Answering The Question Why A BML Standard Has Taken So Long To Be Established?

Jeff Abbott
Systems Architect
CAE USA Professional Services
3501 Quadrangle BLVD
Orlando, FL, 32817 USA
jeff.abbott@caemilusa.com

Dr. Stanley Levine
SIMCI Architect
1209 Marsalis Way
Cary, NC 27519 USA
stanlevine13@gmail.com

Dr. J. Mark Pullen
C4I Center
George Mason University
Fairfax, VA 22030
mpullen@c4i.gmu/edu

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ABSTRACT: *ABSTRACT: Many development organizations of the past have failed to develop a battle management language. The current SISO Product Development Group has taken over five years to reach a trial use phase. Have the teams approaching this problem suffered failures resulting from ignorance of lessons learned in other acquisition and standards development efforts? Has some common set of factors led to team incompetence again and again? Or is there something else more complicated involved here? Is there some serious failing in the team that has been working on the standard or the environment in which they are working? We believe the progress made on a SISO C-BML standard is commensurate with the major factors in its development, which we see as (1) technical readiness to achieve the goal, (2) the need for a deliberate process that puts forward a standard which has been confirmed to be usable, and (3) adequacy of resources to pursue standard development. This paper first examines lessons learned from past BML development efforts to explain how technical readiness has been the common factor in failures of the past. Second, the paper examines how the current SISO C-BML Program Development Group and Drafting Group approached decomposing the problem, given the need to work within available resources, decomposing technical readiness into layers and cycles enabling the team to leverage evolving technologies and emergent requirements to achieve the promise of computational battle management language. Finally the paper identifies lessons learned from C-BML to explain how the need for a deliberate process to ensure that the standard will result in effective use of resources for the integration battle command with modeling and simulation systems that ultimately will finally achieve the promise of interoperability from individual levels of combat through the coalition.*

1. Introduction

This executive summary overviews the challenges navigated by the C-BML product development group (PDG) and drafting group (DG). The PDG and DG have spent over five years developing a trial use standard for C-BML. The PDG members involved in C-BML experimentation and/or drafting of the standard are representative of an international team from the United States, Germany, Sweden, France, Norway, and Canada. Their efforts have been tested and evaluated by NATO modeling and simulation groups (MSG) MSG-048 and MSG-085 [18]. Their efforts were informed by many BML efforts of the past. In spite of this the technical readiness level (TRL) [1] of BML was still below 4. BML development efforts were further complicated by the scale of the multi-disciplinary nature of BML. The time taken to reach a functional and effective C-BML trial use standard can largely be attributed to the time required for the technology and team to mature and evolve. This paper explains these challenges and methods used by team members to move past them. The dedication and commitment of this team to work through those challenges reflects their collective belief of the need and benefit to SISO and NATO alike. This paper is as much a case study in how the SISO standards process can evolve as it is a document of why a BML standard has taken so long to be established.

2. Background

Many organizations have drafted BML implementations to bridge the gap between natural languages and semi-automated (SAF) and computer generated forces (CGF) applications.

- Eagle BML [14] – Eagle BML is a highly structured BML developed for simulations. Eagle BML was one of the earliest attempts at creating a language to bridge C2 and simulations.
- CCSIL [16] – Command and Control Simulation Interchange Language was an attempt to develop and mature technology for translating command and control directives into simulation based "orders."
- SIMCI (Army) BML [21] – The Simulation to C4I Interoperability (SIMCI) Integrated Product Team

(IPT) has sponsored the development of two battle management languages: the 2003 BML proof of principle based on the Joint Common Data Base (JCDB), and the 2009 Integrated BML.

- CEIT BML – Under the Close Combat Tactical Trainer (CCTT) Exercise Initialization Tool (CEIT) effort, a BML implementation was derived from the CCTT SAF unit orders for use by commanders in planning their training scenarios for application in CCTT ground maneuver virtual simulators.
- OneSAF – OneSAF has implemented a BML interlay that leverages much of the work from George Mason University (GMU). This BML is used to interchange messages between the OneSAF SAF/CGF and battle command C2 systems through the common C2 adapter. [23]
- HLA – HLA based federations have implemented a level of battle management language specific to their federation object model (FOM). This enables one federate the initiate the actions of another federate as an order communicated over the run-time infrastructure (RTI).

In each case, in spite of the promise and success each enjoyed, these implementations failed to scale beyond their initial intended scope. Some of the reasons for this are:

- The implementations fell short of being a formal computational language.
- The implementations were not based on a formal logical data model or ontology.
- The development approach followed a typical build to print style commonly followed in systems engineering (see section 3.2.1 below).
- A deliberate process was not followed to ensure a usable standard that scaled to joint, national and coalition levels would be achieved.

Each of these languages did share a great deal of success in their own scope. They were not failures in terms of the big picture. They did lead to important insights of the limitations that existed at the time. Without those insights C-BML could not have learned the lessons necessary to move technical readiness forward in order to succeed.

3. Obstacles - Technical Readiness

3.1 Multi-Disciplined Approach

Multi-disciplined expertise was and still is one of the principal challenges in drafting C-BML. C-BML is a language intended to be interpreted by people and computer systems alike. The language must be able to represent orders, tasks, and reports in a way that does not presuppose a specific data structure beyond its basic XML encoding. It must be capable of communicating information not anticipated by the authors of the language. The consequence of failing in this objective is that the language itself will require extensions for new uses and for application to additional natural languages (other than English); it will not scale to required scope.

3.1.1 Multiple Perspectives

Multiple perspectives, in terms of expertise and experience, are necessary to ensure a BML can scale to the task of communicating information across:

- National and Joint Doctrines
- Service, Unit and Echelon Doctrines
- National Recovery & Emergency Management

This broad scope represents a significant problem for any BML effort. A similar problem exists in the definition of the language's grammar, terms and lexicons. Two disciplines in particular are required:

- Computational Linguistics
- Systems and Software Engineering

Expertise in computational linguistics is necessary to create a computational language. As noted above, this was a common problem in past efforts. The second is in systems and software engineering. These disciplines are required to (1) define extensible data structures that encapsulate expressions to be interchanged, and (2) develop the infrastructure to verify and validate the unambiguous communication between systems and people. It is worthwhile to note that the SME disciplines which encompass the application of BML are also involved in the development of the language by interpreting the doctrine to the engineers and linguists and peer reviewing the decisions and implementations of the software and systems engineers.

3.2 Technology Development

Much has been written concerning the failings of systems engineering approaches that reached too far too soon. Even in cases where new systems were designed to replace outdated systems, engineers have failed to recognize the lack of technical readiness or the need for new approaches.

3.2.1 Build to Print and the TRL

Build to print approaches, (i.e. build to specification) where system requirements are created followed by design, implementation and test only work when the technical readiness of all required technologies are at level 6 or above [1] (see Table 1). The larger the scale of development, the more necessary TRL 6 becomes.

For example, many billions of dollars have been spent attempting to replace the outdated US air traffic control system (ATCS). This would appear to be a straightforward problem, since the current system was fielded in the 1950s. However, since that time, sub-systems have evolved to incorporate new capabilities and new linkages between those systems that are not fully understood by the engineers attempting to replace them [24].

More recently, programs such as the functional description of the battlespace (FDB), and future combat systems (FCS) have fallen victim to the same shortcomings in systems engineering.

Table 1: Technical Readiness Levels [1]

Technical Readiness Level	
1.	Basic principles observed and reported.
2.	Technology concept and/or application formulated.
3.	Analytical and experimental critical function and/or characteristic proof of concept.
4.	Component and/or breadboard validation in laboratory environment.
5.	Component and/or breadboard validation in relevant environment.
6.	System/subsystem model or prototype demonstration in a relevant environment.
7.	System prototype demonstration in an operational environment.
8.	Actual system completed and 'flight qualified' through test and demonstration.
9.	Actual system 'flight proven' through successful mission operations.

The cause behind these failures has been a failure of another type: Systems engineering principles used for these projects do not incorporate management of emerging requirements.

3.3 Emergent Requirements

Emergent requirements are those requirements not yet understood or recognized by the stakeholders. In the case of ATCS, requirements emerged through the evolution of new capabilities between 1950 and today. In the case of FCS and the FDB, efforts were not put into place to facilitate the emergence of requirements and document them as they became understood.

> "FCS was designed to make the Army a lighter and more agile force by replacing combat systems with a family of manned and unmanned systems linked by an advanced communications network. It was to be the central component of the Army's plans for a network-centric battlefield ... the program's goal of building a linked system of systems — rather than the traditional approach of building individual systems and then deciding how to integrate them — is seen as an advance. Even though the approach resulted in an overly broad scope for a single acquisition program…" [8]

What was not understood in these two acquisitions is that while individual components/systems of technology were mature, the scale of a system of system implementation resulted in the emergence of additional requirements. In a sports analogy, training individual skills for each team position does not make a team. Requirements of team skills emerge in addition to the individual skills.

In all three cases (1) build to print approaches failed to move technology readiness forward, and (2) stakeholders failed to understand the TRL was far below that anticipated.

For C-BML, TR should be reviewed at a coalition scale that includes Nations, Military Services, national disaster, and recovery/emergency management operations. This is the principal factor in past BML shortcomings. While the TRL was at 6 or greater in their limited scope, the expansion in scope pushed that level back to 5 or even to 4.

The C-BML team addressed this by facilitating the evolution of technical readiness. Some of those highlights are described in the following subsections.

3.3.1 Emergence in Systems of Systems

The problem with a conventional systems engineering approach is that systems of systems (SoS) cannot be planned and designed when signification gaps exist in either the maturity or scale of any of the underlying systems involved. The typical consequence of this would be failure to meet some or all system goals. Recognition of this problem-consequence drove the C-BML team to adapt and evolve development approaches that are just beginning to be common in commercial and DOD acquisition efforts today.

Some of the emergent requirements C-BML faced were:

- How to integrate with the MSDL standard.
- How to communicate with multiple C2 and simulation systems that use a variety of internal and external data formats.
- How to bring purpose to the meaning of C-BML messages [5].
- How to deal with the evolving data model of C2IEDM/JC3IEDM.

- How to deal with varying levels of specificity from a C-BML light implementation to a full C-BML.

The challenge of varying levels of specificity was perceived by many to be a fracturing of the standard yet again. This arose from the C-BML Phase 1 Drafting Group (DG) decision that C-BML should be capable of the full expressiveness of the JC3IEDM, which resulted in a schema that many developers found to be too complex for ready understanding. As a result, the DG augmented the Phase 1 Trial Use schema with a Light version, which is more readily implementable. These decisions can be supported by observing that some SAF/CGF implementations, such as OneSAF, are rich and thick with complex behavior detail, not just at the entity level but at the unit associated C2 levels as well. Others such as JCATS have behaviors restricted to the entity level, and is lean and thin in behavioral representations. Both are necessary, but neither is sufficient in all applications. A solution was for the standard to support C-BML implementations that are compliant with the standard but compete for users along the same lines that SAF/CGF applications compete for users.

Additionally, there is a view shared by many C-BML stakeholders that JC3IEDM is too complex, which can cause system sponsors to give up on BML. The counter-view is that BML must support all military doctrines across services, nations, and coalitions. C-BML is not a simple undertaking at any level, particularly in the area of the language's ontology.

3.3.2 Plan, Test, Evaluate and Adjust in Cycles

Build to print cannot work in areas of new science; technology must be advanced and matured first [1]. This will of course occur over time as the natural evolution of the technology. However, the time it takes to evolve can be reduced by appropriate resources. The reduction comes through tight coupling of development efforts in a spiral with trial uses and experiments. Trial uses represent evaluations of limited deployment/execution of the intended/planned capabilities. Development of capabilities informs the trials regarding what is to be evaluated. Likewise, execution of the trials informs planning/development.This cyclic pattern is representative of deliberate evolution, in contrast to opportunistic evolution that occurs randomly in the acquisition/development process. In a relevant environment, each cycle of evaluation events is equivalent to a validation event (TRL 6) [1].

The staging of tests is critical as well. TRL 4 and 5 stages build the infrastructure layers on which prototype evaluations are built. In this way, the MSG-048 team created simple layers of BML first, then built the new simple layers over those, while not changing the simple capabilities of those lower layers.

The MSG-048 team took advantage of resources available to them to conduct these tests. TRL 4 activities were conducted in experimental projects by the drafting group. TRL 5 activities were conducted in trial tests and demonstrations. These tests were conducted not just to evolve BML but also to conduct coalition exercises/demonstrations on multi-national SAF/CGF applications communicating with multi-national C2 systems under MSG efforts. SISO C-BML is heir to these developments.

As previously noted in the case of the ATCS, simply creating systems that function at a high TRL does not ensure success. If the stakeholders don't understand the capabilities that evolved and the requirements that emerge from them, the system cannot be replicated.

4. Deliberate Process

BML has been developed piecemeal, rather than arising from a coherent program in a single sponsoring agency. There has been no plan for scalability. The goal of a formal standard has been supported only by volunteer efforts within SISO, mostly derived from results in the NATO MSG.

The supporting science of C-BML is computational linguistics. However, only limited work has been sponsored in this area [17]. The C-BML development process will require significantly increased DG resources in this area in order to produce a successful Phase 2 draft.

Concepts of ontology and web services, which are fundamental to advancement of C-BML beyond Phase 2, continue to develop and so represent a "moving target" that will make further C-BML development challenging for the reasons explained in section 3.2 above.

4.1 Plan the Phases/Versions of C-BML

The SISO C-BML PDG developed a plan for the first three versions of C-BML [19].

- Phase 1: Data Model: Phase 1 of the C-BML standardization effort (described in this paper) is defining the basic XML data model underlying the construction of C-BML expressions (plans, orders, and reports). The scope of Phase 1 was further defined by a PDG process following the Tiger Team report [6] [7].
- Phase 2: Formal Structure (Grammar): Phase 2 of the C-BML standardization effort will extend the Phase 1 products to more completely create unambiguous expression of Plans and Orders through a formalized grammar (syntax, semantics, and vocabulary).
- Phase 3: Formal Semantics (Ontology): Phase 3 will involve specification of a battle management

ontology to enable conceptual interoperability across systems.

In addition to planning the scope of each version, the PDG decided enable each version to look forward to future versions through trial use and reference implementations illustrating how the PDG and DG expected the next version take form. These will enable stakeholders of C-BML to evaluate approaches envisioned for each version of BML before it is approved as a standard.

4.2 Computational Linguistics

Wikipedia provides an excellent definition of computational linguistics applicable to C-BML development.

"Computational linguistics is an interdisciplinary field dealing with the statistical and/or rule-based modeling of natural language from a computational perspective. This modeling is not limited to any particular field of linguistics. Traditionally, computational linguistics was usually performed by computer scientists who had specialized in the application of computers to the processing of a natural language. Computational linguists often work as members of interdisciplinary teams, including linguists (specifically trained in linguistics), language experts (persons with some level of ability in the languages relevant to a given project), and computer scientists." [10]

The C-BML PDG development has included computational linguists in development of the C-BML language. As a result, even the Phase 1 Trial Use draft of C-BML is not simply a set of defined/known messages. It holds the roots of a future language that will be capable of expressing descriptions of anything within its ontology.

The vocabulary to be represented in Phase 1 C-BML is defined in the JC3IEDM as a reference data model. As the model is extended to meet the needs for information interchange, C-BML will extend as well. Depending on the degree of change, this may occur as a consequence of JC3IEDM schema reuse alone.

C-BML was planned deliberately with the distinction that grammar was to be focus of the Phase 2 of the standard. The challenge in Phase 1 is to define the schema to be used in the construction of C-BML expressions.

We emphasize that the planning process applied to C-BML is a significant factor that differentiates it from past BML efforts. This planning alone has demanded more time to complete than many SISO standards. The result is not a failure, but a success story of C-BML. The potential interdisciplinary nature of C-BML has been enabled by processes of planning. We anticipate that C-BML compliance will be a requirement in future defense system acquisitions; therefore it is appropriate to ensure that it represents an effective solution to the C2-simulation interoperability challenge, worthy of investment of taxpayer funding.

4.3 Concepts of Ontology

The concept of ontology is very important to C-BML. In linguistics, an ontology is the conceptualization of the world that can be described by a language [9]. It is a restriction of what can be described by a language. Reference [11] provides the following description of the web ontology language.

The Web Ontology Language (OWL) [11] has emerged in the last decade as a game-changing means for capturing a standardized representation of worldviews as semantic data models. In principle, OWL emphasizes:

- Semantics over syntax – integrate on concept meaning rather than format.
- Application independence – organize models so they may be used in different ways by applications based on different perspectives.
- Web-centric – follows tenets of the WWW for distributed, composable, and extensible management of data models with uniform resource locators (URLs) as globally unique identifiers.
- Standardized representation – OWL is built upon the Resource Description Framework (RDF), its homogenous, consistent representations and conventions, such that all data and models are read exactly the same way, regardless of domain or topic of those data and models.

The processes required to develop C-BML are not simply been procedural. They involve an extremely steep learning curve for the PDG and DG alike. The phases of C-BML standardization are seen as necessary in order to soften the "acceptance" curve of C-BML within the C2 and M&S communities. To create an ontology-based C-BML standard that satisfied the goals of phase 3 of C-BML would simply have been too much too soon; it would have required a TRL that is not yet available.

4.4 Distributed Development Obstacles

C-BML, like other SISO PDG efforts, has required a distributed development effort. Distributed development efforts must deal with issues related to trust, establishment of leadership and work share, and mixed cultures [20]. These problems are typical of those that SISO DG efforts generally must overcome. When these challenges are coupled with the development of a multi-disciplined new technology, misunderstandings can arise quickly. A consequence can be a fracturing of a team along lines of perceived differences. The C-BML PDG became fractured due to a perception driven by the points of view taken. The second problem here was that the PDG members did not recognize their points of view were from different perspectives. One side of the PDG viewed the effort top-down, the other bottom-up. The bottom-up view was focused on the application/employment of BML where the top-down was focused on the enhancement of BML development. The consequence of this as that both sides used the same terms to describe BML, but as they are in different contexts, they disagreed on the definitions and impact of those terms. A tiger team was formed to work through the differences [5]. The tiger team realized the difference and made some interesting findings. First, the concepts and terms they thought they agreed on, they in fact disagreed on. Second, the concepts and terms they thought they disagreed on, they in fact agreed on. The tiger team efforts was able to establish sufficient trust, leadership roles, and hence work share by those roles. The common culture became more homogeneous as a result.

5. Adequacy of Resources

The obstacles of technical readiness combined with level of process and planning required to achieve a functional C-BML is taking place in an environment of constrained resources. The major issue here lies in having a purely volunteer non-funded effort that is not driven by an official program/system. Because of this, there is little schedule force behind the development.

5.1 Funding and Sponsorship

It has been noted that MSDL's rapid success in reaching standardization was due to sponsorship. But it was the funding of MSDL development before it was brought to SISO that facilitated MSDL's rapid success at SISO. PM OneSAF was able to verify and validate approaches to MSDL before bringing it to SISO. Sponsorship of writing the specification did contribute to MSDL's success, but compared with C-BML that was an exercise in tedium.

Stronger sponsorship from DOD programs would do a great deal of good in moving the C-BML specification forward. Strong sponsorship brings a level of governance and focus on cost, schedule, and performance that is very difficult to achieve without it. Simply put, a purely volunteer non-funded effort is not driven by an official program/system. As a direct result there is little schedule force behind the development.

The opportunity for the DOD is to accelerate the process of reaching the third phase of C-BML that will include a common ontology. That ontology will enable open interoperability between C-BML, MSDL, battle command systems, SAF/CGF applications and much more. We note that significant support will be needed in the area of ontology support to BML, before SISO can achieve standardization of C-BML Phase 3.

5.2 Team Makeup – Volunteers

SISO policies and procedures are largely focused on openness within PDG, SG, SSG, and PSG efforts. Integration across these groups is very limited.

As a result, the adequacy challenge of resources affects the way SISO develops standards, using volunteers who are focused on their own interests. Processes and policies of SISO ensure openness in standards development, but they also can hamper development. Strong leaders are needed to keep the PDG and DG focused on their path, but there is a tension between strong leadership and openness. Compromise is necessary to succeed in this environment, but it cannot be forced without violating openness. This problem becomes even more difficult when trying to define how disparate standards should integrate. Entire PDGs must compromise in order for their standards to integrate; this is a difficult task at best.

The need for strong leaders, with a funded priority, within C-BML largely emerges due to the C-BML PDG's efforts in maturing/developing the technology. If C-BML was developed under a DOD program, that program could provide the leadership to mature the technology before bringing it forward for standardization.

5.3 C-BML PDG Volunteers

With openness within a PDG comes the challenge of gaining support and buy-in of the approach from the PDG as a whole. C-BML has seen its share of strong leaders come and go, each providing their own contribution to the C-BML vision. Some focused on technology readiness and trial uses, others on resolving challenges of distributed development. All of C-BML's leaders shared a single vision and belief; that C-BML would succeed. Many have remained strongly committed, but more will be required before the vision of C-BML becomes a reality at phase 3 of the standard.

It is worth noting the level of technological development that members C-BML have achieved. Early on, the PDG recognized the formal computational linguistics was necessary for success. The scope of expertise brought to the effort is apparent from the list of fourteen SIWzie and best papers related to C-BML.

Table 2: SIWzie and Best Paper Awards

C-BML Related Best Papers
Andreas Tolk, Saikou Y. Diallo, Charles D. Turnitsa: "Data, Models, Federations, Common Reference Models, and Model Theory," European Simulation Interoperability Workshop 2007, Paper 07E-SIW-052, Genoa, Italy, June 2007
Andreas Tolk, Saikou Y. Diallo, Charles D. Turnitsa: "Merging Protocols, Grammar, Representation, and Ontological Approaches in Support of C-BML," Fall Simulation Interoperability Workshop 2006, Paper 06F-SIW-008, Orlando, Florida, September 2006
David Perme, Michael R. Hieb, J. Mark Pullen, Bill Sudnikovich, Andreas Tolk: "Integrating Air and Ground Operations Within a Common Battle Management Language," Spring Simulation Interoperability Workshop 2005, Paper 05S-SIW-154, San Diego, California, April 2005
Andreas Tolk, Curtis L. Blais: "Taxonomies, Ontologies, and Battle Management Languages – Recommendations for the Coalition BML Study Group," Spring Simulation Interoperability Workshop 2005, Paper 05S-SIW-007, San Diego, California, April 2005
Charles Turnitsa, Sai Kovvuri, Andreas Tolk, Liam DeMasi, Verlynda Dobbs, Bill Sudnikovich: "Lessons Learned from C2IEDM Mappings within XBML," Fall Simulation Interoperability Workshop 2004, Paper 04F-SIW-111, pp. 792-801, Orlando, Florida, September 2004
Andreas Tolk, Kevin Galvin, Michael Hieb, Lionel Khimeche: "Coalition Battle Management Language," Fall Simulation Interoperability Workshop 2004, Paper 04F-SIW-103, pp. 724-735, Orlando, Florida, September 2004
Schade, U. & Hieb, M.R. (2007). Battle Management Language: A Grammar for Specifying Reports. 2007 Spring Simulation Interoperability Workshop (Paper 07S-SIW-036), Norfolk, VA.
Schade, U. & Hieb, M.R. (2006). Formalizing Battle Management Language: A Grammar for Specifying Orders. In: Proceedings of the 2006 Spring Simulation Interoperability Workshop (pp. 441-453) (Paper 06S-SIW-068). Huntsville, AL.
Kevin Heffner, Fawzi Hassaine. "Using BML for Command & Control of Autonomous Unmanned Air Systems." Proceedings of the 2007 Fall Simulation Interoperability Workshop, 07F-SIW-054, Simulation Interoperability Standards Organization, 2007.
Kevin Gutpon, Dr. Saikou Diallo, Jeff Abbott, Kevin Heffner, Curtis Blais, Check Turnitsa. "Management of C4I and M&S Data Standards with Modular OWL Ontologies: Paper 11S-SIW-061, Spring Simulation Interoperability Standards Organization, Boston, MA April 2011.
Schade, U. & Hieb, M.R. (2006). "Development of Formal Grammars to Support Coalition Command and Control: A Battle Management Language for Orders, Requests, and Reports". 11th International Command and Control Research and Technology Symposium, September 2006. Cambridge, UK.
Pullen, J., M. Hieb, L. Khimeche, M. Powers, and K. Galvin, Evaluating the Proposed Coalition Battle Management Language Standard as a Basis for Enhanced C2 to M&S Interoperability, NATO Modeling and Simulation Group Annual Symposium, Prague, Czech Republic, October 2007
Kruger, K., Frey, M., Schade, U., Battle Management Language: Military Communication with Simulation Forces, NATO Modeling and Simulation Group Annual Symposium, Prague, Czech Republic, October 2007
Gustavsson, P., M. Hieb, L. Niklasson, P. Moore, and P. Eriksson, Machiine Interpretable Representation of Commander's Intent, International Command and Control Research and Technology Symposium 2008

6. Lessons Learned

6.1 Multiple Perspectives and Team Structure

Control is a false perspective: lacking an established resource base, the most that can be accomplished in volunteer SISO efforts is coordination.

A useful way to view the necessary process is the way the US Army views C2: command takes place from above, but control must combine top-down with bottom u because situational awareness comes from lower levels. In C-BML, vision comes from the PDG and is focused by its leadership, but understanding of technical capabilities comes from the membership of the DG.

6.2 Technical Readiness & Emergent Requirements

All necessary technologies from the multiple disciplines required for each phase of C-BML must reach adequate TRL through exploratory, spiral processes that demonstrate adequate readiness for use. Assuming that it is possible for smart people simply to write a specification, to be implemented by other smart people, will result in failure: a standard that, when implemented, is unlikely to result in the expected capabilities.

6.3 Ontology

During the period since the SISO C-BML PDG was formed, the science and technology of ontology has undergone rapid development. C-BML should maintain a strong focus on the resulting capabilities in support of ongoing development in general and Phase 3 in particular.

6.4 Integrating Roles of Acquisition and Development

The PDG must establish trust, leadership roles, work share, and culture. Without these, no amount of effort will succeed in reaching the desired capabilities; indeed, it is unlikely there will be agreement on the vision as to what capabilities are desired.

7. Conclusions

The exposition above supports our contention that the progress made on a SISO C-BML standard to date is commensurate with the major factors in its development:

- Technical readiness to achieve the goal;
- The need for a deliberate process that puts forward a standard which has been confirmed to be usable; and
- Adequacy of resources to pursue standard development.

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9. Author Biographies

JEFF B ABBOTT holds a Master's degree in engineering from the University of Central Florida. Mr. Abbott has worked in the area of modeling and simulation for 22 years. Much of that time has been spent working issues of interoperability related to simulation based training. Mr. Abbott has been working standards development under SISO in support of interoperability between battle command and modeling and simulation technologies.

DR. STANLEY H. LEVINE is currently Co-Chair of the SISO CBML Product Development Group and an Architect with the US Army Simulation to C4I organization. He also serves as a Program Director and senior advisor in the areas of: System of Systems acquisition, information system technologies, architectures, technology transition, and interoperability. Dr. Levine has spent over 40 years in systems acquisition for US Army and Joint organizations. He is a recipient of over 60 awards including the Army's three highest Civilian Service Awards. Dr. Levine has published many papers on a wide variety of subjects. He has also been a keynote or invited speaker at many major national and international symposiums/conferences.

DR. J. MARK PULLEN is Professor of Computer Science at George Mason University, where he serves as Director of the C4I Center and also heads the Center's Networking and Simulation Laboratory. He is a Fellow of the IEEE, Fellow of the ACM, and licensed Professional Engineer. He served as Principal Investigator for several BML development and implementation projects. The most recent of these developed open source software for BML, which has been used by US Army and NATO projects.