NATO-MSG-058 Conceptual Modeling for M&S

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ABSTRACT: *The NATO Research and Technology Agency has set up the Modeling and Simulation Group (MSG) 058 with title "Conceptual Modeling for M&S" to produce guidance on conceptual modeling for modeling and simulation (M&S) development within NATO. The Task Group is comprised of CAN, ESP, NOR, NLD, ROM, SWE, TUR and USA. This paper introduces the group's mandate and reviews the state-of-the-art of doing conceptual modeling.*

Current M&S standards, such as DIS and HLA, have provided the first steps to composability, interoperability, and reuse, but they are not sufficient to support understanding simulation development and to facilitate semantic consistency at the conceptual level of consequent simulation products. Systematic conceptual modeling will help to improve common understanding between stakeholders that are involved in simulation development, composition, and use for the defense establishment. This will lead to better requirement specification; and it is key to the transformation of requirements to implemented simulations fit for their intended use.

NMSG-058 is committed to clarify the process and results of "Conceptual Modeling", and to recommend best practice to generate, document, and use conceptual models. The group is studying the fundaments of conceptualization of existing and prospective realities; methodologies for generating, documenting, and sharing conceptualizations; correlation of conceptual modeling with simulation and software engineering processes; and relevant initiatives and technologies. The main deliverable is a guide on the conceptual modeling process and product, that will provide best practice instruction and serve the needs of relevant stakeholders. Furthermore, the group is committed to offering the results of its efforts as the basis for establishment of a SISO standard.

Introduction

In modeling and simulation, the focus is more and more on support towards developing interoperable and re-usable simulation assets that are fit-for-purpose. Conceptual modeling has been recognized as an important step within the development process towards achieving that goal. Unfortunately, current practice is such that this step is omitted out or done poorly. Currently, neither a consensus definition of conceptual model content nor a standard practice for conceptual model development exists. Where conceptual modeling is practiced, it is typically defined on a project-to-project basis.

NMSG-058 has adopted as a working definition of a ‘conceptual model’ the following:

Conceptual Model - an abstract (mental) model of some part of reality. A conceptual model describes the key concepts, and their relationships within this specific part of reality. A conceptual model is a theoretical construct that represents something, with a set of variables and a set of logical and quantitative relationships between them.

In interpreting this definition, the Group assumes that a conceptual model includes the identification of what artifacts are being represented (ontology), what attributes characterize those artifacts, and what processes are manifest in the behaviors of entities individually or in concert. Relationships among artifacts included in a conceptual model may be concrete (e.g. communication, reporting responsibility, perception, and health and status influence), or abstract (generalization or is-a-kind-of relationships or compositional or is-a part-of relationships).

This definition in the context of conceptual modeling for M&S in the defense establishment leads to:

A domain specific (i.e. defense establishment) conceptual model is the abstraction of military or defense-domain reality, that can be used as foundation for building military simulation models.

The North Atlantic Treaty Organization (NATO) Research and Technology Organization (RTO) Modeling and Simulation Group (MSG) recognized the important role that conceptual modeling could play in interoperable simulation assets, and set up the NMSG-058 task group to investigate this area. A NATO Task Group (TG), working in conjunction with the Simulation Interoperability Standards Organization (SISO), is in the unique position to develop a standard that will be used by multiple nations, thus meeting the reusability and interoperability goals. NMSG-058 started on July 2007 and will finish in 2010.

The NMSG-058 task group expects that a recommended practice for conceptual modeling will increase interoperability, reusability, and relevant employment of simulations, because it guides multiple stakeholders through an evolutionary process that will result in sufficient common understanding of the semantic significance of simulation representation. NMSG-058 will draft a guide that contributes to developing a proper conceptual. This guide will cover:

- the conceptual modeling process;
- the conceptual model artifact;
- the role within simulation development for the defense establishment; and
- supporting standards.

The remainder of this paper gives some background on conceptual modeling, as well as on the NMSG-058 task group. It gives an overview of the task group’s current status, how the task group sees the role of relevant standards and the way ahead.

Background on Conceptual Modeling

A conceptual model contributes to the common understanding of multiple stakeholders at the most difficult level of understanding: *The conceptual level* as identified by the “Levels of Conceptual Interoperability Model (LCIM)” [13].

A Conceptual Model is used:

- for human understanding and sharing information;
- to arrive at a consensus on the intended meaning of the models before actual development;
- for making the implicit domain assumptions explicit;

- as an abstract pattern or template for knowledge representation; and
- for sketching the outline of intended program, code or simulation models.

Trying to understand a conceptual model is like trying to understand a joke in a foreign language. Even if you are able to understand the words and how they form a story, you will probably not "get the joke" until you understand how the story is supposed to be funny in the intended context. You have to understand the concepts of the story and how they fit in the concepts of the intended cultural and social context. For some jokes, you already "get the joke" if you map the story onto your own context (i.e. culture). You will, however, still miss the clue if it depends on a local cultural habit that you are unfamiliar with.

Actually, it is even more complicated than that. Imagine a joke-teller who is making his story up while he goes along and he himself does not even know how it is going to end or if it is going to be funny at all. This metaphor allows us also to introduce some other aspects.

The joke teller should not just tell his joke like a robot, but use the feedback of his audience and play with it in order to get a good laugh. This is exactly what separates a good comedian from mediocre ones. He must explore what listeners like, and sculpture his joke into that direction. This compares to the art of developing a conceptual model where the feedback from all stakeholders is required to sculpture the conceptual model until everybody "gets it".

Using a metaphor, as we did above, is one way of explaining concepts. It conveys properties, behavior and effects of an unfamiliar concept in an unfamiliar context to an analogue familiar metaphor in a familiar context. Other modeling strategies are described by Pidd [12]:

- model simple, think complicated;
- start small and evolve;
- divide and conquer;
- use metaphors, analogies and similarities;
- do not fall in love with data; and,
- modeling may feel like muddling through.

Reasons for using conceptual models in the defense establishment with the intention of developing cost effective and fit for purpose simulations are:

- support simulation developers to design the right solution, by helping them to understand the properties, behavior and effects of military concepts (e.g. domain concepts);
- support subject matter (e.g. military) experts to get the right solution, by helping them to understand the impact and implicit side effects of major design decisions (e.g. engineering concepts); and,
- support reuse by helping domain experts to agree on a complete and unambiguous model of their common domain authoritative information or knowledge.

Conceptual models are key to the transformation of user needs and requirements to M&S design, and eventually implementation. A conceptual model is intended to form a bridge of understanding between the users of M&S, the military domain experts and simulation engineers. Without conceptual models, history has shown that simulation developers often do not sufficiently understand the military domain to be modeled and implement M&S that do not reflect the intended reality, and thus do not satisfy the user's needs. Information is either incomplete or ambiguous, and therefore useless for simulation model development.

While technical or communications-level interoperability of simulations has been thoroughly researched and solutions have been implemented, for example the High Level Architecture (HLA)[6] for M&S, it does not adequately address higher levels of interoperability (semantic, pragmatic, and conceptual [13]).

How does conceptual modeling fit in the overall simulation development process? An accepted standard within simulation development process is the HLA Federation Development and Execution Process (FEDEP) [7]. The FEDEP shows that developing a conceptual model is one of the first steps in the simulation development process together with scenario definition.

Developing a conceptual model is an important step, because it is an input for requirements analysis. However, the FEDEP does not elaborate on how to develop and maintain a proper conceptual model. Our guidance is going to fill that gap. Our task group assumes that the FEDEP is used iteratively and that, during each iteration, the conceptual model becomes upgraded and enhanced to the appropriate level of detail in supporting that FEDEP iteration. Robinson [1] mentions that an evolutionary development is a central theme in conceptual modeling practices. Although the FEDEP is an important standard, the NMSG-058 guidance is also appropriate when other development processes are being used for simulation development.

Unlike the FEDEP, other sources mention additional requirements on conceptual modeling, such as DMSO CMMS that indicates:

- correctness;
- adequate documentation;
- utility;
- consistency;
- composability;
- reusability; and
- reducibility.

In addition to these, concepts like Swedish DCMF – Defence Conceptual Modelling Frame-work [2] put further requirements for how the final conceptual models should be:

- Readable and usable for a person as well as a Machine
- Traceable the whole way back to the original knowledge sources
- Useable as a basis for simulations models.

It's worth to mention that both DMSO CMMS and Swedish DCMF have more focus on problems related to acquisition and representation of authoritative knowledge. Thus both concepts try to address the following problems:

- reducibility;
- to gain access to authorized knowledge of military operations is not easy, and modelers instead rely on various, sometimes not authoritative, sources for the same information, which leads to a confusion of ideas;
- the supplied knowledge (information) is not sufficient enough to be used in simulation model development, or it is ambiguous; and
- the obtained knowledge, which often has been achieved at a very high price, is not preserved for future use, which leads to unnecessary repetition of work.

Stakeholders that are involved in simulation development do not always have a common understanding of shared concepts. This can lead to simulations that are unfit for purpose or simply too expensive for their intended purpose. Fitness for purpose is about validation in which a conceptual modeling has a crucial role.

Validation is about determining that the application domain has been described sufficiently to meet users' needs while accurately incorporating subject matter expert knowledge. Pace [5] promotes validation to increase correctness of the simulation and credibility of the model. Conceptual models contribute to the validation process because a conceptual model is one of the first comprehensible deliverables during M&S development that can be reviewed by subject matter experts (SME). An important advantage is that SMEs can give feedback early in the development process.

NMSG-058's Activity

Mission and Planning

NMSG recognized the important role that conceptual modeling could play in interoperable simulations, and set up the NMSG-058 task group to investigate this area. The participating nations are: US (co-chair), Romania (co-chair), Canada, Sweden, Spain, Netherlands, Norway and Turkey.

NMSG-058's mission is to clarify what a conceptual model is and what it represents. Furthermore does this group investigate methodologies, simulation and software engineering processes, initiatives and technologies, as well as the content of conceptual models. The final objective is to provide guidance to the M&S community on conceptual modeling. If possible, a future guidance will be proposed to the international community for standardization via the SISO. The NMSG-058 purpose is to foster M&S interoperability and reusability between NATO nations to achieve better integrated operational allied forces.

Collaboration and dissemination is key to the success of the task group. That is why NMSG-058 will open its guide to an M&S standard product, developed through an open consensus-based standards body, such as SISO. SISO has a strong background and current focus on military M&S, but does also include M&S practitioners from outside the military domain.

More collaboration is found within the RTO of NATO, of which the NMSG is also part. The task group has teamed up with the Information Systems Technology (IST) panel, IST-75 to be precise, that deals with "Semantic Interoperability". IST-75 particularly explores the ontology field.

NMSG-058's criteria for success are:

- specific, usable, ecumenical process for conceptual modeling best-practice;
- guidance on notation and presentation-views of conceptual model artifact;
- standards document suitable for return to SISO for international balloting;
- national participation and buy-in to the work product; and
- guidance on conceptual modeling.

The main deliverables of the task group will be:, several interim publications, a draft guidance deliverable and a final report.

Current Status of the Task Group

Up to now, the task group has held quarterly meetings in which the following topics were elaborated:

- stakeholder analysis and context;
- specification of a conceptual modeling process;
- specification of a conceptual model artifact;
- relationship to standards.

A concise description of these four topics will follow.

Stakeholder Analysis and Context

Stakeholder roles and responsibilities will drive the task group's recommended practice, and the ultimate acceptability of the work-product.

Nominal base-class roles include:

- conceptual modeling authority (subject matter expert, requirements custodian, etc.);
- conceptual modeling custodian (simulation information archivist, etc.);
- conceptual modeling producer (simulation system architect, system analyst, etc.); and
- conceptual modeling consumer (sponsor, simulation developer, software engineer, re-user, etc.).

There are many potential users, with various missions and tasks, and many of them definitely need to be supported by certain tools and views. Some examples of these are listed below.

- analyzer, designer and program: can use the conceptual model as aid in the comprehension of components within military operations, and in the understanding of the course of events in produced simulations;
- evaluator: can use the conceptual model for verifying and validating models, and as a basis for accreditation of simulation systems;
- scientists and engineers: use the conceptual model means and guide for their modeling activities;
- mission leader and planner: can use the conceptual model as a support when developing scenarios for simulations;
- requirements setter: may use the conceptual model as support for composition of requirements specifications;
- purchaser of simulators: may use the conceptual model to decide scope and limitations; and
- end-user: may use the conceptual model as a tool for describing and formalizing the functional requirements for the specific model and simulation use, as well as help for evaluating results of simulation and practice.

Specification of Conceptual Modeling Process

The goal is to produce a disciplined procedure by which the simulation developer is systematically informed about the real world problem to be synthesized. Robinson [1] identified a few questions. When should detail be added? When should elaboration stop? We have identified that it is unlikely that just one waterfall iteration will produce a suitable conceptual model. Multiple iterations allow for stakeholders to become gradually acquainted with the complexity of a concept, which is a much more natural way for humans to understand complexity, than dealing with elaborated models at once. This evolution may well start on the infamous back of a beer mat, gradually becoming more and more detailed, until it is mature enough to be represented in an executable format (i.e. formal). The task group foresees the role of a formal conceptual model to act as a base reference that serves as an implementation independent model for further implementation generation, as intended in MDA [11].

Unlike the specification of the FEDEP, the task group has chosen a canonical model [4] to describe the conceptual modeling process.

In previous studies, Pace [5] has identified the following steps for the process of conceptual modeling intended for simulation, being:

- collect authoritative information on the problem domain;
- identify entities and processes that need to be represented;
- identify simulation elements; and
- identify relationships between the simulation elements.

Other studies have suggested a slightly different subdivision of conceptual modeling process steps, like DCMF which suggest the following four steps:

- Knowledge Acquisition (KA);
- Knowledge Representation (KR);
- Knowledge Modeling (KM); and
- Knowledge Use (KU).

The DCMF process is an iterative process where some parts and steps sometimes are done in parallel. By the end of every phase there are one or more products that are used as input for the next or a following phase. Depending of the purpose for acquiring knowledge some products may be ready for use after perhaps only one or two phases. [2]

From the expertise of validation, some quality assurance measures are proposed. A conceptual model should at least be reviewed and approved by a:

- subject matter expert; and a
- lead simulation engineer.

Specification of Conceptual Model Artifact

A conceptual model artifact is comprised of a set of reference information that that satisfy the needs of the military simulation community-of-interest to understand the simulation representation; to establish its credibility for one or another intended use; and to support the business practice of composition, sharing and re-use of simulations. In this spirit, for instance, the simulation SME should employ to communicate with the military operations SME and obtain their feedback.

A set of knowledge elements are required for a complete representation of a conceptual model. However, choosing a set of "Knowledge Elements" can never be the only way of representing a conceptual model. Other forms may use different decomposition or nomenclature by applying other approaches, and arrive at different representation for the same conceptual model. The important issue is that such alternative representations have to be translatable to each other.

A minimal conceptual model should contain:

- entities mentioned in the scenario;
- interactions mentioned in the scenario;
- an operational view;
- a high level implementation independent system decomposition;
- what systems are to be simulated; and
- pseudo physics.

The task group does not intend to prescribe a modeling language, such as UML. Although it recognizes that a common way of describing models is significant, it is also rather engineering domain dependent. Dynamic models, for example, are often represented using causal loops, while discrete event simulations have no generally agreed method of description.

Relationship to Standards

An important part of the task group's work has been a survey on existing standards and how they can contribute, either to the conceptual modeling process or the conceptual model artifact. These standards have been selected because they are well-known in the M&S domain, in the defense establishment and/or in the practice of conceptual modeling. We discuss the role of these standards and indicate how they relate to conceptual modeling for the defense establishment with the intention of developing a simulation.

The next section elaborates more on a selection of standards that the task group identified so far:

- IEEE 1516.3 FEDEP[7];
- IEEE P1516.4 HLA VV&A[8];
- Base Object Model (BOM)[9];
- Architecture Frameworks, such as DoDAF[15] and NAF[10]; and

- Model Drive Architecture (MDA[11]).

In the text that follows, individual listed standards are described that, in the view of the Group, can contribute to the prospective NMSG-058 conceptual modeling draft guidance.

HLA IEEE 1516.3 FEDEP

In the domain of distributed modeling and simulation (M&S), HLA has been an important interoperability standard in the last 10 years. One of the objectives of the MSG-058 is to foster the establishment of its guideline as a SISO standard. It means we will foster our work to be part of the standards that are in line with the FEDEP initiatives. This will require the creation of a detailed plan following the HLA.

Doing conceptual modeling is a step of the FEDEP. There is, however, not sufficient guidance from the FEDEP to draft a conceptual model. The task group is going to explain how conceptual modeling fits in the overall FEDEP process.

HLA VV&A IEEE P1516.4

IEEE 1516.4-2007 [8] is a recommended practice for Verification, Validation, and Accreditation of a federation. It is an overlay to the FEDEP.

This VV&A recommended practice mentions three activities which deal explicitly with a conceptual model [3].

1) Support developing federation conceptual model. — A conceptual model needs to be carefully evaluated before continuing to the succeeding stages of federation development. At a minimum, the user/sponsor should review key processes and events to ensure the adequacy of the conceptual representation. A VV&A team participates from the initial conceptual model through its evolution. This VV&A team also contributes to establishing the credibility of the conceptual model by locating and collecting information.

2) Contribute to verifying federation conceptual model. — This activity verifies the internal consistency, completeness, and correctness of the conceptual model and its consistency with the verified federation objectives and the scenarios. It is assumed that the scenarios and the conceptual model can be developed in concert over several iterations.

3) Validate federation conceptual model. — The conceptual model provides the first meaningful insight into the federation validity. The conceptual model defines the representations upon which all subsequent activities build. This activity should result in the user/sponsor's approval of the conceptual model. This task improves the relevance of the resulting federation to the user/sponsor and contributes to the process of building federation credibility with those users.

Base Object Model

The Base Object Model (BOM)[9] is a concept created by SISO to enables composability for HLA simulations. The BOM concept is based on the assumption that piece-parts of simulations and federations can be extracted and reused as modeling building blocks or components in different contexts and simulations. A BOM has four major elements:

- Model Identification,;
- Conceptual Model;
- Model Mapping; and
- Object Model Definition.

The BOM's "Conceptual Model" element is of the most interesting part from the task group's perspective. It deals with the knowledge, while the other elements have a more administrative focus. The BOM Conceptual Model part consists itself of four parts:

- Pattern of Interplay, describing the interactions between different entities and the activities involved in the interactions;
- State Machine, describing the states that the conceptual entities can have as well as the transitions between these states; and
- Entity Type; and
- Event Type, identifying and describing the entities and activities used in Pattern of Interplay and State Machine.

However, when considering the BOM as a semantic base for representing the conceptual models, in the context of NMSG-058, the lack of some capabilities will appear. Mojtahed discussed the most important [14], listed below.

The current BOM is too general which can cause ambiguity and a risk for interpretation problems when composing BOMs. More semantic expressivity will decrease those risks and give the opportunity to more detailed descriptions, more specialized BOMs.

Automatic composition of BOM Assembly is not possible today. The semantic richness and formal representation of knowledge instances are needed to make this possible.

The BOM structure supports syntactic descriptions of a conceptual model while the developed conceptual models also have to be semantically interoperable.

The BOM standard documentation does not include the concept of ontology. Extending the BOM by relating it to an ontology can have advantages. The main advantage is that simulations described by a BOM (or rather, a BOM Assembly which is a set of BOMs) are given the possibility to relate to common understanding of the world. That is, by relating to the same ontology the participants in a BOM Assembly agree on what concepts exist and how they are related.

Today the BOM is expressed with XML[1] (eXtensible Markup Language) which is a good foundation to guarantee interoperability at the syntax level. If the BOM could be expressed with OWL[2], for example (Web Ontology Language), using Ontologies, it would also support the semantic-level interoperability.

The State Machine, which is the heart of the BOM and will handle the dynamics, is inherently designed from a data-centric perspective and not with action-centric perspective where actions themselves are objects of interest for getting the higher level of abstraction than is provided by the BOM State Machine. The caters to a simple linear sequence of states, where one state can lead to another and that leads to another till a final exit condition is reached. This is a rather simple case to be assumed. It does not cover the possibility of sequences, forks, joins and all other possible alternatives for a state to be followed by one or more other activities. We agree that a single state can be followed by one state, but an action taken may lead to several consequences as well.

Taking into account above shortcomings and improvements, a semantically enriched BOM[14] could serve as a semantic base for representing a conceptual model.

Architecture Frameworks

An architecture framework defines a standard way to organize an enterprise architecture or systems architecture into complementary and consistent views. These frameworks introduce multiple consistent and coherent views, each tailored towards a stakeholder. The US Department of Defense Architecture Framework (DoDAF) [15] contains the following categories of views:

- the “All View”, which is a representation of a whole system from a particular viewpoint (i.e. from the perspective of a related set of concerns);
- the “Operational View” which is a description of the tasks and activities, organizational and operational elements, and information flows required to accomplish or support an operation;
- the System View which is a description, including graphics, of systems and interconnections providing for, or supporting, system functions; and
- the Technical View which is “the minimal set of rules governing the arrangement, interaction, and interdependence of systems parts or elements, whose purpose is to ensure that a conformant system satisfies a specified set of requirements.

NATO has its own architecture framework called NATO Architecture Framework (NAF) [10].

The views proposed by the architecture frameworks are potential candidate views of a conceptual model artifact, especially the Operational View, which is considered a required one. Having multiple views is also relevant to address multidisciplinary stakeholders. Several of DoDAF instruments, may also provide useful input to our work. Such as:, the High-Level Operational Concept Graphic, the Organizational Relationships Chart and the Operational Activity Sequence, as well as the Repository which has been used by the DoDAF.

1 eXtensible Markup Language
2 Web Ontology Language

While the DoDAF provides direction on how to describe the architectures, it does, however, not provide guidance on how to implement or construct a specific architecture. Current practice shows that architecture frameworks are still not directive enough for proper conceptual modeling. We will thus examine these architecture frameworks further and see whether we can tailor their views for our intended use.

Model Driven Architecture

The MDA is a software design approach launched by the Object Management Group (OMG) [11] in 2001. MDA supports model-driven engineering of software systems. MDA provides a set of guidelines for structuring specifications expressed as models. The MDA approach defines system functionality using a Platform-Independent Model (PIM) using an appropriate domain-specific language. Then, given a Platform Definition Model (PDM), the PIM is translated to one or more Platform-Specific Models (PSMs) that computers can run. Automated tools generally perform this translation.

Even though a conceptual model is often not a model that is suited for code generation and does usually not have formal semantics, there is high potential for conceptual models to evolve into formal, and precise enough models that can indeed be used to generate an executable implementation. MDA is considered a promising approach for achieving the goal of executable models, applicable for “automated” implementation-generation in order to shorten development iterations.

Way Ahead

Having identified stakeholders and their respective needs and interests, having derived requirements for conceptual model process and artifacts, and having analyzed the relevance of existing standards, the MSG-058 is proceeding to draft best practice guidance for the generation, documentation, and employment of conceptual models for military-domain simulations.

Several activities are necessarily part of completion of this task, and some significant challenges remain to be resolved in order to achieve the desired objective.

First, to be completed is the capture, analysis, and consolidation of existing good-practice and the determination of necessary and sufficient attributes of prospective ‘best’ practice. All member nations currently execute successful and preferred (if not altogether comprehensively consistent) practices. These current practices, together with influences from other sources such as the standards mentioned above, need to be conflated into a minimally sufficient set of features that are acceptable to the participating member nations representatives’ and that may serve as the basis for a systematic canonical best practice prescription.

Secondly, a definitive commitment must be made to the specific process elements and semantic content of consequent conceptual model product artifacts that may reasonably be expected to be sufficient to meet the needs of the several relevant stakeholder communities, sufficiently ecumenical to be acceptable to the community at large, and consistent in spirit with existing SISO commitments for simulation best practice processes and products. These particular attributes, process and product will form the core of consequent prescriptive standards.

Next, determination of the form and import of process guidance to be manifest in the standard must be made. Development of conceptual models is a process, and so a process specification is required. In formulating such prescriptive guidance, at least one ‘normal’ form of expression of nominative process must be selected and employed, levels of abstraction or generality of binding or required prescribed behavior to be contained in the guidance must be selected, and degrees of discretion to be allowed to the conceptual model developer practitioner along with required justification for particular discretionary elections must be decided.

No less than process specification for conceptual model development, product artifact specification for the conceptual model itself must be specifically addressed. Concrete determinations of the attributes of satisfactory conceptual model artifacts must be decided, and prescriptive instruction that is: a) necessary and sufficient to guide practitioners to produce expected artifacts, and b) adequate to support the demonstration of the compliance of such artifacts to best practice standards, must be drafted.

Finally, a concept of operations whereby NATO MSG-058 work products can be offered in good order as the basis of initializing a SISO product development group with reasonable expectation of leveraging the NATO best practice draft must be conceived. Any such transition campaign must account for the need for NATO to proceed to establish institutional best practice forthwith, while facilitating the emergence of SISO standards that both include and improve NATO draft best practices relatively promptly.

Contingent significant progress in the activities mentioned above, various partners will plan to start making conceptual models in order to support the simulation development process. It will increase the fitness for purpose and interoperability of simulation assets, because conceptual models can be reviewed and discussed about early in the process. This will help stakeholders to get a common shared understanding of the underlying concepts of the intended simulation in the defense establishment.

Doing good conceptual modeling is not a cheap fix or a one off. It should be an integrated part of the simulation development process and it is likely to evolve iteratively over time. The relevant standards mentioned in this paper contribute to proper conceptual modeling. It all comes together along the iterative development of a simulation.

The task group expects that its guide will contribute to M&S development, such that conceptual modeling becomes common practice within NATO in a standardized way.

It is expected that collaboration with SISO will allow for the guidance to reach a broader community of interest, and establishment of the guidance document as a SISO standard.

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