Developing Effective Standards for C2-Simulation Interoperability

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Abstract

In parallel with NMSG technical activities, the Simulation Interoperability Standards Organization (SISO) has developed technical standards needed to support C2-simulation (C2SIM) interoperability in areas of system initialization and of tasking and reporting.

C2SIM is an exceptionally good example of an area where "Modelling and Simulation has great potential in operational planning and execution of missions." It has become clear that achieving that potential requires partnership between NMSG technical activities and SISO standards-making, so the standards can be developed on the basis of practical usage involving a mixture of experienced national teams.

SISO development groups for C2SIM have merged in order to produce more harmonized results and save effort where there was overlap in their activities. The paper describes the development and characteristics of current C2SIM standards MSDL and C-BML along with the process that is developing next-generation standards while also sustaining the initial versions.

SISO C2SIM standards form an essential element for NMSG work advancing use of simulation in support of military operations. This paper will provide the NMSG technical community with a broad understanding of the work SISO has done and continues to do, to standardize C2SIM.

1.0 INTRODUCTION

Command and control (C2) systems have two major functions: they produce (or accept as input) plans for military operations, which can be sent to units being tasked, as orders; and they display current status of operations, based on intelligence reports, as situational awareness for the user, who may elect to issue new orders as the situation develops. Today's C2 systems generally are computer-based, with commanders and staff at all participating echelons interconnected in a distributed, networked system of systems.

There are at least three major uses for computer-based simulations as part of the operation of C2 systems:

1. Supporting the planning process with course of action (COA) analysis, where the simulation plays out a COA and displays the most likely outcome
2. Supporting military training operations by providing a synthetic operational environment in which participants can input their activities and see in response the most likely result against a simulated adversary; in this case the C2 system normally used by a military force provides the most effective interface for commanders and their staffs, so they can "train as you fight"
3. Supporting mission rehearsal of an operation in a synthetic operational environment that reflects best intelligence regarding the likely behaviors of adversaries and environmental aspects.

Earliest use of simulations required a human intermediary between C2 and simulation systems. However, it has been considered desirable for many years to have simulations coupled directly to C2 systems to reduce time and labor involved [4]. Moreover, it is desirable to have a standardized interface for this purpose, to enable interchangeable use of multiple simulations and C2 systems [5]: C2-simulation interoperability (C2SIM).

In the coalition version of C2SIM used experimentally within the NATO Modelling and Simulation Group (NMSG), multiple coalition partners are able to employ C2SIM over a shared network [1]. Each nation's forces are supported by their own C2 system, which they understand well from long experience; also each nation's forces are represented in virtual engagements by their own simulation, which reflects accurately their personnel, equipment, and doctrine. The national C2 and simulation systems all interoperate, sharing orders, requests, and reports, so that all systems share relevant information. As a result, the coalition force is able to prepare rapidly for its new mission, learning to deal with the unique aspects of each national force while preparing those forces to work together toward their shared mission [5].

The Simulation Interoperability Standards Organization (SISO) has undertaken to provide the standards for coalition C2SIM systems interoperation [6]. SISO C2SIM standards form an essential element for NMSG work advancing use of simulation in support of military operations. This paper is intended to provide the NMSG technical community with a broad understanding of the work SISO has done and continues to do, to standardize C2SIM. Usable operational standards can be developed only on the basis of practical experience; technical and operational experimental work of the NMSG has proved essential to provide that basis.

The remainder of this paper will describe the development of current SISO standards, summarize those NMSG activities supporting SISO standards development, explain the rationale for ongoing SISO C2SIM standards development, and describe how that development is proceeding.

2.0 HISTORY OF C2SIM IN SISO

SISO's mission is to develop, manage, maintain, and promulgate user-driven Modeling and Simulation (M&S) standards that improve the technical quality cost efficiency of M&S implementations across the worldwide M&S community. SISO operating principles are aligned with fostering the open exchange of information and technologies to support the advancement and standardization of M&S-related technologies and practices. SISO work is done on a volunteer basis by government, academic, and industry proponents volunteering their efforts and also by individuals volunteering their efforts. SISO Study Groups are established to consider specific issues and to provide recommendations concerning proposed courses of action for development of standards, guidelines, or reference products. Product Development Groups (PDGs) are formed as a result of approved Product Nominations (PN) to develop or modify standards, references, or guidelines ("Balloted Products"). The PDG does the work required to create the Balloted Product and resolve ballot comments for product review and acceptance. The PDG builds a product based on consensus to meet the PN. The PDG may assume a dual role under another standards organization under an agreement between SISO another body such as the IEEE. A Product Support Group (PSG) will be formed as a result of a completed product and an approved Terms of Reference to provide support to the product.

2.1 SISO BML Study Group

Various interested parties, including several NMSG participants, formed a SISO Study Group to consider the possibility of developing a Coalition BML standard. After due deliberation, in 2005 that group produced a report [7] recommending that SISO charter a Product Development Group (PDG) for that purpose. The Coalition BML (C-BML) Product Development Group was chartered by SISO in 2007. Figure 1 shows the general architecture assumed for C-BML The coalition's C2 systems and simulation systems provide input XML documents to a server, or distributed system of servers. The server replicates those inputs as outputs to the participating C2 and simulation systems on a publish/subscribe basis. We will refer to the combined C2SIM system of systems as a "Coalition."

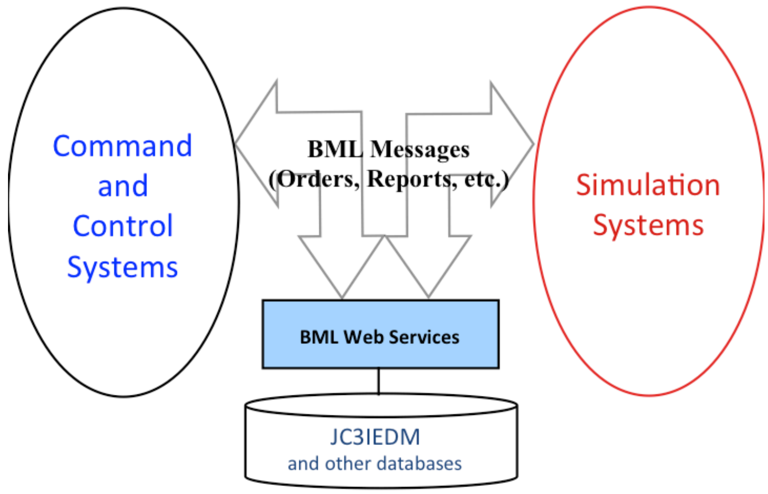

Figure 1: General Architecture for C-BML

2.2 SISO MSDL PDG

The Military Scenario Development Language (MSDL) is focused on providing consistent initialization or start-condition data for both C2 and Simulation systems participating within a Coalition. The US Army OneSAF simulation development program management team was directed to give priority to development of specifications, formats, process, and tools that could be matured into industry wide standards [8]. As a result, they supported the SISO standards process that developed MSDL. Meeting their scenario development time and cost reduction/cost avoidance goals required defining not only how to develop appropriate scenario development tools but also how to specify an interface to the scenario data that would maximize reuse across the modeling and simulation community with low introductory costs. Four design characteristics were considered fundamental to meet these goals; these were reflected in the way MSDL was developed:

- Application independence, to allow the MSDL format and native (OneSAF) simulation initialization format to evolve independently
- Separation of data from code, to allow users to access the data as appropriate for their application
- Separation of concerns to ease understanding of the data, reduce maintenance costs, and to reduce complexity
- Use of commercial and industry standards to allow open, non-proprietary access to reusable scenario data

The MSDL data model holds nine primary elements. These elements describe a military scenario according to the MSDL PDG's military scenario definition:

"A specific description of the situation and COA at a moment in time for each element in the scenario. The description of the scenario conveys reality (what is true about the situation, such as the forces identified as participants in the situation) and perceived reality…"

MSDL provides for initialization of nine primary data elements [9]:

- Scenario ID – metadata regarding the scenario
- Options – parameters to be applied across the scenario
- Environment – scenario time, extents of the geographic area, and the weather, meteorological and

oceanographic conditions

- ForceSides – Sides and Forces relationships for a scenario
- Organization – the organizations within a scenario.
- Overlays – collections of tactical graphics and associations among them and owners of particular units or entities
- Installation – installations as they stand at scenario start time for the forces, sides, or units.
- Tactical Graphics – the tactical action-based iconic information
- MOOTW Graphics – Military Operations Other Than War action-based information for a scenario

The contents of the specification are expected to grow and extend over time to support other types of information such as equipment loading information, unit orders and individual soldier tasking and individual platform readiness or damage state. The evolving Coalition-Battle Management Language (C-BML) was recommended to be used to supply order and task information. When combined with the C-BML formatted orders, tasks, and reports, a much richer set of initial conditions, plans, and perceptions can be created.

It should be noted that in addition to the MSDL specification a formalized coordination process between all participants is recommended to ensure common and consistent interpretation and import of the initialization data. The formality and coordination of the initialization process depends on the size and complexity of the exercise: for a simple single simulation exercise without external connectivity to other simulations or Mission Command devices the process can and should be defined within the simulation's documentation.

For larger more complex simulation-based events involving single or multiple real-world Mission Command devices as well as multiple simulation federates, a well-defined rigorous system of systems initialization process is necessary. This section does not intend to provide a one size fits all initialization process, but instead identifies the high risk areas that need to be addressed with the initialization process to support reduced costs and enhanced federation stability as the following:

- Agreement on environmental representation consistency and correlation boundaries
- Agreement on unit, platform, and life-form enumeration definitions and the enumeration mapping and tracking process
- Agreement on pre-runtime scenario change management and control. Scenario here includes order of battle, positions, health status, graphics overlays, environmental representation, actor ownership, and Mission Command device interaction
- Steps and magnitudes of change (for example, is it permissible for one Coalition member to change the order of battle and then reflect this change during simulation runtime or does this change need to be made and disseminated to all or some subset of the federates prior to runtime) for orderly pre-runtime changes within the scenario

2.3 SISO C-BML PDG

Antecedents of SISO C-BML include the Command and Control System Interface Language (CCSIL), developed under of DARPA's 1995 Synthetic Theater of War program, and the US Army SIMCI Battle Management Language (BML) experiment [10], which sought ways to replace the natural language of battlefield C2, which is too ambiguous to be used as input to software, with an unambiguous but usable language. The SIMCI experiment worked well; people who saw demonstrations were impressed, though it was too *ad hoc* to serve as a general solution. It in turn stimulated the Extensible BML (XBML) project, supported by the former US Defense Modeling and Simulation Office (DMSO) [11].

The SISO C-BML Study Group was formed when the XBML project was demonstrated at the 2005

Interservice/Industry Training, Simulation and Education Conference (I/ITSEC), where a French system-of-systems also demonstrated C2-simulation operation. The French configuration combined the SICF C2 system with the APLET simulation. The US and French development teams created an experimental combined system-of-systems [12] as shown in Figure 2. This experiment stimulated formation of the SISO C-BML Study Group to consider an open standard that could support a general C2SIM coalition, as well as the NMSG ET-016 that is described below.

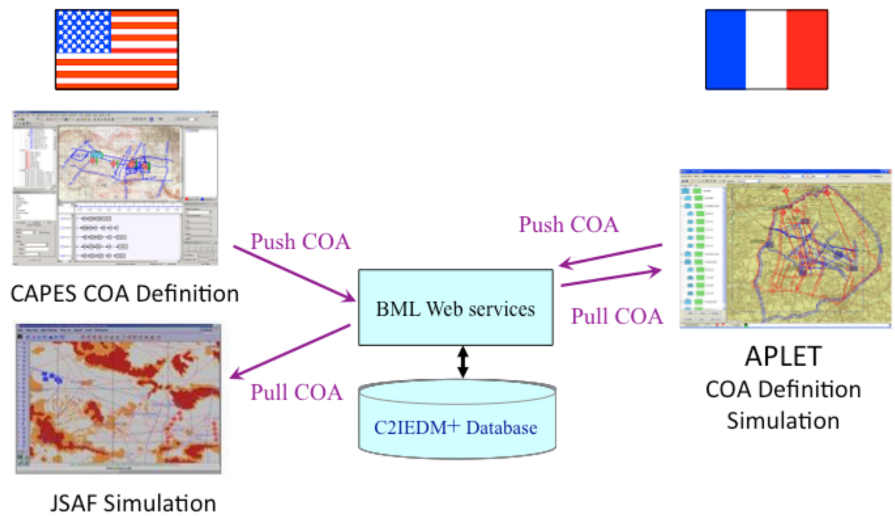

Figure 2: Architecture of US-France BML Pre-Prototype

SISO C-BML PDG undertook to define data exchange standards for tasking (order and requests) and reporting. An explicit requirement for the initial phase of C-BML was to use the Multilateral Interoperability Programme (MIP) Joint Consultation, Command and Control Interchange Data Model (JC3IEDM) [13] as a well-defined source of vocabulary. C-BML Phase 1 took considerably longer than MSDL to complete; at one point, the leadership of the PDG found it necessary to publish an analysis of the reasons for delay [14]. Late in 2012, the SISO C-BML PDG completed balloting of the Phase 1 C-BML standard, including two subschemas: the “full” subschema is intended to address a very wide range of possible data representations, as broad as the complete JC3IEDM, while the “light” subschema is intended to facilitate rapid implementation of C-BML for the large majority of cases that do not need such complexity. Final editing of the C-BML Phase 1 document took place late in 2013; official standardization occurred in 2014, a long-anticipated event [15].

3.0 NATO MSG SUPPORT OF C2SIM

This section summarizes activities of the NMSG that have supported development of SISO C-BML and MSDL since inception of a C2SIM community of interest in 2005. Reference [5] provides more details.

3.1 NATO MSG Exploratory Team 016

The need for C2SIM interoperation is particularly acute in coalition operations. Differences among coalition partners’ C2 systems make convergence on a single system impractical while differences in organization, equipment, and doctrine result in a situation where only a national simulation system may represent the sponsoring nation’s forces well. Parties interested in C2SIM from France and the US became aware of each other’s work and interests in 2005 and proposed to the NATO Modelling and Simulation Group (MSG) that a multinational Technical Activity be organized with the purpose of exploring use of the BML approach for coalitions. The MSG charted a multinational Exploratory Team (ET) to consider this possibility. France and the US were leaders in that team, which was numbered ET-016, and cooperated to provide an initial example of successful international C2SIM integration using a BML approach [2]. When demonstrated for the MSG, this example resulted in considerable enthusiasm for Coalition BML development.

3.2 NATO MSG-048 Coalition Battle Management Language

With the successful France-US demonstration concluding ET-016, Coalition BML moved from an interesting idea to a challenging problem. France and the US were joined by other NATO nations, as described below. The NATO MSG chartered Technical Activity 048 *Coalition Battle Management Language* for the period 2006 to 2009, to coordinate collaborative efforts of the nations and provide input to the SISO C-BML PDG. MSG-048 was organized under co-chairs from France and the US and included national representatives from Canada, Denmark, Germany, the Netherlands, Norway, Spain, Turkey, the United Kingdom (UK), and the US. About four meetings per year were held; the final meeting of each year was associated with the I/ITSEC conference, where a demonstration was presented in the NATO MSG booth, representing the current state of C-BML at the time. MSG-048 work was conducted in three main areas:

1) Establish requirements for the C-BML standard;
2) Assess the usefulness and applicability of C-BML in support of coalition operations through experimentation; and
3) Educate and inform the C-BML stakeholders concerning the results and findings of the group. .

The Technical Activity Proposal for MSG-048 stated: "An open framework is needed to establish coherence between Command & Control (C2) and Modelling & Simulation (M&S) type systems in order to provide automatic and rapid unambiguous initialisation and control of one by the other. To accomplish this, C2 and M&S concepts must be linked in an effective and open manner defining new, system-independent, community standards and protocols." This charge led to a primary objective: evaluating the available specification of a Coalition BML and a secondary objective: assessing operational benefits to C2 and M&S communities [16]. Since a SISO C-BML specification or implementation was not available at the time the experimentation work was conducted, the MSG-048 utilized a version of BML based on contributions from participating nations, such as the Command & Control Lexical Grammar (C2LG) [17, 18] and the Joint Battle Management Language (JBML) project [19 - 21].

MSG-048 culminated in a one-week period of exploratory experimentation, conducted with operational military subject matter experts (SMEs) in 2009. Intensive preparation for this activity took place over the Internet, which at the time was a new way of working for most of the participants. In addition, two physical integration events were held: September in Portsmouth, UK and October in Paris, France. These events proved to be a successful risk reduction mechanism. The system-of-systems architecture used is shown in Figure 3. The experience gained in MSG-048 proved extremely useful in establishing the SISO C-BML standard and also in stimulating interest for a more extensive MSG Technical Activity.

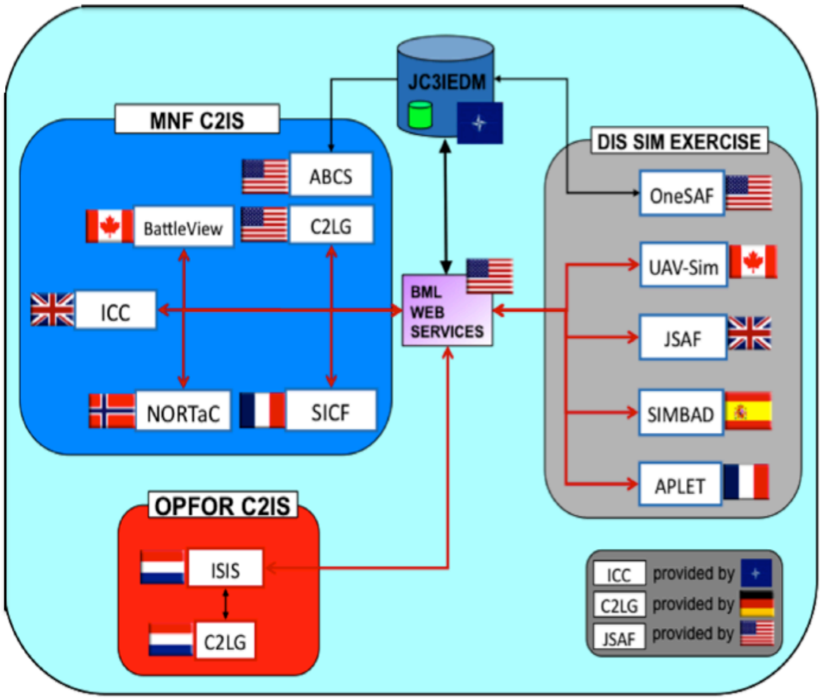

Figure 3: Architecture for MSG-048 Final Experimentation

3.3 NATO MSG-085 Standardization for C2-Simulation Interoperation

As MSG-048 was preparing for its final experimentation, the NATO MSG considered a charter for a follow-on Technical Activity. It was clear even before the experimentation that Coalition BML was a very promising approach, so a new charter was approved with no hesitation. The new Technical Activity 085 was named *Standardization for C2-Simulation Interoperation* and was focused on assessing the operational relevance of Coalition BML while increasing its Technical Readiness Level (TRL) to a point consistent with its operational employment in the period 2010-2014. Consistent with this charter, MSG-085 has been, to a large extent, a process of maturing the technical and operational basis for coalition use of standardized C2SIM.

MSG-085 began in 2010, chaired by France and co-chaired by Canada. Nations participating included the original nine from MSG-048 plus Belgium and Sweden, with interest also expressed by Italy and Australia. With increased focus on operational relevance came more participation from operational military and their support staffs. The technical and military participants collaborated to provide input via SISO's Simulation Interoperability Workshops [22 - 24].

An important finding of MSG-048 had been that, for an effective operational capability, the SISO C-BML focus on Orders, Requests and Reports must be supplemented with another SISO standard: the Military Scenario Development Language (MSDL) [9] to provide effective initialization. Accordingly, in its first year MSG-085 pressed its members to implement MSDL in the simulation systems they had made BML-capable under MSG-048. This implementation was effective but it illuminated another problem: although SISO policy called for MSDL and C-BML to work together, the two were developed independently and there was no "roadmap" telling how to use them together. As a result, considerable effort went into exploring alternatives [25 - 27] before a path forward was adopted [28].

The Final Demonstration of MSG-085 took place at Fort Leavenworth, Kansas in December, 2013. MSG-085 partnered with the US Army Mission Command Battle Laboratory there to engage in a short integration session. The featured capability was Joint and Combined Mission Planning [29]. The architecture of the demonstration system-of-systems is shown in Figure 4.

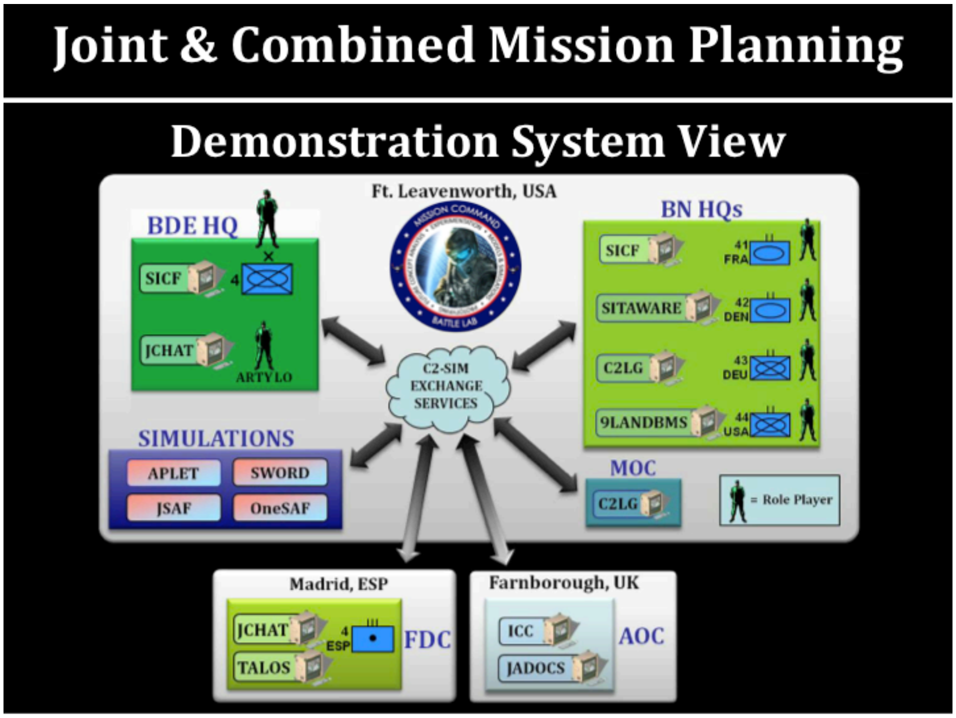

Figure 4: MSG-085 Final Demonstration System of Systems

While the complexity of the MSG-048 and MSG-085 final events is roughly similar, the latter had displayed considerable improvements in Technical Readiness Level, thus meeting an established goal.

- *Distributed operation*: The MSG-085 network included two remote participants and operated with two linked servers and three schemata (C-BML Full, while available on the WISE-SBML server, was not used by any of the systems). This models the sort of operation expected in operational BML use.
- *Integration effort*: The MSG-048 setup was somewhat chaotic, with some of its capabilities becoming usable only on the last day of experimentation. By contrast the MSG-085 systems came together smoothly. There were a few problems but mostly they "just worked".
- *Refined results*: The MSG-048 final audience got the message "We have an exciting new capability. It's not working very well yet but it has great potential for the future." In contrast, the MSG-085 final audience got the message "We have an exciting new capability and it works very well to improve some unmet needs of coalition C2, using interoperable simulations."

3.4 NATO MSG Exploratory Team 038

The technical success of MSG-085 has left the C2SIM community eager to pursue operationalization. Accordingly, a new Exploratory Team has been chartered for 2015 to explore possibilities and lay plans for a new Technical Activity, intended to build experience in deploying C2SIM with operational NATO forces.

4.0 CHARTER OF SISO C2SIM

MSG-085 successes in demonstrating technical and operational relevance built considerable experience that helped in completing the C-BML Phase 1 standard. However, MSG-085 also produced some clear results [30] indicating a need for more work by SISO:

- MSDL and C-BML were developed separately and are less than perfectly suited to working together; an integrated standard is needed
- C-BML Phase 1 requires extension in order to be used for the full spectrum of military operations

MSG-085 represented important "early adopters" of MSDL and C-BML; SISO responded to these findings attentively. Both MSDL and C-BML had been intended to move forward to at least one more version. Moreover, the PDGs responsible for the two standards had learned in their initial developments that the effort needed to produce an effective standard is considerable; thus, they could see significant benefit in combining their efforts in the second phase of each. They therefore proposed a new, unified effort to replace the second phase of MSDL and C-BML: a single C2SIM Product Development Group for C2-simulation interoperation, to include other systems dependent on the same information (e.g. autonomous or robotic systems) [31]. Because a Product Support Group (PSG) is also required under SISO methodology, the SISO Standards Activity Committee responsible for the new PDG added a PSG for MSDL and C-BML to the proposed organization, making it the first instance of a combined PDG/PSG.

The Product Nomination for SISO C2SIM [32] defines the products of the PDG as:

- C2SIM Logical Data Model (C2SIM-LDM) Standard: The logical data model that provides the logical definitions of initialization, tasking, and reporting business elements and associations referenced in the syntactic representation standards of C2SIM.
- C2SIM Initialization XML Representation (C2SIM-Initialize) Standard: The XML syntax representation for C2SIM initialization messages. Depends on C2SIM-TaskingReporting for task and report message elements.
- C2SIM Tasking and Reporting XML Representation (C2SIM-TaskingReporting) Standard: The XML syntax representation for C2SIM tasking and reporting messages.
- Guideline for C2SIM-Initialize Implementation: document for implementing the C2SIM-Initialize standard.
- Guideline for C2SIM-Tasking Reporting Implementation: document for implementing the C2SIM-TaskingReporting standard.

The C2SIM Product Nomination goes on to define the nature of these documents:

- C2SIM-LDM will provide, at a logical level (i.e. independent of how the data will be communicated), a core set of data elements common to most C2 and Simulation systems, combined with a standard way of adding to that core a collection of additional elements specific to a particular domain and/or context.
- C2SIM-Initialize will supersede the MSDL v1 standard and is an XML message format developed with the purpose of initializing the operational environment in a wide variety of simulations and connected systems in the US-DoD and NATO-nation agencies.
- C2SIM-TaskingReporting will supersede the C-BML v1 standard and is an XML message format developed with the purpose of describing task and report assertions in operational or simulation

environments. It expands the range of tasking and situational awareness information relative to the C-BML v1 standard.

5.0 SISO C2SIM STRATEGY AND PLAN

The SISO C2SIM PDG/PSG was chartered in September 2014. Most authors of this paper serve as officers of the PDG. The leadership positions established are:

- Co-Chairs (two): responsible for overall leadership and ensuring that PDG products form an integrated whole, but they have no specific role in drafting the standards, though they can contribute like other PDG members. Initial co-chairs are from the UK and USA, which should help to maintain international breadth.
- Vice-Chairs associated with specific functions: the Logical Data Model, Initialization, and Tasking-Reporting. They lead PDG activities in these areas.
- Lead Editor: responsible to ensure documents form adequate, coherent suite; not responsible to develop technical concepts, but must understand them in order to ensure adequacy of the documents.
- Secretary: manages information necessary for PDG process (not product).
- C2SIM PSG Co-chairs (two): work closely with the PDG Co-chairs to maintain effectiveness of previously released standards and ensure that PDG products account for transitioning systems from old standards to new ones.

5.1 C2SIM LDM Development

C2SIM must be extensible to cover a wide range of domains relating to military operations. The intention of the LDM is to provide a unified, logical model of data elements for the C2SIM Initialize and Tasking-Reporting standards to ensure consistency and provide a logical path to extensibility. C2SIM will provide a standardized way to build and extend this data model and also will standardize a core set of data elements that are expected to be applicable to a wide variety of domains. The approach being planned is shown in Figure 5.

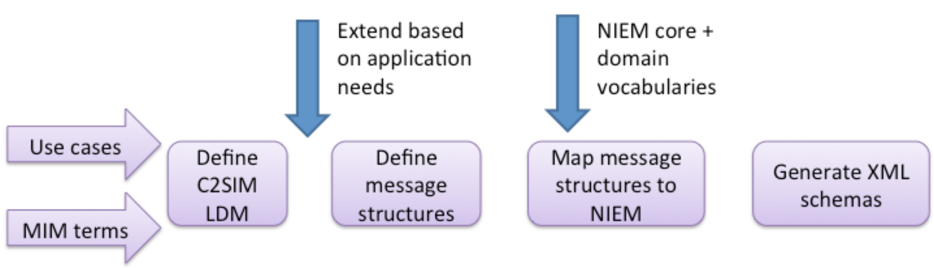

Figure 5: Methodology for Model Generation

LDM development is being driven by two major inputs:

- Use cases collected by the PDG, intended to cover a wide range of military operations
- The MIP Information Model (MIM) [33] recommended for use by the MSG-085 Final Report [30]; however strict adherence is not possible due to scope of the MIM

After the PDG defines the C2SIM LDM (including core data elements), it is specifically intended that any user domain desiring to do so will be able to extend the LDM for that domain, and that if multiple such domains follow the standard they will be able to join together for interoperation, after removing any ambiguity that might have been caused by extending independently. Toward that end, C2SIM will define general purpose message structures that can work across domains. The message structures will require mapping into the US National Information Exchange Model (NIEM) naming rules and vocabulary that have been adopted by SISO, including possible adjustment for compatibility. The final step to prepare the extended LDM of a particular domain for use will be to generate XML schemas. This approach, starting with the LDM and ending with XML schemas, is intended to provide a manageable schema size. (The alternative would be to standardize a single, ever-growing, centrally-defined schema. Since there is broad agreement that the C-BML Phase 1 "Full" schema already is unmanageably complex, the C2SIM PDG does not consider this to be a practical approach.)

5.2 C2SIM Initialize Standard Development

Within the context of this paper, three driving factors bound the development of the C2SIM Initialize Standard:

- the ability to be compatible with existing MSDL implementations
- the ability to align and conform to the constraints provided within the LDM
- to allow customer driven extensions for a wide range of initialization needs

The following paragraphs describe how each of these is supported within the C2SIM Initialization development process and evolving design.

The MSDL Standard was ratified in 2008 and has an internationally-based user community. As such the new C2SIM standards intend to respect the investment of existing MSDL implementations by ensuring a means of mapping to/from the new C2SIM initialize implementation data model to an MSDL compliant schema. In addition to high-level concept mapping the Initialize sub-group intends to create an entry-level set of "reference" translation tools to automate translation to and from MSDL and new C2SIM initialize data model. Additionally, for those users that would like to use existing MSDL formatted documents in conjunction with a new C2SIM Initialize formatted data set without translation, the C2SIM Initialize and Tasking-Reporting sub-groups are co-developing an extensions strategy and design pattern that will allow for this type of data set combination.

The second foundational boundary is conformance with the LDM. To this end, the C2SIM Initialize sub-group is an active participant within LDM development; from requirements elicitation and use case identification to data model development. To ensure conceptual support for the MSDL concepts within the LDM the Initialize sub-group is actively developing a UML representation of the MSDL schema to inform and map to the LDM. Early results from this activity has found that the UML generated from the MSDL schema is a very complex and can be drastically simplified, once the primary MSDL elements are understand the UML model is created from the ground up. This is currently underway with the intent to provide a simplified model that will allow easier and more reliable, consistent, and comprehensive concept mapping to the LDM.

The third key area directly supports easy, customer focused, initialization data extensibility. Design concepts here will allow customized data models to be added without breaking existing data sets. The basic concept is to allow identification points among all types and sub-types of data elements within the C2SIM and the customer-provided data so that cross-referencing can occur in a consistent and logical manner. At this point the design intends and has been shown to support references across a variety of different customizations for one compliant core data set.

5.3 C2SIM Tasking-Reporting Standard Development

The plan for development of the C2SIM Tasking-Reporting Standard is as follows:

- Support identification of the C2SIM LDM core by exploring existing experiments to identify tasks and reports that have been expressed using C-BML or MSDL. Most of these experiments have been published in SISO workshops or MSG reports. This set of tasks and reports, once identified, constitutes the initial tasking/reporting vocabulary for C2SIM. The set may grow as the C2SIM group becomes aware of tasks and reports being used in further experiments but it is intended to keep the core as small as practical by providing a standardized way for user domains to extend the LDM beyond the core, for use within their domains.
- Use the message structure defined in the LDM to identify a tasking and reporting grammar. This grammar has to be compatible with the existing C-BML tasking and reporting structure proposed in the C-BML guidance document. The grammar exploration will focus on the statements obtained from past experiments to limit the expressiveness of the tasking and reporting portion on the C2SIM language.
- Explore how to distinguish the state of the battlefield based on tasking and reporting. As a situation unfolds over time, the generation of tasks and reports correspond to changes in the state of key variables (status, weather, affiliation, etc.). It is important to be able to save these states and use them for initialization in another simulation or in future experiments. Therefore, the C2SIM standard should provide a way to organize and track tasks and reports and, most importantly, to map them back to the LDM to be expressed as initialization files.

The Tasking-Reporting group will work with the LDM and Initialize groups to align the three parts in such a way that we can not only seamlessly link initialization, tasking and reporting through the LDM but also generate snapshots of the battlefield that can be used by other simulations or at a later time in the same simulation.

6.0 CONCLUSIONS

This paper has reviewed how, based on SISO efforts and NMSG support, C2SIM has become a standardized capability that can improve decision-making and training in coalition military operations. Starting with an exciting concept, the community involved in C-BML and MSDL, both in NATO and SISO, has made continued progress toward the goal that, in the not too distant future, military coalitions will be able to come together and benefit from interoperating C2 and simulations across all nations participating.

While commendable progress has been made, much remains to be accomplished. MSG-085 has demonstrated the utility of C2SIM as implemented in MSDL and C-BML but also has illuminated the need for an integrated, extensible C2SIM standard; this is the purpose of SISO's ongoing C2SIM standards effort. There also is a need to engage the operational military community in the various NATO nations and provide them compelling evidence, in the form of well-supported training events, that C2SIM should be an integral part of NATO and national C2 systems; this task remains for the NMSG. It can be anticipated that, as in MSG-048 and MSG-085, an additional benefit of MSG Technical Activity will be a broader, deeper experience base for the next generation of SISO C2SIM standards.

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