standards in some specific areas and some obvious gaps in other ones. When there are too many "standards" in support of a particular domain it means "no real standard but many working technologies or methodologies".

2 Previous chapter of this profile identifies gaps. There is a need that NMSG cooperate with the overall M&S community and, particularly, SISO, trying to fill main gaps and align overlapping standards.

0502 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 organisations 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 guidance document are required to maintain currency of the information.

b. Given the role and mandate of the NMSG, and as the Delegated Tasking Authority for NATO M&S Standards, a sub group of the NMSG was the appropriate body to implement and manage the task of developing and maintaining this publication on the long term; in addition, the role of the MSCO as a permanent office in charge of supporting this activity and the focal point is to be emphasized.

c. That a framework structure was required, taking into account functional areas of M&S as well as maturity levels of the various standards and processes.

d. That 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".

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

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

g. Gaps exist within current standards development regarding certain functional areas of M&S, or gaps exist within current standards regarding breadth of application in a functional area.

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

0503 General Recommendations

It is recommended that:

1. This Allied M&S Publication (AMSP-01) be the document for meeting the NATO M&S guidance objectives, and that copy be maintained by the MSCO and made available including via the NATO Simulation Resource Library.

2. The NMSG continue to maintain the MS3 subgroup to manage the process of review and maintenance of the AMSP-01.

3. NATO organizations, member and partner nations be encouraged to contribute additional standards for consideration, and consider active participation in the MS3 subgroup.

4. Review and update of the publication be done at least once per year.

5. Review of the framework of functional areas and maturity levels be included in the annual review.

6. Review of the selection criteria be part of the annual review.

7. The submission procedure be given widest distribution.

8. The NMSG actively solicit support of standards development organisations to address gap issues. This supposes a large diffusion of the AMSP-01 inside and outside NATO.

9. Considering the number of current standards identified and those emerging it could be time to elaborate a strategy about standardization, distinguishing what type of technology should be standardized and which topics are not of interest for standardization.

0504 Specific Recommendations

As far as the categories of standard are concerned:

1. Additional efforts need to occur to align national and international efforts on V&V, cultural differences of nations are slowing down the elaboration of international standards.

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

3. Efforts on standards for describing, archiving and reusing scenarios need to be continued and even reinforced in cooperation with the C3I community based on its preferred standards like JC3IEDM that is the current reference; the M&S community should carefully follow JC3IEDM development.;

4. Considering modelling aspects, requirements of modelling standards are really specific to some communities of interest such as Tactical Data Link domain or the Virtual Ship effort; those communities are encouraged to draft their own standards as required and publish them to contribute to the M&S body of knowledge.

5. The M&S community cannot influence software engineering evolutions but shall seriously monitor what is happening in this domain to take profit of emerging technologies as it was successfully done in the past.

6. 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.

7. Data 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.

Data 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 in this domain and the idea of a collective reflection should be promoted and better specified.

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Annex A

STANDARD DESCRIPTION TEMPLATE

Standard Title: Full title of the standard

Standard Identifier: Unique identifier; could be the one provided by a standards development organization (SDO)

Version Identifier Alpha indicators designating Editions and Amendments.

Standard Development Organization ISO/IEC

STANAG identifier

STANAG status (Study Draft, Approval/Ratification Draft, Ratif. Withdrawn, Promulgated, Inactive, Superseded, Cancelled)

Abstract Description of the standard

Technical Maturity Description of how mature the standard is, 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 Specific examples of how the standard has been used in programs and products within individual Nations and in NATO.

Limitations of this Standard

Standard Type General M&S, M&S Interoperability, Simulation Software Standards, Data Standards, etc.

Public Availability How the standard can be accessed by the general public.

URL or instructions to Access or Acquire

Input Date: Date the standard was included in the NMSSP

Last Updated: Date of last update for the standards metadata

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Annex B

STANDARD DESCRIPTIONS

B.1 Verification and Validation (V&V)

B.1.1 GM V&V

Standard Title: Guidance for a Generic Methodology (GM) for Verification and Validation (V&V) and Acceptance[3] of Models, Simulations and Data.
Standard Identifier: GM V&V
Version Identifier: Second Draft in discussion within SISO.
Standard Development Organization: Simulation Interoperability Standards Organization (SISO).
STANAG identifier: Not a STANAG**.**
STANAG status: Not applicable**.**
Abstract: This product will provide 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 1516.4 "Overlay of the HLA FEDEP", the REVVA 1 project, the V&V International Test Operations Procedures (ITOP) Working Group, and the US DoD VV&A Recommended Practices Guide (RPG). The proposed products will include the following:

- The **User Manual**, which will guide users through the V&V and Acceptance efforts and clarify their responsibilities by explaining how to apply the methodology in practice. It will describe the activities to perform and the products to produce, the interactions taking place among those involved, the flow of products, and how to tailor the methodology to the specific needs of a Modelling and Simulation (M&S) project.

- The **Reference Manual** will document the underlying concepts of the methodology, including the foundations of the chosen terminology, the explanation of the dependencies between activities and products, their meaning for the V&V and Acceptance endeavour, and the rationale for their execution and creation. The reference manual will refer to whenever a deeper understanding of the methodology is required.

- The **Recommended Practices** document will provide user specific guidance with regards to the selection and use of techniques and tools in support of the User Manual. This will include domain specific case studies thereby illustrating the application and tailoring of the methodology.

Technical Maturity [Emerging]: In development: the Reference Manual and User Manual have already gone under one comment round in SISO. There is a first draft of the RPG to be discussed soon in SISO.

Applicability: Is currently experienced in some benchmarking cases (in Canada ("MALO case") and in Europe ("NBC case")).
Information on implementation: Two testing cases will be introduced in future SISO 2008 workshops.
Limitations of this Standard: Some lack of maturity. Too early to be identified.
Standard Type: Verification and Validation (V&V).

Public Availability: SISO open standard (available to SISO members under usual SISO copyright conditions).

URL or instructions to Access or Acquire: www.sisostds.org
Input Date: 19 March 2008
Last Updated: 19 March 2008

[3] 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.

B.1.2 REVVA1

Standard Title: Common Verification, Validation and Accreditation (VV&A) Framework for Simulation.

Standard Identifier: REVVA1

Version Identifier: Version 1 (2005).

Standard Development Organization This standard was developed by the former EUCLID4/CEPA5 11 organization (now disbanded) under the Joint Project JP11.20 consortium (France (lead nation), Denmark, Italy, The Netherlands, and Sweden).

STANAG identifier: No related STANAG.

STANAG status: Not applicable.

Abstract: Description of a common methodological framework for the VV&A of data, models and simulations.

Technical Maturity [Old]: REVVA1 is a set of draft documents developed from 2003 to 2005 : definition documents, guideline documents, state-of-the-art documents, best practices documents and a VV&A process document. It has provided the foundation for the future GM V&V[6] standard development (SISO) which should supersede REVVA.

Applicability: Main objective was to produce the technical basis for a common VV&A methodology able to support and to facilitate the exchange of M&S products within the international M&S community.

Information on implementation: REVVA methodology has been tested on some VV&A cases as benchmarks, in different countries: the five REVVA-consortium nations and also in Germany and the UK.

Limitations of this Standard: Some lack of maturity: should be superseded by the future GM V&V SISO standard.

Standard Type: Verification and Validation (V&V)

Public Availability: Freely available on request to the French MoD procurement agency (DGA, General Delegation for Armament).

URL or instructions to Access or Acquire: send e-mail to Stephane.Chaigneau@dga.defense.gouv.fr

Input Date: 19 March 2008

Last Updated: 19 March 2008

[4] EUCLID : EUropean Co-operation for the Long term In Defence disbanded in 2006, now replaced by the European Defence Agency (EDA)
[5] CEPA : Common European Priority Area ; main topic of CEPA 11 was “Defence M&S Technology”
[6] GM V&V : Generic Methodology for Verification &Validation

B.1.3 V&V Information Exchange

Standard Title: General Procedure for Modelling and Simulation Verification & Validation Information Exchange.

Standard Identifier: ITOP 1-1-002

Version Identifier: 1-1-002

Standard Development Organization: International Test Operations Procedures (ITOP).

STANAG identifier: no STANAG.

STANAG status: N/A

Abstract: This ITOP document describes general procedures for verification and validation (V&V) of Models and Simulations (M&S). It provides a standardized methodology to support the exchange of V&V information among the ratifying nations. It comprises procedures and guidance for planning, implementing, and documenting V&V efforts of M&S. It has influenced the work of the REVVA Consortium.

Technical Maturity [Old]: The current version exists since 2004. This ITOP group has been disbanded in 2006.

Applicability: Used as part of contracts for the development and procurement of defence technology in T&E.

Information on implementation: This standard has been used in programs and products within four individual Nations. More information can be found on the ITOP website: **https://itops.dtc.army.mil /MA63.html**

Limitations of this Standard: Restricted to Four-Nation MoU.

Standard Type: Verification & Validation (V&V).

Public Availability Restricted to Four-Nation MoU

URL or instructions to Access or Acquire: https://itops.dtc.army.mil/MA63.html (access is restricted)

Input Date: 20.03.2008.

Last Updated: 20.03.2008

B.1.4 VV&A Overlay to the HLA FEDEP

Standard Title: "Recommended Practice for Verification, Validation and Accreditation (VV&A) of a Federation — An Overlay to the High Level Architecture (HLA) Federation Development and Execution Process (FEDEP)".

Standard Identifier: IEEE Std 1516.4™-2007

Version Identifier: IEEE Std 1516.4™-2007

Standard Development Organization: Developed by the NATO NMSG Task Group 019 and the Simulation Interoperability Standards Organization (SISO, acting as a standards sponsor for The Institute of Electrical and Electronics Engineers, Inc. (IEEE)).

STANAG identifier: Not yet available (could be either a new AP or a part of a new version of STANAG 4603 (HLA)).

STANAG status: N/A

Abstract: This recommended practice defines the processes and procedures that should be followed to implement Verification, Validation and Accreditation (VV&A) for federations being developed using the High Level Architecture (HLA) Federation Development and Execution Process (FEDEP). This recommended practice is not intended to replace existing VV&A policies, procedures, and guidance, but rather is intended to focus on the unique aspects of the VV&A of federations. It provides a higher-level framework into which such practices can be integrated and tailored for specific uses.

Technical Maturity [Current]: It is a relatively recent recommended practice document but it benefits from 10 years' practical experience.

Applicability: Primarily targeted for users, developers and VV&A personnel working with simulations and simulation compositions based upon the HLA and the FEDEP. Users, developers and VV&A personnel working with simulations and simulation compositions not based upon the HLA and the FEDEP can also benefit from the guidance in this document since the activities that this overlay describes can be tailored to support any type of distributed simulation application.

Information on implementation: Has been applied to federations in multiple nations, including US and Canada.

Limitations of this Standard: It provides implementation-level guidance to VV&A practitioners; however, it does not describe the individual techniques that might be employed to execute the VV&A processes for federations. It focuses upon the VV&A processes that apply to federations and not the VV&A processes associated with individual simulations (federates), but does consider using the information produced by those processes.

Standard Type: Verification & Validation (V&V)

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: 19 March 2008.
Last Updated: 10 April 2008.

B.1.5 U.S. DoD - Verification, Validation & Accreditation (VV&A) Recommended Practices Guide (RPG)

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

Standard Identifier: VV&A RPG Build 3.0

Version Identifier: RPG Build 3.0, September 2006

Standard Development Organization: U.S. Department of Defense

STANAG identifier: Not Applicable

STANAG status: Not Applicable

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 [Emerging]: Used on dozens of applications in the US. Date of latest revision – 15 Sep 2006.

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: Verification & Validation

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

URL or instructions to Access or Acquire: http://vva.dmso.mil/ or http:www.msco.mil/

Input Date: 27.08.08

Last Updated: 27.08.08

B.1.6 – U.S. DoD - Templates for the Verification, Validation, & Accreditation (VV&A) of 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, 28 January 2008**

Standard Development Organization: U.S. DoD

STANAG identifier: Not Applicable

STANAG status: Not Applicable

Abstract: This standard was developed by the U.S. 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 U.S. Department of Defense, other government agencies and allied nations.

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

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

Information on implementation: Not known

Limitations of this Standard: Not known

Standard Type: Verification & Validation

Public Availability: Yes, from U.S. Dept. of Defense **MIL-STD-3022**

URL or instructions to Access or Acquire: http://www.assistdocs.com/

Input Date: 27 August 2008

Last Updated: 27 August 2008

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B.2 Simulation System Engineering (Including M&S Processes and Systems Engineering)

B.2.1 HLA FEDEP

Standard Title: IEEE Recommended Practice for the High Level Architecture (HLA) Federation Development and Execution Process (FEDEP)

Standard Identifier: IEEE P1516.3-2003

Version Identifier: None

Standard Development Organization: IEEE with SISO acting as an IEEE standards sponsor.

STANAG identifier: 4603

STANAG status: Promulgated 2nd July 2008

Abstract: This IEEE document is part of the 1516 Family on the High Level Architecture (HLA). The processes and procedures that should be followed by users of the HLA to develop and execute federations are defined in this recommended practice. This recommended practice is not intended to replace low-level management and systems engineering practices native to HLA user organizations, but is rather intended as a higher-level framework into which such practices can be integrated and tailored for specific uses.

Technical Maturity [Current]: The document was published on January 1, 2003, copyrighted on February 1, 2003. This document is based upon a US Department of Defense (DoD) Defense Simulation and Modeling Office (DMSO) publication entitled High Level Architecture Federation Development and Execution Process (FEDEP) Model, version 1.5, dated December 8, 1999. A replacement for this recommended practice is under development--"IEEE P1730™ Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)". When IEEE P1730 is approved, the FEDEP standard will be retired.

Applicability: The HLA has been designed to be applicable across a wide range of functional applications. The purpose of this document is describe a high-level process by which HLA federations can be developed and executed to meet the needs of a federation user or sponsor. It is expected that the guidelines provided in this document are generally relevant to and can facilitate the development of most HLA federations.

Information on implementation: Widely implement across NATO and PfP nations.

Limitations of this Standard: Primarily meant for use with HLA-based federations. Distributed simulation environments constructed using other protocols will need to adapt this document to suit the needs to the particular environment.

Standard Type: Simulation Systems Engineering

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

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

Input Date: 8 April 2008.
Last Updated: 8 September 2008

B.2.2 SEDEP

Standard Title: Synthetic Environment Development and Exploitation Process (SEDEP).

Standard Identifier: Not applicable.

Version Identifier: Version 2.0.

Standard Development Organization: Not applicable.

STANAG identifier: Not applicable.

STANAG status: Not applicable.

Abstract: EUCLID[7] RTP[8] 11.13 was a major initiative to promote the use of Synthetic Environments (SEs) in Europe. A SE is also called a Distributed Simulation or a Distributed System of Simulations or a Federation in some other nations. One of the main results from the programme was the concept of the SE Development Environment (SEDE) for creating and utilising SEs, which is analogous to an integrated development environment for developing software applications.

The purpose of the SEDE is to provide a facility that will assist the different types of SE users, i.e. Problem Setters, Problem Solvers, and SE Implementers, so that SEs can be delivered faster, better and cheaper. The SEDE comprises of five main components:

- the SE Development and Exploitation process (SEDEP)
- Repository
- SE Management Tool
- SE tools (both COTS and those being developed in Euclid 11.13)
- a Knowledge Base.

The SEDEP was developed from FEDEP US DoD version 1.5 (1998) and its purpose is to provide additional information to the SE community not covered by the terms of reference of the FEDEP. In particular, it is a generic process that is not dedicated to one kind of interoperability technology and covers the complete SE lifecycle, from eliciting the user needs through to evaluating the results from operating the SE.
In order to capture the work done in RTP 11.13, the FEDEP and SEDEP development teams worked together to pull-through applicable information into the IEEE 1516.3-2003 version of the FEDEP. Following the conclusion of RTP 11.13, further development of the SEDEP has stopped whilst a new 'owner' is found for it. However, the SEDEP version 2.0 is still publicly available (http://www.euclid1113.com) and SE developers are encouraged to use it since it complements the information provided by the FEDEP.

Technical Maturity [Obsolete]: Version 2 has been released and it's in use in various projects. Should be superseded by the new IEEE FEDEP version named Distributed Simulation Engineering and Execution Process (DSEEP)

[7] EUCLID : European Cooperation for the Long-term in Defence (now disbanded)
[8] RTP: Research and Technology Project

Applicability: The SEDEP is relevant to all military and civil applications of SEs and covers all aspects of their specification, development and operation. It is applicable to creating and utilising small SEs, involving a few networked simulations running on a local area network, through to large SEs, running on a wide area network across national borders. Although the SEDEP uses terms from the High Level Architecture e.g. federation, the process can be tailored to support other interoperability technologies e.g. DIS. The SEDEP is most relevant where there is an emphasis on reusing existing assets and making new assets available for reuse rather than the one-off standalone development of SEs.

The SEDEP is initiated when either an SE is being considered to satisfy a particular user need or when a decision has already been taken to use an SE i.e. where a through life SE master plan has been defined to support a high-level process. It is intended to support all the stakeholders who are involved over the lifecycle of an SE.

Information on implementation: Specific examples of how the standard has been used in programs and products within individual Nations and in NATO.

Limitations of this Standard: A generic standard; can be tailored to many different applications.

Standard Type: M&S process

Public Availability: Via Euclid web site.

URL or instructions to Access or Acquire: e-mail to nsmith@dstl.gov.uk

Input Date: 19 March 2008.

Last Updated: 19 March 2008.

B.2.3 DSEEP

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

Standard Identifier: IEEE P1730™

Version Identifier: Draft Dv2.0

Standard Development Organization: IEEE with SISO acting as an IEEE standards sponsor.

STANAG identifier: N/A

STANAG status: N/A

Abstract: The DSEEP is intended as a high-level process framework into which the lower-level systems engineering practices native to any distributed simulation user and can be easily integrated. DSEEP describes processes and procedures that should be followed by practitioners to develop and execute distributed simulation systems. This recommended practice is not intended to replace low-level management and systems engineering practices native to user organizations, but is rather intended as a higher-level framework into which such practices can be integrated and tailored for specific uses.
DSEEP is intended to be a generic process and not linked to any specific interoperability standard; there are specific annexes covering HLA and DIS..

Technical Maturity [Emerging]: Currently DSEEP is still a draft guidance document building on the experience of both the IEEE 1516.3 FEDEP and the European SEDEP effort (which will be superseded when the DSEEP becomes available).

Applicability: It is likely that the DSEEP will be widely used in future projects as was the FEDEP in previous HLA federation developments.

Information on implementation: Draft, not yet implemented.

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

Standard Type: Simulation Systems Engineering

Public Availability: Copies of this standard may be purchased from IEEE when available. Current draft is available only to the DSEEP SISO Product Development Group (PDG) members.

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

Input Date: 28 July 2008.

Last Updated: 27 August 2008

B.2.4 DODAF

Standard Title: DoD Architecture Framework (DoDAF)

Standard Identifier: None

Version Identifier: Version 1.5 dated 23 April 2007

Standard Development Organization: The DoDAF Working Groups.

STANAG identifier: N/A
STANAG status: N/A

Abstract: The DoDAF is a three-volume set that inclusively covers the concept of the architecture framework, development of architecture descriptions, and management of architecture data.

- Volume I introduces the DoDAF framework and addresses the development, use, governance, and maintenance of architecture data
- Volume II outlines the essential aspects of architecture development and applies the netcentric concepts to the DoDAF products
- Volume III introduces the architecture data management strategy and describes the pre-release Core Architecture Datamodel (CADM) v1.5, which includes the data elements and business rules for the relationships that enable consistent data representation across architectures.
  [Reference: DoD Architecture Framework Version 1.5 dated 23 April 2007]

Technical Maturity [Current]: Version 1.0 of the DoDAF was first approved in 30 August 2003. The
C4ISR Architecture Framework was the predecessor to the DoDAF. Multiple commercial tools produce documentation consistent with the DoDAF.

Applicability: The DoDAF provides the guidance and rules for developing, representing, and understanding architectures based on a common denominator across DoD, Joint, and multinational boundaries. It provides insight for external stakeholders into how the DoD develops architectures. The DoDAF is intended to provide a number of complementary and consistent views to ensure that architecture descriptions can be compared and related across programs, mission areas, and, ultimately, the enterprise, thus, establishing the foundation for analyses that supports decision-making processes throughout the DoD.
[Reference: DoD Architecture Framework Version 1.5 dated 23 April 2007]

Information on implementation: Required for use within US DoD major acquisition programs. Adopted (e.g. France), and in some cases modified, by other nations (e.g. UK MODAF).
Limitations of this Standard: Limited support for systems of systems architectures.
Standard Type: Simulation System Engineering
Public Availability: The DODAF is available publicly online in three volumes – see URLs below.
URL or instructions to Access or Acquire: This standard has three volumes which are accessible at:
http://www.defenselink.mil/cio-nii/docs/DoDAF_Volume_I.pdf
http://www.defenselink.mil/cio-nii/docs/DoDAF_Volume_II.pdf
http://www.defenselink.mil/cio-nii/docs/DoDAF_Volume_III.pdf

Input Date: 8 April 2008
Last Updated: 10 April 2008.

B.2.5 IDEF0

Standard Title: Integration Definition for Function Modelling (IDEF0).

Standard Identifier: Federal Information Processing Standards Publications (FIPS PUBS) Number 183

Version Identifier: none

Standard Development Organization: The US National Institute of Standards and Technology (NIST)

STANAG identifier: N/A

STANAG status: N/A

Abstract: Describes the IDEF0 modelling language (semantics and syntax), and associated rules and techniques, for developing structured graphical representations of a system or enterprise. Use of this standard permits the construction of models comprising system functions (activities, actions, processes, operations), functional relationships, and data (information or objects) that support systems integration. [Reference: FIPS PUBS Number 183]

Technical Maturity [Old]: The standard was approved in 1993.

Applicability: The use of this standard is strongly recommended for projects that:

- Require a modeling technique for the analysis, development, re-engineering, integration, or acquisition of information systems;
- Incorporate a systems or enterprise modeling technique into a business process analysis or software engineering methodology. [Reference: FIPS PUBS Number 183]

Information on implementation: Examples of current uses of IDEF0 are more evident in the examples of the use of the DoDAF OV-5 Operational View Diagrams. Some older examples of OV-5 can be found in the US DoD Architecture Framework Version 1.0 Deskbook dated 15 August 2003. Also used in other nations.

Limitations of this Standard: Strictly an activity modelling language. Does not include full process semantics (e.g., dependency and synchronization of operations)

Standard Type: Simulation Systems Engineering

Public Availability: The standard can be accessed on the NIST website under the list of FIPS publications.

URL or instructions to Access or Acquire: http://www.itl.nist.gov/fipspubs/by-num.htm and choose FIPS number 183.

Input Date: 09 April 2008

Last Updated: 28 August 2008

B.2.6 NAF - NATO Architecture Framework

Standard Title: NATO Architecture Framework (NAF).

Standard Identifier: As above

Version Identifier: Version v3 (2007).

Standard Development Organization: NATO C3 Board (NC3B)

STANAG identifier: N/A
STANAG status: N/A

Abstract: NAF promotes the use of models to develop architecture core data and provides this data to architecture specialists. The purpose of an architectural framework such as NAF is to define the operational context (organizations, locations, processes, information flows, etc.), the system architecture (interfaces, data specifications, protocols, etc.), and the supporting standards and documents that are necessary to describe the enterprise. The information presented in an architectural framework is split into logical groupings – usually known as 'Views'. The same system and business elements may be present in more than one view, but the purpose of each view is different and so each provides a different viewpoint on the information. NAF views and subviews are created based on the architecture core data for the benefit of non-specialists. The views include Capability Views, Service Oriented Views and Programme Views. NAF has similarities with MODAF (and DODAF) Enterprise Architectures, but goes beyond these. The current version of NAF (v3) has seen extensions to improve support for Capability development, Service orientation as required by NATO Network enabled Capability (NNEC) and support for NATO transformation. NAF v3 supports Stakeholders so that an extensive analysis can be made to provide rationale for prioritization in decision making. NAF v3 has improved support for the achievement of NNEC and NATO transformation by facilitating the move from a system-oriented paradigm to a service-oriented paradigm, and by identifying mechanisms to handle the complexity of the relationships within the NATO federation of systems in a holistic manner. The NAF Meta-Model (NMM) and repository enable stakeholders and users to extract and exchange bespoke architecture information and make necessary analyses to support development, interoperability, acquisition or technical considerations.

Technical Maturity: NAF v3 was approved by NC3B in Nov 2007.

Applicability: NAF v3 is mandated for all NATO programmes

Information on implementation: Started immediately after approval.

Limitations of this Standard: None.

Standard Type: Systems Engineering.

Public Availability: Yes.

URL or instructions to Access or Acquire: http://www.nhqc3s.nato.int/HomePage.asp (follow link to 'architectures')

Input Date: 22 Sept 2008

Last Updated: 11 Dec 2008

B.3 M&S-Scenarios

B.3.1 MSDL

Standard Title: Military Scenario Definition Language (MSDL).

Standard Identifier: SISO-REF-015-2006.
Version Identifier: Version 1.2
Standard Development Organization: SISO.
STANAG identifier: Not applicable.
STANAG status: Not applicable.

Abstract: The Military Scenario Definition Language (MSDL) is intended to provide a standard 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.) Command and Control (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 to 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) SISO Product Development Group (PDG).

Technical Maturity [Emerging]: MSDL Specification Version .01 is a product of the US OneSAF development provided the basis for the MSDL current version. MSDL v.01 has been matured through the development of the Close Combat Tactical Trainer Commander's Exercise Initialization Toolkit, the OneSAF Objective System (OOS) and the OneSAF Testbed Baseline (OTB), and currently through the enhancements proposed by the US MATREX federation, and through MSDL PDG comments to the originally proposed OneSAF MSDL specification.
Additionally, the MSDL PDG established and executed a disciplined review process and associated change request form to affect modifications to MSDL. It is expected that MSDL will continue to evolve and that a disciplined change management process is critical to MSDL's long-term viability.
MSDL 1.2 is currently balloted to become an official SISO standard.

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) easily ported to military simulations.
- Easier comparison of military simulation products using the same initial conditions.
- Enables third party products for military scenario design.

Information on implementation: Mainly used in the OneSAF Program.
Limitations of this Standard: Mainly targeted to land operations; needs to be generalized to joint operations.
Standard Type: M&S scenarios.
Public Availability: Via SISO web site.
URL or instructions to Access or Acquire: www.sisostds.org

Input Date: 19 March 2008
Last Updated: 19 March 2008

B.4 Modelling (including Conceptual Modelling and M&S Representation)

B.4.1 Base Object Model (BOM)

Standard Title: Base Object Model (BOM)

Standard Identifier: This standard is comprised of two documents:

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

Version Identifier: SISO-STD-003, year of publication: 2006
Standard Development Organization: SISO
STANAG identifier: N/A
STANAG 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]: One freeware tool implements the BOM standard. First use of BOMs are 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 the US and France.

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: Modelling, M&S Interoperability

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: www.sisostds.org and www.boms.info

Input Date: 8 April 2008
Last Updated: 28 August 2008

B.4.2 UML

Standard Title: Unified Modeling Language™ - UML

Standard Identifier: UML

Version Identifier: Version 2.1.1

Standard Development Organization: OMG (Object Management Group)

STANAG identifier: Not applicable.

STANAG status: Not applicable.

Abstract: UML is a standardized specification language for object modelling. UML is a general-purpose modelling language that includes a graphical notation used to create an abstract model of a system, referred to as a UML model.
UML is officially defined at the Object Management Group (OMG) by the UML metamodel, a Meta-Object Facility metamodel (MOF). Like other MOF-based specifications, the UML metamodel and UML models may be serialized in XML Metadata Interchange (XMI). UML was designed to specify, visualize, construct, and document software-intensive systems.
UML has been a catalyst for the evolution of model-driven technologies, which include model-driven development (MDD), model-driven engineering (MDE), and model-driven architecture (MDA).
UML is extensible, offering the following mechanisms for customization: profiles and stereotype. The semantics of extension by profiles have been improved with the UML 2.0 major revision.

Technical Maturity [Current]: UML has matured significantly since UML 1.1. Several minor revisions (UML 1.3, 1.4, and 1.5) fixed shortcomings and bugs with the first version of UML, followed by the UML 2.0 major revision, which is the current OMG standard.
The final UML 2.0 specification has been declared available and has been added to OMG's formal specification library. The other parts of the UML specification, the UML 2.0 infrastructure, the UML 2.0 Diagram Interchange, and UML 2.0 OCL specifications have been adopted.
The current version available is 2.1.1 (August 2007) and is available in the form of an XMI 2.1 version of the UML 2.1 version.

Applicability: Not dedicated to simulation, but in very general use in the M&S domain.

Information on implementation: many commercial and free tools available

Limitations of this Standard: very specialized, requires detailed understanding.

Standard Type: Conceptual modelling.

Public Availability: Via OMG web site.

URL or instructions to Access or Acquire: http://www.uml.org/

Input Date: 20 March 2008

Last Updated: 20 March 2008

B.4.3 SIMPLE

Standard Title: Standard Interface for Multiple Platform Link Evaluation (SIMPLE)

Standard Identifier: SIMPLE

Version Identifier: EAPC(AC/322-SC/2)DS(2005)0001 (Edition 2, 12 September 2006)

Standard Development Organization: NATO Consultation, Command and Control Board (NC3B), C3 Capabilities Coherence Sub-Committee (C3CCSC)

STANAG identifier: 5602 (Edition 2)

STANAG status: Promulgated (future version, Edition 3, in the ratification process)

Abstract: The aim of STANAG 5602 is to provide specifications for a common standard to interconnect ground rigs of all types (e.g. simulation, integration facilities etc.) for the purpose of Tactical Data Link (TDL) Interoperability testing. The STANAG specifies the distributed transfer using the IEEE Distributed Interactive Simulation (DIS) protocols which are defined in the IEEE Std.1278.1 and 1a.

Technical Maturity [Current]: Second version of SIMPLE was promulgated in 2006 and the next version (edition 3) is under ratification. The standard is evolving thanks to feedback coming from a large basis of users.

Applicability: SIMPLE STANAG specifies the requirements for transfer of data between remote sites in different locations to support interoperability testing of TDL implementations in the different platforms of NATO Nations and Organizations.

Information on implementation: In use in NATO

Limitations of this Standard: Not fully/only targeted to simulation interoperability. Was not originally designed to model Link 16 for training, but testing only. Standard does not model all Link 16 capabilities, such as net entry, net exit, perceived versus actual position, Link 16 relay, message encryption, and Time Slot Reallocation. Only based on DIS and does not address HLA federations' requirements. Applicable to Real Time simulation applications.

Standard Type: Data Standards, M&S Interoperability

Public Availability: Available on the NATO NSA web site

URL or instructions to Access or Acquire: http://nsa.nato.int

Input Date: 10 July 2008

Last Updated: 18 September 2008

B.4.4 Link 11 Simulations

Standard Title: Standard for LINK 11/11B Simulation

Standard Identifier: SISO-STD-005-200x

Version Identifier: Draft Version 1.4

Standard Development Organization: Simulation Interoperability Standards Organization (SISO).

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

STANAG status: Promulgated

Abstract: A SISO standard that defines the methods to simulate a Link 11/11B Network within the Distributed Interactive Simulation (DIS) or High Level Architecture (HLA) framework. The SISO standard has 3 levels of fidelity, from message exchange only to Link 11/11B network modelling. The NATO STANAG 5602 "Standard Interface for Multiple Platform Link Evaluation" (SIMPLE) standard another protocol. SIMPLE address not only Link 11 but all other Tactical Data Links. While SIMPLE is based on DIS, SISO Link 11/11B standard will address both DIS using Transmitter and Signal PDUs, and HLA under the BOM and RPR FOM paradigms.

Technical Maturity [Emerging]: Near Completion. September 2008 SISO conference will incorporate comments from draft 1.4, and release draft version 1.5, which will be ready for SISO standard balloting. Will benefit from the experience of the "Link 16 Simulation" standard (SISO-STD-002-2006, 10 Jul 06).

Applicability: There are immediate and overdue operational requirements for existing military simulations to exchange Link 11/11B data using a single interoperable method.

Information on implementation: There will be a draft implementation soon from the Canadian Defense Ministry, as well as the U.K. E-3D training program. They are awaiting the final approved standard for official implementation..

Limitations of this Standard: This standard should only apply to Link 11/11B.

Standard Type: Data mediation, M&S Interoperability.

Public Availability: Draft 1.4 is available on the SISO Link 11/11B PDG website..

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

Input Date: 07 July 2008

Last Updated: 18 September 2008

B.4.5 Link 16 Simulations

Standard Title: Tactical Data Information Link – Technical Advice and Lexicon for Enabling Simulations (TADIL TALES)

Standard Identifier: SISO-STD-002-2006 *(approved 10 Jul 06)*

Version Identifier: 1.0 (10 June 2006)

Standard Development Organization: Simulation Interoperability Standards Organization (SISO).

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

STANAG status: Promulgated

Abstract: There are immediate operational requirements for existing military simulations to exchange Link 16 data using a single interoperable standard. The purpose of this standard is to meet this need by providing a standard for simulating the Link 16 protocol. This standard defines 5 fidelity levels, from message exchange only to Link 16 network modelling, including Return Trip Timing messages, Net Entry and Exit, Actual versus Perceived location, and encryption methods. The NATO STANAG 5602 "Standard Interface for Multiple Platform Link Evaluation" (SIMPLE) Link 16 standard is one such protocol. SIMPLE address not only Link 16 but all other Tactical Data Links. While SIMPLE is based on DIS, it was originally intended to test Link 16 terminal connections. That use has been expanded to include Link 16 training, and as such, does not adequately model some Link 16 network parameters. The SISO Link 16 standard addresses this in DIS using Transmitter and Signal PDUs, and HLA under the BOM and RPR FOM paradigms.

Technical Maturity [Current]: In use for 2 years by the U.S. Air Force, Navy, and Marines for distributed simulation training. Regularly updated.

Applicability: The main objective of Link 16 protocol is to establish a standard for Link 16 message exchange and JTIDS network simulation in the DIS and HLA interoperability paradigms. The intent is to prescribe the content of the standard fields of the Transmitter and Signal PDUs (and the corresponding RPR-FOM Transmitter Object and Signal Interaction) and establish procedures for their use. Compliance with these procedures will facilitate interoperability among Link 16 simulation systems.

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. Its consistency with the SIMPLE STANAG NATO STANAG 5602, edition 1, Standard Interface for Multiple Platform Link Evaluation (SIMPLE) 20 Feb 2001.

Standard Type: Data mediation, M&S Interoperability.

Public Availability: On the SISO website.

URL or instructions to Access or Acquire: http://www.sisostds.org/
Input Date: 20 March 2008.
Last Updated: 18 September 2008

B.4.6 RPR FOM

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

Standard Identifier: SISO-STD-001.1-1999.
Version Identifier: 1.0. (Version 2.0 draft 18 still to be approved)

Standard Development Organization: SISO

STANAG identifier: Not known
STANAG status: Not known

Abstract: While the HLA Standards dictate 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 RPR FOM is a reference FOM that defines HLA classes, attributes and parameters that are appropriate for real-time, platform-level simulations. Applications that have previously used DIS (or would have considered using DIS), often use the RPR FOM (or a derivative of it) when they playing in an HLA world. The RPR FOM was developed by a SISO Product Development Group (PDG). Its goal 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.

A companion document, known as the GRIM (Guidance, Rationale, and Interoperability Mappings) provides documentation for the RPR FOM. This document is known as SISO-STD-001-1999.

Technical Maturity [Current]: RPR FOM 1.0 is based on the IEEE 1278.1-1995 version of the DIS Standard and became a SISO standard in 1999. It corresponds to the version US DoD 1.3 version of HLA. RPR FOM 2.0 will correspond 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: Data standard (mediation).

Public Availability: Via SISO web site

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

Input Date: 19 March 2008
Last Updated: 19 March 2008

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B.5 Software Engineering

B.5.1 MDA

Standard Title: Model-Driven Architecture
Standard Identifier: MDA™
Version Identifier: 1.0.1
Standard Development Organization: OMG
STANAG identifier: Not applicable
STANAG status: Not applicable
Abstract: MDA™ is a software design approach launched by the Object Management Group (OMG) in 2001. It is a variant of the Model Driven Engineering (MDE).
The MDA principle is to create a Platform Independent Model (PIM) of a system which describes the business logic and rules behind a specification without taking care of its possible implementations. Then model transformations have to be defined to convert the PIM into Platform Specific Models (PSM) which contain implementation details. PSMs may need to be completed after the transformation. There are as many PSM as possible implementations. The PSM may then be transformed into an even more detailed PSM or into text (eg: code, documentation).
Since MDA separates concerns, there is no need to be a technology expert to create a PIM but only a subject matter expert. To complete the PSM there is a need to be a technology expert not a business expert. Model transformation is the key of the MDA process and captures the best proven implementation practices on technologies.
MDA is built on the solid foundation of well-established OMG standards, including:

- Unified Modelling Language™ (UML®), UML which is a modelling notation used and supported by every major company in the software industry
- XML Metadata Interchange (XMI®), which is the standard for storing and exchanging models using XML.
- Query View Transformation (QVT) which is a standard for expressing model transformation.

MDA main objectives are:

- Portability,
- Platform Independence
- Domain Specificity, through Domain-specific models.
- Productivity

Technical Maturity [Emerging]: The MDA has proven its efficiency in Software Oriented Architecture in particular in the Web development.

Applicability: Software design / engineering

Information on implementation: In use in various projects. Numerous tools are available including commercial or government-owned simulation frameworks.

Limitations of this Standard: MDA major drawback lays on reverse engineering to keep PIM coherent with PSM/Code. The engineering process has in fact an iterative nature which may make it difficult to apply strictly the MDA theory.

Standard Type: Software Engineering.

Public Availability: Via OMG web site. Many UML tools (including free ones) conform nowadays to this approach.

URL or instructions to Access or Acquire: http://www.omg.org/mda/
Input Date: 20 March 2008
Last Updated: 03 September 2008

B.5.2 CORBA

Standard Title: Common Object Request Broker Architecture (CORBA).

Standard Identifier: CORBA

Version Identifier: 3.0.3

Standard Development Organization: OMG

STANAG identifier: Not applicable.

STANAG status: Not applicable.

Abstract: CORBA, the Common Object Request Broker Architecture, is OMG's open, vendor-neutral architecture and infrastructure that computer applications use to work together over networks. Using the standard protocol IIOP®, a CORBA-based program from any vendor, on almost any computer, operating system, programming language, and network, can interoperate with a CORBA-based program from the same or another vendor, on almost any other computer, operating system, programming language, and network.

Technical Maturity [Old]: Version 3.0.3 has been released.
CORBA is a mature, standard middleware that combines the interoperability, deterministic execution, and absolute dependability required by distributed embedded systems.

Applicability: Has been used for simulation interoperability even though it was not dedicated to simulation. Has been use by some HLA and TENA middleware designers.

Information on implementation: Many uses in different countries and on different platforms but few uses for simulations.

Limitations of this Standard: Through its history, CORBA was plagued by shortcomings of its implementations.

Standard Type: Software engineering

Public Availability: Via OMG web site.

URL or instructions to Access or Acquire: http://www.omg.org/docs/formal/04-03-12.pdf

Input Date: 20 March 2008

Last Updated: 20 March 2008

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B.6 M&S Interoperability

B.6.1. High Level Architecture (HLA) for M&S

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

Standard Identifiers: Three documents: IEEE 1516-2000 (Framework and Rules), IEEE 1516.1-2000 (Federation Interface Specification), IEEE 1516.2-2000 (Object Model Template)

Version Identifier: 2000 (year of publication)

Standard Development Organization: Institute of Electrical and Electronics Engineers (IEEE) with the Simulation Interoperability Standards Organization (SISO) acting as an IEEE standards sponsor.

STANAG identifier: 4603
STANAG status: Promulgated 2nd July 2008

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 document was published on January 1, 2000, copyrighted on February 1. 2000. HLA is considered a mature standard and is in use in numerous countries.

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.

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.

Standard Type: M&S Interoperability
Public Availability: Copies of this standard may be purchased from IEEE.
URL or instructions to Access or Acquire: www.ieee.org

Input Date: 8 April 2008
Last Updated: 28 August 2008

B.6.2 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: 2006 (year of publication)

Standard Development Organization: Simulation Interoperability Standards Organization

STANAG identifier: None

STANAG status: Not applicable

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 [Current]: In use for 2 years and currently being incorporated into the next version of the core IEEE HLA specification.

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: www.sisostds.org

Input Date: 21 August 2008

Last Updated: 28 August 2008

B.6.3 DIS

Standard Title: "IEEE Standard for Distributed Interactive Simulation" (DIS)

Standard Identifier: DIS (IEEE 1278 series)

Version Identifier Current official versions:

- IEEE 1278-1993 - Standard for Distributed Interactive Simulation - Application protocols
- IEEE 1278.1-1995 - Standard for Distributed Interactive Simulation - Application protocols
- IEEE 1278.1-1995 - Standard for Distributed Interactive Simulation - Application protocols - Errata (May 1998)
- IEEE 1278.1A-1998 - Standard for Distributed Interactive Simulation - Application protocols
- IEEE-1278.2-1995 - Standard for Distributed Interactive Simulation - Communication Services and Profiles
- IEEE 1278.3-1996 - Recommended Practice for Distributed Interactive Simulation - Exercise Management and Feedback.
- IEEE 1278.4-1997 - Recommended Practice for Distributed Interactive - Verification Validation & Accreditation

  1278.1 and **1278.2** are under revision by the Simulation Interoperability Standards Organization (SISO).
  1278.3 is planned to be reaffirmed and eventually should be replaced by a new IEEE standard (Annexe B to the future IEEE Standard "IEEE P1730™ Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)"
  1278.4 is planned to be reaffirmed and eventually should be replaced by a new IEEE standard (Annexe B to the VV&A Overlay to the Distributed Simulation Engineering and Execution Process (DSEEP).
  There was also a draft standard IEEE 1278.5-XXXX – "Fidelity Description Requirements" but it was never published.

Standard Development Organization "DIS workshops" organization until 1997, presently SISO, as a Standards Sponsor of The Institute of Electrical and Electronics Engineers, Inc. (IEEE)

STANAG identifier no current STANAG: former STANAG 4482; "Standardised Information Technology Protocols for Distributed Interactive Simulation (DIS)", was adopted in 1995 but retired in 1998.

STANAG status an updated version of STANAG 4482 was not ratified in 1999 and 4482 was declared superseded by the future STANAG on HLA (4603).

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 15 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 behavior (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: 10 April 2008

B.6.4 Test and Training Enabling Architecture (TENA)

Standard Title: The Test and Training Enabling Architecture Reference Document

Standard Identifier: None

Version Identifier: 2002 (year of publication)

Standard Development Organization: US Department of Defense Test Management Resource Center under the Central Test and Evaluation Investment Program (CTEIP)

STANAG identifier: N/A

STANAG status: N/A

Abstract: TENA is a product of the Foundation Initiative 2010 (FI 2010) project, sponsored by the Central Test and Evaluation Investment Program (CTEIP). The core of TENA is the TENA Common Infrastructure, including the TENA Middleware, the TENA Repository and the TENA Logical Range Data Archive. TENA also specifies the existence of a number of tools and utilities, including those necessary for the efficient creation of a logical range. Range instrumentation systems (also called range resource applications) and all of the tools interact with the common infrastructure through the medium of the TENA object model. The TENA object model encodes all of the information that is transferred between systems during a range event. It is the common language with which all TENA applications communicate.

Technical Maturity [Current]: Widely used with the US range community and actively managed through an Architecture management Team.

Applicability: Live Range Interoperability, LVC Interoperability, Test Interoperability

Information on implementation: The initial implementation for TENA is to interoperate the US National Test and Training Ranges. Has been used at USJFCOM to incorporate Live and Range assets into LVC Training exercises. See https://www.tena-sda.org/display/intro/news for extensive listing of program usage.

Limitations: Currently targeted for real-time applications only.

Standard Type: M&S Interoperabilty (although targeted toward range interopability)

Public Availability: See https://www.tena-sda.org for detailed information. Some restrictions on non-US citizens. *(US will establish exact restrictions/releasability)*

URL or instructions to Access or Acquire: This standard is accessible at https://www.tena-sda.org. An account is required for some information.

Input Date: 8 April 2008

Last Updated: 28 August 2008

B.7 Data Standards (Including Data Mediation and Exchange, Data Production and Data Engineering)

B.7.1 IDEF1X

Standard Title: Integration Definition for Information Modelling (IDEFIX)

Standard Identifier: Federal Information Processing Standards Publications (FIPS PUBS) Number 184

Version Identifier: none

Standard Development Organization: The US National Institute of Standards and Technology (NIST)

STANAG identifier: N/A

STANAG status: N/A

Abstract: Describes the IDEF1X modelling language (semantics and syntax), and associated rules and techniques, for developing a logical model of data. IDEF1X is used to produce a graphical information model which represents the structure and semantics of information within an environment or system. Use of this standard permits the construction of semantic data models which may serve to support the management of data as a resource, the integration of information systems, and the building of computer databases. [Reference: FIPS PUBS Number 184]

Technical Maturity [Old]: The standard was approved in 1993. Multiple products exist that implement the standard.

Applicability: This standard is the reference authority for use by information modelers required to utilize the IDEF1X modelling technique, implementers in developing tools for implementing this technique, and other computer professionals in understanding the precise syntactic and semantic rules of the standard. [Reference: FIPS PUBS Number 184]

Information on implementation: Multiple commercial tools implement the IDEF1X language. The language is widely used in documenting data standards, such as the JC3IEDM maintained by the Multinational Interoperability Programme.

Limitations of this Standard: Based on relational theory; does not address object modelling.

Standard Type: Data Standards

Public Availability: The standard can be accessed on the NIST website under the list of FIPS publications.

URL or instructions to Access or Acquire: http://www.itl.nist.gov/fipspubs/by-num.htm and choose FIPS number 184.

Input Date: 8 April 2008

Last Updated: 28 August 2008

B.7.2 XML

Standard Title: Extensible Markup Language (XML)

Standard Identifier: XML 1.0 and 1.1

Version Identifier: Version 1.0 and Version 1.1 (Second Edition)

Standard Development Organization: W3C

STANAG identifier: Not applicable

STANAG status: Not applicable

Abstract: The Extensible Mark-up Language (XML) is a general-purpose mark-up language. It is classified as an extensible language because it allows its users to define their own elements. Its primary purpose is to facilitate the sharing of structured data across different information systems, particularly via the Internet and it is used both to encode documents and to serialize data.

XML is recommended by the World Wide Web Consortium. It is a fee-free open standard. The W3C recommendation specifies both the lexical grammar and the requirements for parsing.

Technical Maturity [Current]: There are two current versions of XML. The first, XML 1.0, was initially defined in 1998. It has undergone minor revisions since then, without being given a new version number, and is currently in its fourth edition, as published on August 16, 2006. It is widely implemented and still recommended for general use. XML is used in many simulation standards like HLA.

Applicability: For sharing of structured data across different information systems, particularly via the Internet and it is used both to encode documents and to serialize data.

Information on implementation: XML 1.0 - widely implemented. XML 1.1 not very widely implemented.

Limitations of this Standard: n/a

Standard Type: Data Engineering.

Public Availability: Via W3C web site.

URL or instructions to Access or Acquire: http://www.w3.org/TR/xml11/#sec-xml11

Input Date: 20 March 2008

Last Updated: 20 March 2008

B.7.3 C-BML

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

Standard Identifier: SISO-REF-016-2006

Version Identifier: Under development.

Standard Development Organization: SISO

STANAG identifier: N/A

STANAG 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.

b. Provide for situational awareness and a shared, common operational picture.

It can be seen as a standard representation of a digitized commander's intent to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding.

A Coalition BML developed and applied by the all Services and by coalition members would not only allow interoperability among their C4ISR 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.

Technical Maturity [Emerging]: This language is under development. Different experimentations have been completed which prove the validity of this concept.

Applicability: One significant effort to leverage interoperability between C4I systems and simulations.

Information on implementation: Many experiences in different nations with predecessor activities that have led to the current standardization effort.

Limitations of this Standard: Still different approaches being considered.

Standard Type: Data Standards

Public Availability: Via SISO web site

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

Input Date: 19 March 2008
Last Updated: 19 March 2008

B.7.4 JC3IEDM

Standard Title: Joint Command, Control and Consultation Information Exchange Data Model (JC3IEDM).

Standard Identifier: JC3IEDM

Version Identifier 3.1b

Standard Development Organization Multilateral Interoperability Programme (MIP).

STANAG identifier 5525

STANAG status Ratified.

Abstract JC3IEDM specifies the minimum set of data that needs to be exchanged in coalition or multinational operations.

JC3IEDM is intended to represent the core of the data identified for exchange across multiple functional areas and multiple views of the requirements. Toward that end, it lays down a common approach to describing the information to be exchanged in a command and control (C2) environment.

Technical Maturity [Current]: Highly mature in use in numerous nations and in NATO. In continuous development since 1984. Current version released in 13-Dec-2007.

Applicability For the specification of NATO C3 systems and national systems wherever required to aid full interoperability of NATO Forces.

In general for facilitating the timely flow of accurate and relevant information using the Information Exchange Mechanisms specified by MIP between the different national C2IS.

Information on implementation This standard has been used in programs and products within NATO and non-NATO nations. It is the basis for developing simulation data standards like C-BML and MSDL. More information can be found on the MIP website: www.mip-site.org

Limitations of this Standard Not known.

Standard Type Data Mediation and Exchange Standards

Public Availability From the MIP website.

URL or instructions to Access or Acquire www.mip-site.org

Input Date: 20 March 2008

Last Updated: 20 March 2008

B.7.5 Synthetic Environment Data Representation and Interchange Specification (SEDRIS)

SEDRIS is a series of 8 ISO standards addressing:

- (a) the representation of environmental data, and,
- (b) 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 under ratification process:

STANAG 4664 - SEDRIS Functional Specifications and Abstract Transmittal Format

Part 1: **Functional Specification** (DRM, APIs, and STF)
Standard Identifier: ISO/IEC 18023-1:2006(E)
Version Identifier: 2006 (year of publication)
Abstract: This part of ISO/IEC 18023 addresses the concepts, syntax and semantics for the representation and interchange of environmental data. It specifies:
- (a) data representation model for expressing environmental data,
- (b) 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.

STANAG identifier: Part of STANAG 4664
STANAG status: Ratification in process.

Part 2: Abstract Transmittal Format
Standard Identifier: ISO/IEC 18023-2:2006(E)
Version Identifier: 2006 (year of publication)
Abstract: SEDRIS Part 2 defines the abstract semantics and abstract structure used to encode SEDRIS transmittals. The Abstract Transmittal Format (ATF) defines how concrete encodings are developed so that conversion can be performed with a minimum of effort. ATF also ensures that SEDRIS API implementations behave consistently regardless of transmittal encoding.
STANAG identifier: Part of STANAG 4664
STANAG status: Ratification in process.

Part 3: Transmittal Format Binary Encoding
Standard Identifier: ISO/IEC 18023-3:2006(E)
Version Identifier: 2006 (year of publication)
Abstract: SEDRIS Transmittal Binary Encoding defines the binary coding for Data Representation Model objects.
STANAG identifier: Part of STANAG 4664
STANAG status: Ratification in process.

Part 4: Language Bindings: C
Standard Identifier: ISO/IEC 18024-4:2006(E)
Version Identifier: 2006 (year of publication)
Abstract: The SEDRIS language binding defines a language dependent layer for the C programming language based on the 18023-1 Application Program Interface (API).
STANAG identifier: Part of STANAG 4664
STANAG status: Ratification in process.

STANAG 4662 -- SEDRIS — Environmental Data Coding Specification (EDCS)

Environmental Data Coding Specification (EDCS)
Standard Identifier: ISO/IEC 18025:2005(E)
Version Identifier: 2006 (year of publication)
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.
STANAG identifier: Part of STANAG 4662
STANAG status: Ratification in process

EDCS Language Bindings Part 4: C
Standard Identifier: ISO/IEC 18041-4:2007(E)
Version Identifier: 2007 (year of publication)
Abstract: EDCS language binding specifies the binding of the Application Program Interface (API) defined in ISO 18023-6 to the C Programming language.
STANAG identifier: Part of STANAG 4662
STANAG status: Ratification in process**.**

STANAG 4663 -- SEDRIS —Spatial Reference Model (SRM)

Spatial Reference Model
Standard Identifier: ISO/IEC 18026: 2006(E)
Version Identifier: 2006 (year of publication)
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.

STANAG identifier: Part of STANAG 4663
STANAG status: Ratification in process.

SRM Language Bindings Part 4: C
Standard Identifier: ISO/IEC 18042-4:2006(E)
Version Identifier: 2006 (year of publication)

Abstract: This part of ISO/IEC 18041-4 specifies the language dependent layer for the C programming language based on the API defined in ISO/IEC 18026.
STANAG identifier: Part of STANAG 4663
STANAG status: Ratification in process.

Standard Development Organization: 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 US, most frequently by ground forces. Some use in other nations (France, for example).

Limitations of this Standard: None identified

Standard Type: Data Mediation and Exchange Standards

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: 29 October 2008

B.7.6 VMAP

Standard Title: Vector Map (VMAP).

Standard Identifier: MIL-STD-2407

Version Identifier: VMAP-1 (Future version VMAP 2i)

Standard Development Organization: US Defense Mapping Agency

STANAG identifier: N/A

STANAG status: N/A

Abstract: A vector-based collection of Geographic information system (GIS) data about Earth at various levels of detail. An updated and improved version of the US National Imagery and Mapping Agency's (NIMA) Digital Chart of the World (DCW).

Also known as Vector Smart Map; formerly known as Digital Chart of the World-DCW.

The vector map product comes in three flavours: low resolution (level 0), medium resolution (level 1) and high resolution (level 2).

Technical Maturity [Old]: Used since 1993 in nations and NATO.

Applicability: Used to represent culture for Geographic Information Systems on applications such as synthetic natural environments.

Information on implementation: The use of VMAP is extremely widespread although more modern alternatives are now often preferred.

Limitations of this Standard: None.

Standard Type: Data standard.

Public Availability: Yes

URL or instructions to Access or Acquire: N/A

Input Date: 28 August 2008

Last Updated: 28 August 2008

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B.8 Visualisation

B.8.1 OpenFlight

Standard Title: OpenFlight Scene Description Database Specification ®

Standard Identifier: OpenFlight ®

Version Identifier: 16.3

Standard Development Organization: None – Owned and controlled by Presagis

STANAG identifier: N/A

STANAG status: N/A

Abstract: OpenFlight is a file format for describing 3D scenes and entities. The owner of the format, Presagis, sells software applications for creating and showing 3D scenes, but so do many other vendors because the standard is readily available. OpenFlight is intended for use in real-time systems and supports: multiple levels of detail, sound, animation sequences, bounding volumes for real-time culling, lighting effects, transparency, texture mapping, material properties, and many other features.

Ref: OpenFlight® Scene Description Database Specification. Version 16.3, Revision A, November 2007. MultiGen-Paradigm Inc.

Technical Maturity [Current]: OpenFlight is a very mature standard.

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 (e.g. flight simulators) and in software development tools from MultiGen-Paradigm/Presagis and other companies. Many major commercial businesses have incorporated OpenFlight in their products.

Limitations of this Standard: OpenFlight is owned and controlled by Presagis and the standard or the open source availability of the standard may change at any time. It is protected under the copyright and trademark laws of the United States of America.

Standard Type: Visualisation

Public Availability: The standard can be downloaded for free from MultiGen-Paradigm's website: http://www.multigen.com/support/dc_standards.shtml.
Access to the OpenFlight Application Program Interface (API), which is software that enables ready use of OpenFlight data, involves a nominal annual fee.

URL or instructions to Access or Acquire: http://www.multigen.com/support/dc_standards.shtml

Input Date: 29 April 2008
Last Updated: 28 August 2008

B.9 M&S Miscellaneous

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Annex C

POINTS OF CONTACT

MS3 Chairman

Mr. Wim HUISKAMP
TNO Defence, Security and Safety
PO Box 96864
2509 JG The Hague, The Netherlands
Tel: +31 (0)70 3740274
Fax: +31 (0)70 3740642
wim.huiskamp@tno.nl

MS3 Secretary

LTC. Adrian VOICULET
MSCO Technical Officer
NATO Research and Technology Agency
BP 25 F-92201 Neuilly sur Seine
Cedex 01 - France
Tel: +33 1 55 61 22 46
Fax: +33 1 55 61 96 22
voiculeta@rta.nato.int

NATIONS

Canada
Mr. Robert D. ELLIOTT
National Defence Headquarters
CFEC/SECO
101 Colonel By Drive Ottawa,
Ontario ON K1A 0K2 Canada

Tel: +1 613 991 61 44
Fax: +1 613 991 58 19
elliott.dr@forces.gc.ca

Czech Republic
Dr. Jan HODICKY
University of Defence
Department of Information Technology
Kounicova 65
612 00 Brno, Czech Republic
Tel: 420 973 443 296
Fax: 420 973 442 987
jan.hodicky@unob.cz

France
Dr. Jean-Louis IGARZA
DGA/CAD
16 bis, avenue Prieur de la Côte d'Or
94114 ARCUEIL Cedex France
Tel: +33 1 42 31 95 81
jean-louis.igarza@dga.defense.gouv.fr
igarzaj@voila.fr

Germany
Mr. Holger HENRICH
Bundesamt für Wehrtechnik und Beschaffung SAbt T5.4
Ferdinand-Sauerbruch-Strasse 1
56073 Koblenz, Germany

Tel.: +49 (0) 261 400 6732
Fax: +49 (0) 261 400 6612
HolgerHenrich@bwb.org

The Netherlands
Mr. Wim HUISKAMP
TNO Defence, Security and Safety
PO Box 96864
2509 JG The Hague, The Netherlands
Tel: +31 (0)70 3740274
Fax: +31 (0)70 3740642
wim.huiskamp@tno.nl

Romania
Col.dr. Mircea CERNAT
Military Equipment and Technologies Research Agency
Aeroportului Str., No. 16
CP 19 OP Bragadiru
Cod 077025, jud. Ilfov, Romania
mcernat@acttm.ro

UK
Mr. Grant BAILEY
Defence Equipment and Support – Ministry of Defence
Walnut 1b # 1129, MOD
Abbey Wood, BRISTOL BS34 8JH
Tel: 0117 913 7995
DESJBTSE-NET4@mod.uk

USA
Mr. Edwin Jay CURLE
US DoD M&S CO
4501 Ford Ave, Suite 300
Alexandria, VA, 22302
Tel: +1 703-975-9369
Fax: +1 703-998-0667
Edwin.Curle.CTR@osd.mil

NATO ORGANISATIONS

NATO ACT
Dr. Gokay SURSAL
Scientist
HQ ACT
7857 Blandy Road
Norfolk, VA 23511-2490, USA
Tel: +1 757 445-3386
gokay.sursal@act.nato.int

NATO RTO
LTC. Adrian VOICULET
MSCO Technical Officer
NATO RTA
BP 25 F-92201 Neuilly s Seine
Cedex 01 - France
Tel: +33 1 55 61 22 46
Fax: +33 1 55 61 96 22
voiculeta@rta.nato.int

NATO NIAG
Dr. Jean-Pierre FAYE
THALES (TRS)
1 Av. Carnot
91883 MASSY, FRANCE
Tel/Fax: +33 1 69 75 51 38
jean-pierre.faye@thalesraytheon-fr.com

ACRONYMS

A

ACT	Allied Command Transformation (NATO)
ADL	Advanced Distributed Learning
AMSP	Allied Modelling and Simulation Publication
AP	Allied Publication
API	Application Programming Interface

B

BOM	Base Object Model

C

C	C Programming Language (ISO/IEC 9899)
C-BML	Coalition Battle Management Language
C2	Command and Control
C3I	Command Control Communication and Information
CMSD	Core Manufacturing Simulation Data (CMSD)
CNAD	Conference of National Armaments Directors (NATO)
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-The-Shelf
CSPI	COTS Discrete Event Simulation Package Interoperability

D

DEVS	Discrete-Event Systems Specification
DFAD	Digital Feature Analysis Data
DIS	Distributed Interactive Simulation
DISA	Defense Information Systems Agency (US)
DISR	Department of Defense Information Technology Standards Registry (US)
DLC	Dynamic Link Compatible (DLC) HLA API
DoD	Department of Defense (USA)
DODAF	DoD Architecture Framework
DSEEP	Distributed Simulation Engineering and Execution Process

DTED Digital Terrain Elevation Data

E

EDCS Environmental Data Coding Specification (SEDRIS)

F

FEDEP Federation Development and Execution Process
FOM Federation Object Model (HLA)

G

GIG Global Information Grid (US)
GM V&V Generic Methodology for Verification and Validation
GOTS Government Off-The-Shelf

H

HBM Human Behaviour Modelling
HLA High Level Architecture

I

I**DEF0** Integration Definition for Function Modelling
I**DEF1X** Integration Definition for Information Modelling
IEC International Electrotechnical Commission of ISO
IEEE Institute of Electrical and Electronics Engineers, Inc.
IPR Intellectual Property Rights
ISO International Organisation for Standardisation
IT Information Technology
ITOP International Test Operations Procedures

J

JC3IEDM Joint C3 Interface and Exchange Data Model
JTC Joint Technical Committee

L

LVC AR Live Virtual Constructive Architecture Roadmap

M

M&S Modelling and Simulation
MC Military Committee (NATO)
MDA Model Driven Architecture
MDE Model Driven Engineering
MODAF MOD Architecture Framework (UK)
MSCO Modelling and Simulation Coordination Office
MSDL Military Scenario Definition Language
MS3 Modelling and Simulation Standards Subgroup (NMSG)

N

NAF NATO Architecture Framework
NGA National Geospatial-Intelligence Agency (USA)
NMSG NATO Modelling and Simulation Group
NMSSP NATO M&S Standards Profile
NAC North Atlantic Council
NC3A NATO Command, Control and Consultation Agency
NCS NATO Committee for Standardisation
NIST National Institute of Standards and Technology (USA)
NSA NATO Standardisation Agency
NSO NATO Standardisation Organisation

O

OMG Object Management Group
OWL Web Ontology Language

P

PDU Protocol Data Unit (DIS)
PfP Partnership for Peace (NATO)
POC Point of Contact

R

REVVA	Reference for VV&A
RPG	Recommended Practice Guide
RPR FOM	Realtime Platform Reference (RPR) FOM
RTA	Research and Technology Agency
RTI	Run Time Infrastructure (HLA)
RTO	Research and Technology Organisation

S

SC	Subcommittee
SCORM	Shareable Content Object Reference Model (ADL standard)
SCORM Sim	SCORM-Simulation Interface Standards
SDO	Standard Development Organization
SEDEP	Synthetic Environment Development and Exploitation Process
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SISO	Simulation Interoperability Standards Organization
SIMPLE	Standard Interface for Multiple Platform Link Evaluation
SRM	Spatial Reference Model (SEDRIS)
SRML	Simulation Reference Markup Language
STANAG	Standardisation Agreement (NATO)
STF	SEDRIS Transmittal Format
SysML	Systems Modelling Language

T

TADIL	Tactical Data Information Link
TC	Technical Committee
TCA	Technical Cooperation Agreement
TENA	Test and Training Enabling Architecture (US DoD)
TOR	Terms of Reference

U

UCATT	Urban Combat Advanced Training Technology
UML	Unified Modelling Language

URL	Uniform Resource Locator

V

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

W

W3C	World Wide Web Consortium
WG	Working Group

X

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

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GLOSSARY

A

accreditation. The Official Certification that a model or simulation or Federation is acceptable for use in relation to a specific purpose (e.g.: the decision-maker has stated, with a "seal of Approval", that the model is suitable for its purpose or use).

accreditation agent. The organization designated by the accreditation sponsor to conduct an accreditation assessment for a M&S application

acceptance. The decision to use a simulation for a specific purpose while the term accreditation is the official certification that a model or simulation is acceptable for use for a specific purpose.

accuracy. The degree of exactness of a model or simulation, high accuracy implying low error. Accuracy equates to the quality of a result, and is distinguished from precision, which relates to the quality of the operation by which the result is obtained and can be repeated.

aggregation. The ability to group entities while preserving the effects of entity behavior and interaction while grouped. domains to interact at the combat object and event level.

algorithm. A prescribed set of well-defined, unambiguous rules or processes for the solution of a problem in a finite number of steps.

Application Programmer's Interface (API). A library of function calls that allows a federate to interact with a software application.

architecture. The structure of components in a programme/system, their interrelationships and the principles and guidelines governing their design and evolution over time.

C

Command and Control Communication System (C3I). A communication system which conveys information between military authorities for command and control purposes.

Command Post Exercise (CPX). An exercise in which the forces are simulated, involving the commander, his staff, and communications within and between headquarters.

Computer Assisted Exercise (CAX). Contained within the SYNEX grouping is the Computer Assisted Exercise (CAX) which is a CPX where computers simulate the operational environment and provide event resolution that may be used in a distributed or non-distributed form or a combination of both.

Computer-Generated Forces (CGF). A generic term used to refer to computer representations of forces in simulations that attempt to model human behaviour sufficiently so that the forces will take some actions automatically (without requiring man-in-the-loop interaction). CGFs are also referred to as Semi-automated Forces (SAF).

computer network. A network of data processing nodes that are interconnected for the purpose of data communication.

conceptual model. A statement of the content and internal representations that are the user's and developer's combined concept of the model. It includes logic and algorithms and explicitly recognises assumptions and limitations.

configuration management. The application of technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a model or simulation, to control changes and to record and report change processing and implementation status.

constructive model or simulation. Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations but are not involved in determining the outcomes.

D

data. The properties of an entity expressed in discrete parametric values describing its attributes.

disaggregation. The ability to represent the behavior of an aggregated unit in terms of its component entities. If the aggregate representation did not maintain state representations of the individual entities, then the decomposition into the entities can only be notional.

distributed exercise. An exercise where the training audience can be at different locations, i.e., different cities, countries or continents due to operational, technical or financial reasons. A distributed exercise can be supported by distributed or centralized models and simulations.

Distributed Interactive Simulation (DIS). (1) A government/industry initiative to define an infrastructure for linking simulations of various types at multiple locations to create a realistic, complex, virtual environment for the simulation of interactive activities. This infrastructure brings together platforms from different military services and systems built by various vendors using different technologies for different purposes and permits them to interoperate. (2) A time and space coherent synthetic representation of world environments designed for linking the interactive, free play activities of people in operational exercises. The synthetic environment is created through real-time exchange of protocol data units between distributed, computationally autonomous simulation applications in the form of simulations, simulators and instrumented equipment interconnected through standard interfaces.

distributed simulation. A simulation that has multiple modules, which can be run on multiple processors. The processors can co-located in the same room or located in remote sites.

E

entity. A distinguishable person, place, unit, thing, event, or concept about which information is kept.

environment. (1) The texture or detail of the domain, that is terrain relief, weather, day, night, terrain cultural features (such as cities or farmland, sea states, etc.); (2) the external objects, conditions and processes that influence the behaviour of a system (such as terrain relief, weather, day/night, terrain cultural features, etc.).

environmental representation. A representation of all or part of the natural or man-made environment, including permanent or semi-permanent man-made features.

events. Events are major occurrences or a sequence of related incidents which are actions or situations that provide greater clarity to an event.

exercise. A military manoeuvre or simulated wartime operation involving planning, preparation, and execution. It is carried out for the purpose of training and evaluation. It may be a combined, joint, or single service exercise, depending on participating organizations.

F

federate. A member of a simulation federation. All applications participating in a federation are called federates. In reality, these applications may include simulations, federate managers, data collectors, live systems, or passive viewers.

federation. A set of interacting simulations, real-world ("live") systems (e.g., Communication and Information Systems (CIS), weapon system hardware, instrumented ranges) and utilities (e.g., federation managers, data collectors, passive viewers), collectively termed "federates," which together provide users with a simulated system in which they can accomplish their objective. This term (and also the Federate term) were made popular by the HLA standard but they are now in larger use in the distributed simulation community.

Federation Object Model (FOM). An identification of the essential classes of objects, object attributes and object interactions that are supported by an HLA federation. In addition, optional classes of additional information may also be specified to achieve a more complete description of the federation structure and/or behaviour.

fidelity. The accuracy of the representation when compared to the real world.

H

highly aggregated model. Highly aggregated simulations are aggregate level simulations where collections of military assets, i.e., units, are the primary objects represented. They are designed for the higher military echelons such as corps level. They typically use lower resolution terrain data but they can simulate in very large areas as large as continents.

high resolution model. High resolution simulations are entity level simulations where singular military objects, e.g. a soldier, a tank, an aircraft, are the primary objects represented. They are typically designed for the lower military echelons such as platoon, company and battalion. They can also be used for operational level exercises. In high resolution models the resolution of terrain data is higher than high resolution models, i.e., sometimes up to the plans of individual buildings.

High Level Architecture (HLA). The High Level Architecture is composed of three parts: the HLA Rules, the HLA Interface Specification, and the Object Model Template (OMT). The HLA Rules describe the general principles defining the HLA, and delineate ten basic rules that apply to HLA federations and federates. The HLA Interface Specification defines the functional interface between federates and the Runtime Infrastructure (RTI). The Object Model Template Specification provides a specification for documenting key information about simulations and federations. Use of the OMT to describe Simulation and Federation Object Models (SOMs and FOMs) is a key part of the HLA. Major functional elements, interfaces, and design rules, pertaining as feasible to all DoD simulation applications, and providing a common framework within which specific system architectures can be defined.

Human-in-the-Loop (HITL). See interactive model.

I

Interactive Model or Simulation. A model or a simulation that requires human participation. Synonym: human-in-the-loop.

interoperability (as applied to M&S). The ability of a model or simulation to provide services to, and accept services from, other models and simulations and to use the services so exchanged to enable them to operate effectively together. (This definition is a slight change from the special case definition in NATO Publication AAP-6.)

L

live simulation. See Live, Virtual and Constructive Simulation.

live, virtual and constructive simulation. The categorisation of simulations into live, virtual and constructive is problematic because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorisation also suffers by excluding a category for simulated people working real equipment (e.g., robotics).

a. live simulation. A simulation involving real people operating real systems.

b. virtual simulation. A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop (HITL) in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a CIS team).

c. constructivem model or simulation. Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations but are not involved in determining the outcomes.

live exercise. An exercise where troops are deployed to a field.

M

M&S reuse. The use of M&S resources, (e.g., models, simulations, databases, algorithms, tools) for purposes beyond those for which they were originally developed. Reuse can occur within an organization or in different organizations, or in different application areas.

Model. A representation of a system, entity, phenomenon, or process. Software models of specific entities are comprised of algorithms and data. A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Multi-Resolution Modeling (MRM). Represents aspects of the real world at more than one level of detail.

N

Network. An arrangement of nodes and interconnecting branches.

O

Object Model. A specification of the objects intrinsic to a given system, including a description of the object characteristics (attributes) and behaviours. Include descriptions of the static and dynamic relationships that exist between objects.

Open System. A system in which the components and their composition are specified in a non-proprietary environment, enabling competing organizations to use these standard components to build competitive systems. There are three perspectives on open systems:

portability -- the degree to which a system component can be used in various environments;
interoperability -- the ability of individual components to exchange information; and
integration -- the consistency of the various human-machine interfaces between an individual and all hardware and software in the system.

P

physical architecture. The identification and arrangement of the physical components of a system architecture into an orderly framework that describes the physical structure, the technical functions, design features and technical attributes that can be achieved by each component and by the system within specified constraints.

R

real-time. In real-time modelling and simulation, simulated time advances at the same rate as actual time; for example, running the simulation for one second results in the model advancing time by one second. Contrast with: fast time; slow time.

real-world. The set of real or hypothetical causes and effects that simulation technology attempts to replicate. When used in a military context, the term is synonymous with real battlefield to include air, land and sea combat.

representation. The portrayal of an entity or process provided by a model, simulation, or federation.

representational resource. Knowledge about the real world (raw materials) used to develop a model, simulation, or federation. Representational resources fall into one of three categories:

a. Functional Description of the Mission Space (FDMS). An operator's view of the entities, actions, relationships, interactions and environmental factors associated with a mission. Mission spaces may include any aspect of the real world, to include military operations, medical treatment, manufacturing, electrical power distribution, etc.

b. Characteristics and Performance Descriptions (C&PD). **An expert's** identification of the entity's nature, which are comprised of (1) attribute definitions, (2) algorithms and (3) data limits.

c. Scenario-specific Data. The particular information used by a given model, simulation or federation execution so that it may provide its representations in the context of a set of real-world circumstances. Scenario-specific data include terrain databases, order of battle, weather, plans and other state data.

resolution. The level of detail of a model or simulation. The degree of detail and precision used in the representation of real world aspects in a model or simulation.

Runtime Infrastructure (RTI). The general purpose distributed middleware that provides the common interface services during the runtime of an HLA federation.

S

scalability. The ability of a distributed simulation to maintain time and spatial consistency as the number of entities and accompanying interactions increase.

scenario. (1) Description of an exercise ("initial conditions" in military terms). It is part of the session database that configures the units and platforms and places them in specific locations with specific missions. (2) An initial set of conditions and time line of significant events imposed on trainees or systems to achieve exercise objectives.

Semi-Automated Forces (SAF). See Computer-Generated Forces.

simulation. The execution over time of models representing the attributes of one or more entities or processes. Human-in-the-Loop simulations, also known as simulators, are a special class of simulations. A method for implementing a model over time.

simulation centre. National facility which designs, develops and integrates all live, virtual, and constructive synthetic environments to support Concepts Development and Experimentation, Training, Exercises and Mission Rehearsal, and Research, Development and Acquisition.

Simulated Mission Space (SMS). A general term that describes the synthetic depiction of the real (or projected) world provided by a model, simulation, or federation.

Simulation Object Model (SOM). A specification of the intrinsic capabilities that an individual simulation offers to federations. The standard format in which SOMs are expressed provides a means for federation developers to determine quickly the suitability of simulation systems to assume specific roles within a federation.

system architecture. The logical structure and operating principles of a system.

V

validation. The process of determining the degree to which a model or simulation is an accurate representation of the real-world from the perspective of the intended uses of the model or simulation.

verification. The process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specification. Verification also evaluates the extent to which the model or simulation has been developed using sound and established software engineering techniques.

Verification, Validation & Certification (VV&C). The process of verifying the internal consistency and correctness of data, validating that it represents real world entities appropriate for its intended purpose or an expected range of purposes, and certifying it as having a specified level of quality or as being appropriate for a specified use, type of use, or range of uses. The process has two perspectives: producer and user process.

virtual simulation. A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop (HITL) in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a CIS team)

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