Enhancing Coalition M&S Responsiveness and Credibility by Understanding and Leveraging Proven Standards Ensembles

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ABSTRACT: *During recent large scale simulation demonstrations (Operation Blended Warrior) and future space operating environment exploration (Simulation Exploration Experience), international community leaders encouraged steps to improve the interoperability, effectiveness, efficiency, and agility while planning, preparing, and executing multi-organizational distributed simulation events. Advancements in computing and network tools have allowed the demand for complexity in our applications to grow, but our collective failure to adequately capture and employ our best practices/lessons learned has condemned us to long and costly preparation and integration schedules. The opportunity to improve future applications has been hampered by a lack of "playbooks" of how plan and execute proven standards ensembles for a typical M&S acquisition or training use. This paper describes the motivation for and progress towards a tool that leverages the NATO M&S Standards profile, captures in an integrated way documented successful approaches, and describes the employment of standards for typical "use cases". This development has been performed within a Product Development Group (PDG) of the Simulation Interoperability and Standards Organization (SISO). The products will be balloted in late 2017. Insights from interviews and papers describing previous NATO acquisition work (NIREUS) and international space exploration work (SEE) will be shared.*

1. Introduction

In this age of inconsistent funding and ever increasing adversary capabilities/complexities, it is becoming more difficult and expensive to execute the development, procurement, and sustainment of major weapons systems or conduct relevant and realistic unit and individual operator training. This dilemma is also operative in the requirements development, test & evaluation, and planning arenas. Compound these training and acquisition domain challenges with the complexity of delivering integrated capabilities, organized around a joint or coalition combination of forces (system of systems), and it becomes obvious that every effort must be made to discover, document, adapt, and adopt more effective and efficient community modeling & simulation (M&S) best practices. This is not to say that individual nations or United States Services aren't making strides on their own to improve individual, team, and collective training or striving to adopt acquisition reform practices like model-based engineering with a high simulation or virtual component. Rather, it is to acknowledge that the practice of incremental and serial evolution or adopting game-changing technologies within one organization at a time is an outdated and bankrupt strategy. It results in a "lowest common denominator" set of combined capabilities in which significant numbers of collaborators are hobbled to keep the team in sync at a lower degree of performance. Our community must think boldly and learn together through committed and frequent collaboration, experimentation, and reflection on continuous improvement steps. Only then can we assess how to best employ these new and emerging processes and tools (e.g., model based engineering; augmented, virtual and blended reality; affordable physics-based modeling) and modern computing and network infrastructure (e.g., on demand affordable high bandwidth network services; cloud-based modeling and simulation microservices) to attack some of our most challenging problems.

This paper provides a brief description of the motivation for and the Product Development Group's (PDG) progress towards a Simulation Interoperability and Standards Organization (SISO) M&S Standards Profile to capture the key implementation details on groups of standards (ensembles) appropriate to various application domain areas (air, space, unmanned systems, etc.) across the entire acquisition life-cycle of a system. Because operations are part of the total life cycle, M&S applications within the training domain are also included in the standards profile. Since contemporary military operations are conducted by coalitions of like-minded nations, this paper introduces how the inclusion of Operation Blended Warrior (OBW) involvement in the PDG technical activities can also support the international focus of how standard ensembles can improve the M&S contribution to the readiness aspects of international coalition operations. OBW is a multi-year, annual exercise demonstration at the International/Industry Training, Simulation, and Education Conference (I/ITSEC). [1] The insights collaboration with OBW can and will bring to the SISO M&S standards profile initial product are believed to be significant and the contemporary content and insights valuable.

The challenges outlined above are not unique to military applications. Inclusion of lessons learned from the NASA inspired and led Simulation Exploration Experience (SEE) annual series of events bolstered our confidence that the benefits gained by employing an appropriate ensemble of standards for relevant technical activities within the space domain has similar positive outcomes.

2. Background

Standards are very important enablers or tools for achieving positive outcomes in terms of modeling and simulation effectiveness, efficiency and usability. "Standards are increasingly being seen as a means of achieving other modeling and simulation goals such as better return on investment, interoperability, reusability and increased capacity." [2] During the 2016 OBW event standards enabled participants to work through some difficult challenges. A single interoperability standard wasn't the solution to connect all of the participants. Although, there is a perception in the LVC community that interoperability will be much easier (and less

costly) if there is only a single architecture available for use. "Many problems exist with respect to the procedures and technologies used to develop mixed architecture live, virtual, and constructive (LVC) environments. The incompatibilities between these architectures require expending a considerable amount of resources to develop point solutions that effectively integrate them into a single, unified set of supporting simulation services." [3] Consequently, the OBW participants agreed to use common capabilities, common data formats and models across all the architectures to overcome some of the interoperability challenges.

Similarly, because current acquisition community practices fund "programs", it is easy to imagine how independently developed and delivered systems would implement M&S strategies that are program-centric rather than mission capability community centric. When these independent programs are asked to participate in an event bringing all the component systems operating within a System of Systems, one can begin to understand how programs that adopt relevant standards experience less challenging integration issues and expend less engineering hours in executing these responsibilities. If there existed an easily accessed and understood profile of standards with descriptions and examples of their relevancy for the likely technical activities a program could expect to execute, why wouldn't the program adopt them?

3. An Opportunity for Innovation (Technology Rule of 3)

In his Forbes article on disruptive changes in markets, Mark P. Mills cited several cases in history when revolutionary systems emerged when (typically) three enabling technologies became sufficiently mature. [4] A contemporary example cited is the Apple iPhone. The three technologies that came of age and were ripe for exploitation were the Large Scale Integrated (LSI) circuit, the Gallium Arsenide radio chip, and the Lithium-Ion battery. Is there a similar convergence of technical and organizational enablers in the M&S technical field that could result in a technical approach applicable to today's challenges?

Consider that in the past twenty years there have been development and evolution of robust and readily available standards and supporting tool implementations enabling distributed simulation (DIS, HLA, TENA). Network performance, data storage, and computing power costs on which to operate M&S applications have dropped dramatically. High performance displays, virtual reality, and augmented reality are affordable and increasingly available in form factors that could support realistic training applications. Is it possible that we are approaching an opportunity to better configure and control these technical enablers that span diverse application areas?

It is often useful to consider a balance between the theory and practice, throughout the architecture and engineering process. In the real estate development business, an architect brings a cohesive and pleasing composition of features that provide needed functions. The details of implementation are often left to the engineers who must provide a practical solution to the conceptual approach. By developing a standards profile that captures the key standard components used in actual practice and well documented successful applications, the community can benefit from a more beneficial learning curve and the tribal knowledge of the senior practitioners will be captured in a way that can inform future similar endeavors.

3.1 Introduction

Every profession has challenges that the members wish could be dismissed with the wave of a magic wand. Unfortunately, despite years of hopes and even formal expressions of technical capability needs, we live in a rich, complex, dynamic environment that is evolving even faster than our tools. Despite this, there exist a few examples of communities worth emulating that chose as a profession to collaborate. Over thirty years ago, the design and construction community embarked together towards a common purpose in which everyone contributed their functional knowledge to develop and sustain an integrated and coherent Building Information Model (BIM). [5] This concept, described in document shown in Figure 1, sustained by a core group of committed professionals and their companies, evolved to the point where standards were developed or employed to ensure that the various traditional disciplines of design, construction, electrical, heating and air conditioning, as well as personnel safety and traffic flow were integrated. This model started small and continued to become more complete and comprehensive in engineering disciplines that required some things in common and others remained unique. The success of this multi-disciplinary approach with supporting standards and tool enablers is evident when the community now has robust supporting tools, rich training options, and emerging policy for required implementation These solutions include integrated design, visualization, and animation tools that embed the building design within a mission and natural environment that predicts structure performance. Couldn't this same approach help the systems engineering community and the M&S community that supports it today? Since most problems are unique, isn't the goal a rich foundation of enablers that can be tailored and composed in ways appropriate to the problem at hand? A standards ensemble that reflects the best practice of how to support a specific technical activity supported by documented use case/operational vignette should reduce risk and save time.

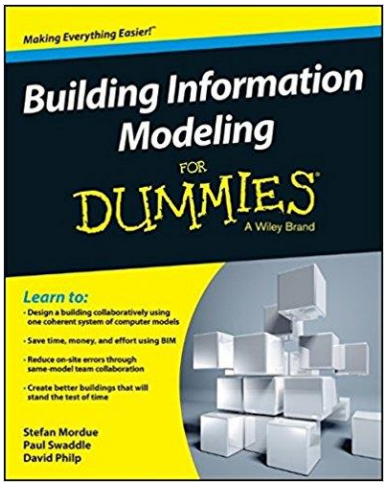

Figure 1 Building Information Modeling (BIM)

3.2 Identify and Apply Proven Standards

Seven years ago, NASA engineers, in conjunction with simulation industry partners and the SISO, designed, developed, and deployed a lunar-based simulation environment and invited student teams from around the globe to participate in an interoperable simulation experience. With one of the primary motivations being to expose engineering students to the power of distributed, collaborative engineering supported by simulation, NASA engineers provided a common "standard" lunar model, shown in Figure 2, upon which the student teams could operate the systems they designed. [6] Teams learned what it took to have their systems interoperate with a physical environment (lunar) they had never thought much about. In addition, the teams benefited from the animation and playback of the lunar base that reflected elements/system contributions from university teams spanning half the globe.

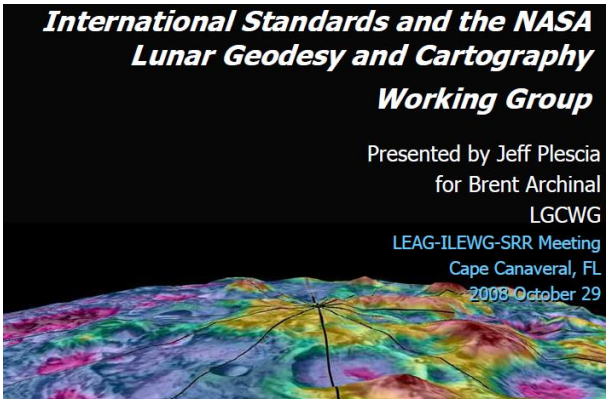

Figure 2 NASA Lunar Standards Example

The High-Level Architecture (HLA) standard was taught and employed during the collaborative mission that was showcased and shared at a Simulation Interoperability Workshop with rewards for best student team designs. The teams were able to explore various concepts of operations and design variations that benefitted from the insights gained by a virtual operating environment populated by NASA and the participating university teams. Each of the participants gained rich insights into how independently developed simulations could be combined into a lunar base and supporting on orbit communications through the understanding and employment of an open and community developed (and evolved) standard such as the IEEE 1516 (High Level Architecture). Dr. Zach Cruzes, NASA Houston, the visionary engineer who helped build the team who implemented the Simulation Exploration Experience (SEE), confided that they could have (and perhaps should have) introduced even more beneficial standards to the student participants (such as DSEEP and VV&A) at this recurring annual event, but the timelines and challenges involved in moving from HLA 1516 theory to practice inside less than half of a year, limited the standards exercised to focus on the engineering benefit of distributed, collaborative simulation. See Figure 3 above for illustration of NASA Inspired SISO Sponsored SEE Visualization. [7]

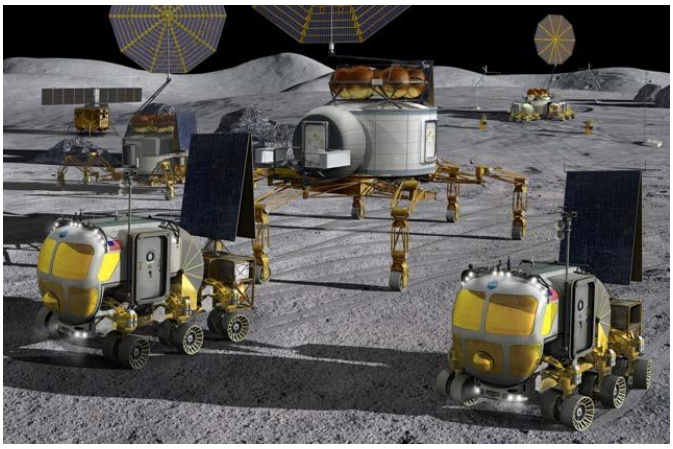

Figure 3 NASA Inspired SISO Sponsored Simulation

3.3 Recognize and Record Best Practices

Almost twenty years ago, thirteen NATO countries joined in a technical project that sought to explore how the power of simulation could help reduce risk and improve performance prediction of NATO ship building and combined operations. The project spanned several years and SISO papers in the 2000-2002 era, many authored by Richard Reading, hold a rich history of this sustained technical undertaking. The research team sought to provide insights into key physical or performance factors that was affected by the operational environment, shown in Figure 4. Since the research challenge was to predict performance of various helicopters attempting to land on various surface ships with landing decks, under variable weather conditions (e.g. sea state, wind over deck, etc.), the problem involved standardizing on technical approaches to modeling each of the physical components, their performance, and the natural environment within which all of the components would have in common. Several versions of the physical components (ships, helicopters, sea state) were proposed from the participating nations. In the end, the focus on standards (like the High Level Architecture) allowed the system of system represented to be composed with different versions from multiple nations. This example demonstrated how a high performing international team of technical experts identified appropriate standards and models to represent typical tasks (landing on deck) through interoperable simulations. It is one of the best early, and well documented, examples of effective and heterogeneous international collaboration on a simulation federation intended to explore best technical approaches to accomplishing common tasks. The profile employed is worth emulating and reusing even today with the benefits of lower risk, more efficient and effective

Figure 4 NATO NIREUS Mission Context

application of modeling and simulation tools that can support NATO combined operations. [8]

3.4 An Acquisition Community Call to Action – The SISO M&S Community Responds

The SISO Acquisition Modeling and Simulation Standards Profile Product Development Group (PDG) that formed and delivered draft products that underwent trial use in 2016 employed a "use case" approach that exercised the practicality of capturing and describing a standards profile relevant to a given operational vignette. This approach appears to be flexible and applicable to use by the training community. As noted by SISO Overview, "The SISO is an international organization dedicated to the promotion of modeling and simulation interoperability and reuse for the benefit of a broad range of M&S communities." [9]

With a focus on themes of "reuse", the Acquisition Community and "promotion of modeling and simulation interoperability" the SISO Acquisition Modeling and Simulation Standards Profile PDG has developed "A Standards Profile for the Use of Modeling and Simulation in Support of Acquisition Activities". The profile provides a compilation of standards and recommended practices used to manage, coordinate, align, and integrate the development and use of model and simulation artifacts through a systems acquisition lifecycle across both time (e.g., acquisition phases) and organizational and activity boundaries as depicted in Figure 5 extracted from the Defense Acquisition Guidebook. [10] What makes this standards profile unique is that the standards are mapped against typical technical activities that occur across the entire life-cycle of a system or capability. This "overlay" or "ensemble" of standards that have been successfully applied in a given technical application area within an operational vignette/use case, allows a prospective study lead to benefit from the proven approaches of fellow practitioners. In the examples cited in the profile product, finding one or more openly available technical papers describing the work was an important criterion so that richer context could be pursued if desired.

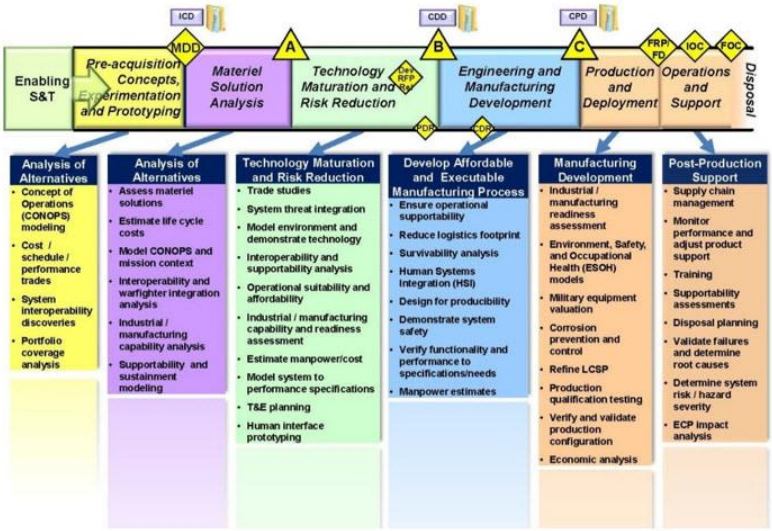

Figure 5 Defense Acquisition Guidebook – The Acquisition Lifecycle

The components of this set of SISO standards products have been developed as two volumes. These volumes provide guidance on the selection and use of model and simulation standards and recommended practices to serve all communities that manage, develop, and/or use models and simulations in support of the acquisition, use, and retirement of systems and system of systems. The communities span multiple user domains (Acquisition, Analysis, Test, and Training) and application areas (Defense, Aerospace, Medical, Information Technology, etc.). [11]

Once these acquisition modeling and simulation standards products have been approved, then other profiles can be developed in support of other communities. SISO is in a unique position to encourage and support other communities as they seek to reuse and promote modeling and simulation interoperability for programs requiring the application of standards.

4. A Way Forward

One of the hallmarks of a healthy profession is that accomplished practitioners document their work and share their challenges and achievements so that others may build upon their work. As was shared earlier, the building construction community started the journey to establish the BIM framework over twenty years ago. For the past twenty years, the modeling and simulation community has developed and evolved interoperability standards (DIS, HLA), distributed simulation best practices (DSEEP), and standards that help organize a professional approach to simulation application verification and validation (GM-V&V). We have built up some of the individual enablers that can allow us to undertake more complex applications at a reduced cost. However, it helps tremendously if there exists a template, a framework, or profile to consistently capture a profile for group of enablers that has been shown to produce quality results and avoid trial and error. The SISO Acquisition Modeling and Simulation Standards Profile PDG products are nearing completion that will provide an organizing blueprint of how to best approach typical technical activities that are recurring across the acquisition and training domains. This PDG product is expected to be balloted in the near future. While the PDG products will provide a blueprint, and be populated with a limited number of use cases or vignettes, it is understood that the richer the content becomes, the more valuable the product will be to our community. It is possible that the "Rule of 3" for M&S technologies that will spark innovation and generate disruptive change are here. The technical activity tailored ensembles of applicable technical standards, the ubiquitous computing power/high speed connectivity, and affordable and deployable immersive environments are about to converge with a beneficial outcome for our communities. Properly nourished and supported, the standards profile effort can capture a deep pool of successful, documented, and published best practices that can be shared and help ignite the cultural change necessary to respond to the complexities and challenges of today and tomorrow.

To extend the practicality and viability of the emerging standards profile, the PDG seeks input from sources that represent application vignettes or use cases of M&S-related standards supporting technical activities across a wide range of applications. Directly involved modeling and simulation practitioners and community leaders offer the opportunity for a rich cross-section of applications included in the standards profile examples and will more completely demonstrate the broad applicability of use of standards at multiple points in the acquisition life-cycle or the diverse distributed LVC training applications. The Artifact-to-Activity crosswalk in Figure 6 illustrates the types of standards that the NIREUS program used (or could have used) for their examination of cross-deck UAS landing on NATO ships. Taken as a group of (eight) standards relevant to the given technical activity for one or more specific domain(s) – in this case Unmanned System and Naval – we refer to this collection of relevant standards as a standards ensemble or an M&S standards playbook. This ensemble of historical best practice standards to consider for use should speed planning, reduce risk, and improve credibility.

ISO/IEC SYSTEM LIFE CYCLE STAGES	DEVELOPMENT					
DEFENSE ACQUISITION GUIDEBOOK LIFE CYCLE STAGES	TECHNICAL MATUATION AND RISK REDUCTION			ENGINEERING AND MANUFACTURING DEVELOPMENT		
M&S Artifacts \ Acqusition Activities	Trade Studies	Model environment & demonstrate technology	Interoperability & supportability analysis	Human Systems Integration (HSI)	Design for producibility	Demonstrate system safety
"IEEE Standard for Distributed Interactive Simulation" (DIS)		X				
IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)		X				
Digital Terrain Elevation Data (DTED)		X				
Guidance for a "Generic Methodology (GM) for Verification and Validation (V&V) and Acceptance" of Models, Simulations, and Data"		X				
IEEE Standard for Modelling and Simulation (M&S): High Level Architecture (HLA)		X				
OpenFlight Scene Description Database Specification ®		X				
Standard for Real-time Platform-level Reference Federation Object Model (RPR FOM)		X				
Verification, Validation & Accreditation (VV&A) Recommended Practices Guide (VV&A RPG)		X				

Figure 6 Artifact-to-Activity Crosswalk – Use of Standards

To participate by contribution of first person experience or nomination of others in our community who can describe their successful application vignettes, please contact the SISO Acquisition Modeling and Simulation Standards Profile PDG Chair: Kenneth "Crash" Konwin, konwin_kenneth@bah.com.

5. Conclusion

Both the acquisition and training community have understood for some time that we can't afford to approach today and tomorrow's challenges with the tools and processes that served us well in the past. As a community, we must move beyond exquisitely crafted one of a kind approaches to the next challenge. Our profession has recognized that we must learn from the past, adapt and adopt existing and emerging technologies, and leave behind blueprints of best practices for the current and future workforce within our school houses, factories, and training ranges. By applying documented and proven best practices, we can better manage risk, keep schedule, increase credibility, and control costs as we engage within a future that is more complex and interdependent across programs, Services, and nations. An open standards profile that is established, populated, evolved, and curated by SISO, an international modeling and simulation community, serving a wide array of application areas is a technical enabler that is long overdue. The leadership of the SISO Acquisition Modeling and Simulation Standards Profile PDG welcomes your suggestions for applications to include in the profile and encourage you to become involved in the ballot pool as the initial product becomes available for general use in the next several months.

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Author Biography

KENNETH "CRASH" KONWIN is a Booz Allen Hamilton professional with over 15 years consulting experience after a 27 year Air Force career. His current assignment is mission support task lead for supporting governance and integration of Joint Command & Control systems within the Department of Defense AT&L/C3CB/C2 Directorate in Washington, DC. Mr. Konwin is a past Director of the Defense Modeling and Simulation Office (DMSO), former Chairman of the NATO Modeling & Simulation Group (NMSG) within the Research and Technology Organization, and original Deputy Director of Requirements and Chief of MS&A for the Joint Strike Fighter (now F-35) program office. He served as the National Team Lead for Modeling & Simulation for the Missile Defense Agency responsible for technical progress across the government, industry, FFRDC/UARC, academia, and international teams. He was a distinguished graduate earning a Master's Degree in Operations Research from the Air Force Institute of Technology, and a Bachelor's Degree in Civil Engineering from the US Air Force Academy. He is a DAWIA trained SPRDE and PM. He serves on the Simulation Interoperability & Standards Organization (SISO) Executive Committee (EXCOM) and is Chair of the Acquisition Modeling & Simulation Standards Profile Product Development Group (PDG)