Coalition Battle Management Language (C-BML)
Phase 1 Specification Development:
An Update to the M&S Community

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ABSTRACT: *The Coalition Battle Management Language (C-BML) is a common language for expressing and exchanging plans, orders, requests, and reports across command and control systems, modeling and simulation systems, and robotic systems. In March 2006, the Simulation Interoperability Standards Organization (SISO) approved initiation of a Product Development Group (PDG) to generate a specification and guidance document for C-BML. The PDG laid out a three-phase development effort: (1) Phase 1 will specify a sufficient data model to unambiguously define a set of military orders using the Joint Command, Control, and Consultation Information Exchange Data Model (JC3IEDM) as a starting point; (2) Phase 2 will develop a formal grammar (lexicon and production rules) to formalize the expression of plans, orders, and reports; and (3) Phase 3 will develop a formal battle management ontology to enable conceptual interoperability across systems. Work continues to prepare the initial draft of the C-BML specification, and supporting materials, for review by the PDG. This paper describes current status of development of the C-BML Phase 1 Specification.*

1. Introduction

The Coalition Battle Management Language (C-BML) is an emerging standard for expressing and exchanging plans, orders, and reports across command and control (C2) systems, live, virtual and constructive modeling and simulation (M&S) systems, and robotic systems participating in Coalition operations.

1.1 Background

During the Spring 2004 Simulation Interoperability Workshop (SIW), a meeting of subject matter experts decided that it would be beneficial to the international M&S community to merge US Army Battle Management Language (BML) initiatives with other countries' BML interests to create a Coalition BML (C-BML) standard. As a result, a statement of work was drafted and submitted to the Simulation Interoperability Standards Organization (SISO) Standards Activity Committee (SAC). In September 2004, the SISO SAC approved the establishment of a C-BML Study Group (SG) to describe requirements and determine international interest in a standardization effort. The C-BML SG was formed under the following premise [1]:

> *In order to improve simulation interoperability and better support the military user with M&S-based capabilities an open standards-based framework is needed that establishes operational and technical coherence among C2 and M&S systems. The objective capability will enable automatic and rapid unambiguous initialization and control of one by the other.*

The C-BML SG formally began work at the Fall 2004 SIW under sponsorship of the SISO Command, Control, Communication, Computers, and Intelligence (C4I) Forum. In addition to its SISO membership, the SG collaborated with other organizations with potential interest in this work; in particular, the North Atlantic Treaty Organization (NATO) Modeling and Simulation Group (MSG) and the Command and Control Research and Technology Symposium (CCRTS). The SG completed work with submission of a final report [2] to the SISO Executive Committee (EXCOM), SAC, and Conference Committee (CC) at the Fall 2005 SIW. That report recommended initiation of a Product Development Group (PDG) to proceed with development of a specification for SISO standardization, and the SG submitted a Product Nomination to that end. The SAC approved the Product Nomination, resulting in establishment of a Product Development Group and Drafting Group for development of the C-BML specification.

In accordance with SG recommendations, the C-BML specification is being produced in the following three phases providing incremental increase in scope and application in each version:

- Phase 1, Data Model: Phase 1 of the C-BML standardization effort defines the basic data model underlying the construction of C-BML expressions (plans, orders, requests[1], and reports). The data model identifies a sufficient data set, using the Joint Command, Control, and Consultation Information Exchange Data Model (JC3IEDM) [3] as a starting point, for expressing portions of basic Orders information so that they can be unambiguously interpreted by C2, M&S and Robotic systems. Discussion of the data model as a basis for C-BML can be found in [4]. The Phase 1 Specification will also specify standard information exchange content and structure in the form of an Extensible Markup Language (XML) schema, as well as an information exchange mechanism expressed as a Web Services Description Language (WSDL) document.
- Phase 2, Formal Structure (Grammar): Phase 2 of the C-BML standardization effort will extend the Phase 1 products to more completely enable unambiguous expression of plans, orders, requests, and reports through a formalized grammar (syntax, semantics, and vocabulary). The objective is to formalize the definition of tasks, requests, and reports such that they are rigorous, well documented, and parse-able. Various C-BML grammar definition, demonstrations, and discussions can be found in [5-11].
- Phase 3, Formal Semantics (Ontology): Phase 3 will involve specification of a battle management ontology to enable conceptual interoperability across systems.[2] Preliminary discussion of C-BML ontology issues can be found in [13].

As recommended by the SG final report, each phase of the C-BML specification development will describe:
- A data model (specifically, the C-BML SG recommended JC3IEDM as a starting point for all phases of the effort);

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[1] Requests (such as calls for fire) have recently been included in the scope of the specification. This is discussed later in the paper.

[2] Tolk and Muguira [12] describe 7 levels of interoperability from weakest to strongest capability: Level 0, No Interoperability; Level 1, Technical Interoperability; Level 2, Syntactic Interoperability; Level 3, Semantic Interoperability; Level 4, Pragmatic Interoperability; Level 5, Dynamic Interoperability; Level 6, Conceptual Interoperability.

- An information exchange content and structure specification defining valid form and content of C-BML expressions;
- An information exchange mechanism specification enabling a common approach to implementation of applications that can process C-BML information;
- Guidelines for adoption and application of the standard that explain C-BML use and provide practical examples.

1.2 Current Efforts

Past papers presented at SIW have informed the community on ongoing progress in development of the Phase 1 C-BML specification [14, 15, 16]. During the past several months since the Spring 2009 SIW, the C-BML Drafting Group (DG) has focused development in response to PDG decisions on the required scope of the specification as reported in [16]. According to those decisions, the Phase 1 Specification will describe the data model (JC3IEDM) as in earlier versions of the draft specification, plus what may be called an "operational" vocabulary (or "base" vocabulary) consisting of (1) the basic 5Ws (Who-What-When-Where-Why) at an abstract level tied to the JC3IEDM logical data model; AND (2) a specialization layer providing an "operational context" to the information elements in a C-BML expression. To be more precise, the Phase 1 Specification needs to describe:

- the abstract `Who` specialized to terms such as `Tasker`, `Taskee`, `Affected`, etc.
- the abstract `What` specialized to terms associated with tasks, actions, events, etc.
- the abstract `When` specialized to terms such as `StartWhen`, `EndWhen`, etc. (possibly including addition of concepts like recurrence and duration)
- the abstract `Where` specialized to modes such as absolute, relative (e.g., range and bearing from an absolute location), indirect (e.g., unit aboard a ship), etc.
- the abstract `Why` specialized to terms associated with concepts such as purpose, objective, desired end state, intent, etc.

Some of the "contextual" terms have been suggested by prior work; for example, the Command and Control Lexical Grammar (C2LG) [5, 6], Joint Battle Management Language (JBML) [17], Integrated Battle Management Language (IBML), and NATO Modeling and Simulation Group 048 (MSG-048) [18]. Additional terms may come out of current work being performed jointly by the Military Scenario Definition Language (MSDL)[3] and C-BML PDGs to define a common tasking

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[3] MSDL version 1.0 was approved as an international standard by SISO in September 2008.

grammar. Other terms need to be considered, as suggested in the descriptions in the list above. There is, in fact, an additional layer of specialization suggested by work such as JBML, where terms like `Taskee` can be an item of equipment or an organization, and things like `time` can be absolute or relative (e.g., to an H-hour). Other vocabulary that needs to be addressed for "operational context" are constraints, controls, or restrictions (such as rules of engagement, control measures, etc.) and other conditions or performance measures (i.e., success criteria [19]) important to specification of tasks.

This paper describes work in progress on development of the draft Phase 1 C-BML Specification and associated materials. It identifies ongoing related technical activities occurring in government and industry that provide information for consideration in preparing the Phase 1 draft.

2. Phase 1 Drafting Activities

C-BML Phase 1 drafting activities are currently focused on development of the Phase 1 Specification. The scope includes an initial specification of underlying data model, information exchange content and structure, and information exchange mechanism for expressing and exchanging plans, orders, requests, and reports across live systems (C2), virtual and constructive systems (M&S), and robotics systems. The inclusion of the new category of C-BML expressions, namely requests, was recently recommended by the C-BML DG to the C-BML PDG. Similarly, the DG recommended to the PDG that robotics systems remain in scope for the Phase 1 specification. In both cases, the PDG agreed to the recommendations, with the stipulation that the fuller scope not delay or unduly complicate the Phase 1 specification effort. The DG believes having a more complete scope actually simplifies understanding of the full intent of C-BML and will provide a more complete basis for the current and follow-on specification efforts. There has also been discussion in the PDG relating to the use of C-BML for exchange of plans, orders, requests, and reports across C2 systems. At this time, the PDG position is to focus first on interactions between C2 systems and M&S systems as the primary requirement for C-BML, and to hold in abeyance application of C-BML between C2 systems.

The data model portion of the proposed standard has been specified as the JC3IEDM logical model. The information exchange content and structure portion of the proposed standard is being addressed through description of the primary concepts that can be used in C-BML expressions, with formal specification using the World Wide Web Consortium (W3C) XML Schema language [20]. The information exchange mechanism portion of the specification will be expressed using WSDL following

completion of the information exchange content and structure portion of the proposed standard. Finally, the guidelines are being developed initially through description of a collection of use cases that will demonstrate application of the Phase 1 standard. The following subsections describe current DG work in each of these areas.

2.1 Specification: Information Exchange Content

The principal information components of C-BML are the 5Ws: Who, What, When, Where, and Why. In the abstract, these information components are fundamental to the expression of plans, orders, requests, and reports for any doctrine of any service, nation, or organization. The following constitute a definition of the 5Ws for purposes of the C-BML standard:

- Who: *C-BML information component identifying the battlespace object directed to perform an action (plan or order), that has been observed or has performed an action (report), or on which an action is to be performed (e.g., target).*
- What: *C-BML information component identifying an action to be performed (plan or order) or that has been performed (report).*
- When: *C-BML information component describing the timeframe in which an action is to occur (plan or order) or when an action or event has occurred (report).*
- Where: *C-BML information component providing the location of an object in the battlespace (*C-BML Who*), the location where an action is to occur (plan or order), or the location where an action or event has occurred (report). The location may be a complex object, such as an area or a sequence of locations.*
- Why: *C-BML information component describing the rationale or purpose of an action to be performed (plan or order), or the desired end state of a planned action.*

The 5Ws constitute a portion of the C-BML "doctrine view," expressions of plans, orders, requests, and reports using terminology particular to a specific nation, service, or organization. This abstraction of fundamental information components in the content of doctrinal expressions of plans, orders, requests, and reports facilitates future employment of the standard by any service, nation, or organization.

In the expression of plans, orders, requests, and reports, each "W" information component is applied in a certain context and role.[4] For example, in the context of an order,

one role for "Who" may identify the authority giving an order (tasker), while another role for "Who" identifies the organization that will carry out the order (taskee). These distinctions in role/context can have implications in how the terms are expressed in the underlying data model. Table 1 identifies various usages (i.e., context and role) of the basic 5W concepts, resulting in a broader set of basic vocabulary terms that can be used in construction of C-BML expressions. Additional considerations for the content of BML expressions are discussed in [21].

2.2 Specification: Information Exchange Structure

The selected formalism for specifying the C-BML information content and structure is the XML Schema language. This language provides a precise description of the information structure and content that can be used to validate XML documents containing C-BML expressions encoded in XML (i.e., to ensure the format and content of an XML document containing C-BML expressions conform to the language specification described by the XML schema). Furthermore, the use of XML facilitates widespread adoption and deployment of the C-BML standard.

The C-BML XML representation of the 5Ws provides information elements for use in expressing portions of plans, orders, requests, and reports that can be exchanged across systems through a variety of mechanisms (a standard information exchange mechanism for C-BML employs web services specified in WSDL, as will be used in the information exchange mechanism of the C-BML Phase 1 specification). Implementation (by any service, nation, or organization) of C-BML applications conformant to the Phase 1 specification will require transformation of respective information elements in current expressions (e.g., textual or binary message formats), some of which may already use defined XML tag sets, into the C-BML XML structures. Legacy systems will generally require adapters to produce and consume C-BML expressions. Over time, however, as C-BML becomes widely adopted, systems will emerge that natively "speak" C-BML, directly producing and processing C-BML expressions in place of older formats. Either way, systems will obtain the benefits of a shared, common structure and content for the expression of certain information elements in plans, orders, requests, and reports.

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[4] C-BML context: The kind of C-BML expression: plan, order, request, or report.

C-BML role: Usage of a concept in a C-BML context.

Table 1. Roles and Contexts for the C-BML Basic 5W's

W	Context	Role	Description
Who			
	Plans		
		IssuingWho	Specifies who is issuing the plan
		ContributingWho	Specifies who is contributing to the plan (i.e., in collaborative planning)
	Orders		
		TaskeeWho	Specifies who is executing the task
		TaskerWho	Specifies who is ordering or authorizing execution of the task
		AffectedWho	Specifies a "who" affected by the task to be performed
	Reports		
		ReporterWho	Specifies who is reporting
		AddresseeWho	Specifies the one to whom the Report is addressed
		ReportedWho	Specifies who is being reported on
	Requests		
		RequesterWho	Specifies who is making the request for some action
		RequestedWho	Specifies who is being requested to perform some action
Why			
	Orders		
		Why	Specifies reason for executing order
	Reports		
		ReporterWhy	Specifies the perceived reason as perceived by the Reporter
		ObservedWhy	Specifies the reason as observed
When			
	Plans		
		CreatedWhen	Specifies when the plan was created
		IssuedWhen	Specifies when the plan was issued/disseminated
	Orders		
		OrderIssuedWhen	Specifies when the order was issued
		StartWhen	Start Time of the task to be performed
		EndWhen	End time of the task to be performed
	Requests		
		IssuedWhen	Specifies when the request was issued
		RequestWhen	Specifies when the requested action needs to be performed
	Reports		
		ReportWhen	Specifies the time the report originated
		WhenEvent	Specifies the time of the event in the Report
Where			
	Plans, Orders, Reports and Requests		
		RouteWhere	Defines a route to be followed in action
		AtWhere	Defines Where an action is done

W	Context	Role	Description
		ControlFeatureWhere	A where defined as a Control Feature
		StartWhere	A where in the context of a initial position
		EndWhere	A where in the context of a final position
What			
	Orders		
		What	Specifies the activity the tasked unit is to do
	Reports		
		ReporterWhat	Defines the perceived 'what' of the action
		ObservedWhat	Defines the observed 'what' of the action

The DG is currently developing XML schema representations of the basic 5W's and the context/role-specific information elements identified in Table 1. The technical approach first specifies *abstract* XML structures; i.e., data structures that are not used directly to declare XML elements, but serve as the base type for declaration (through restriction or extension of the base type) of more specific data types on which XML elements are declared. The principal challenge in the approach is to ensure strict specification of C-BML information components in terms of the underlying JC3IEDM logical data model. Full description of the technical approach is beyond the scope of this summary paper, but will be provided to the community at the Fall 2009 SIW.

2.3 Specification: Information Exchange Mechanism

Active development and demonstration of BML concepts, capabilities, and technical approaches have established information exchange mechanisms using Web Services. Implemented services enable systems to pass and receive BML expressions employing XML structures that have served as exemplars for the Phase 1 specification development. The services provide information extraction and construction between the XML structures and the underlying JC3IEDM physical data model. When the C-BML Phase 1 XML schemas (information exchange content and structure part of the specification) have been vetted in readiness for balloting, specification of a supporting information exchange mechanism using WSDL will be a straightforward adaptation of the prior work.

2.4 Guidelines

The Phase 1 C-BML Guidelines document will provide information to assist early adopters of the standard in development of conformant applications. The document will include descriptions of relevant use cases describing ways BML has been employed in recent years in various development activities as well as additional uses that can be supported by the Phase 1 standard. While the drafting group has performed early planning of the content of the C-BML Guidelines document, full development of the content is dependent on the information exchange content and structure specification and subsequent reference implementation using the specified information exchange mechanism. The plan is for a draft of a portion of the Guidelines document to be available at time of balloting of the Phase 1 C-BML specification to assist in overall understanding of the specification, but for the full content to be completed after approval of the Phase 1 specification when the Phase 1 information exchange content and structure portion of the specification and the information exchange mechanism portion of the specification are broadly accepted.

3. Related BML Activities

Over the past several months, significant development and refinement of BML concepts and implementation approaches have continued in the M&S community. These efforts include the Integrated BML, Scripted BML [22], and NATO MSG-048 BML activities. In July 2009, a meeting was held at George Mason University to discuss and reconcile different approaches reflected in the IBML and MSG-048 efforts. A small work group reviewed the XML schemas for the Operations Order, BML Orders Types, and the Five W Types data constructs. The C-BML DG is reviewing findings of the meeting for possible incorporation of lessons learned into the Phase 1 draft specification. There is also related work in progress by a joint C-BML and MSDL working group to define a common tasking grammar that will be specified in a future version of the MSDL standard to define plans and orders that can be included in scenario initialization files. The working group will report on current status of that effort at the Fall 2009 SIW.

4. Road to Balloting

The primary goal at this time is completion of the draft specification to provide it to the PDG for review and

resolution of comments prior to official balloting. The current development timeline targets the PDG meeting at Spring SIW 2010 for review of comments received and proposed resolutions. If successful, the group anticipates a vote on the Phase 1 Specification during the summer of 2010, with approval of the initial Phase 1 Specification by the Fall 2010 SIW. Completion of the drafting of the Phase 1 Guidelines document is expected to follow analysis of specification review and balloting responses, at which point there should be a clear indication of any changes needed to obtain an approved standard for the C-BML data model, information exchange content and structure, and information exchange mechanism on which the guidelines document would be based.

5. Summary

C-BML is a challenging standardization effort, made the more so due to a continually evolving technical understanding, an active development community, and increasingly complex C2 and M&S system requirements. Even so, the drafting effort is converging on an initial specification that will provide a solid foundation for ongoing development efforts and the follow-on C-BML specification phases.

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Acknowledgements

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