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Harmonizing BML Approaches: Grammars and Data Models for a BML Standard

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ABSTRACT: Battle Management Language (BML) is being developed as an open standard that unambiguously formalizes and specifies Command and Control information, including orders and reports built upon precise representations of tasks. BML is a language specification, based on doctrine and consistent with Coalition standards. The goal of BML is to enable and improve the interoperability in the C2 area, especially by enabling also the military communication with simulation systems and future robotic forces.

Although the need for BML is well documented, a SISO standard has still not been achieved. At present, there are two recommended approaches focusing on different aspects. In order to achieve a SISO standard, the SISO product development group for the development of BML has explored these approaches and presented three possible ways to achieve the standard. On the basis of these recommendations, Bundeswehr's IT office asked supporters of both BML approaches to discuss possible compromises in order to get the best out of the approaches and to facilitate the definition of the standard. In this paper, a way forward is recommended and explained. In short, this compromise recommends using MBDE's transactionals as constituents under the C2LG.

1. Introduction: About BML

The currently driving application domain behind the development of a Battle Management Language (BML) is computer-based training, especially for command staffs, using military simulation systems. Staff training includes exercises in which a military commander will command her or his force relying on the staff's competence and performance to support her or him. Among other things, the staff will use the Command and Control (C2) systems to provide the commander with the operational picture and also use it to send the commander's orders to the forces on the ground. The use of a simulation to play the roles of the force promises not only to reduce the training costs but also to enhance the effectiveness of the training itself. For example, the simulation can be used to confront the commander and the staff with exceptional situations. It even can be used to repeat certain initial situations in order to let the commander try different approaches to deal with them. Furthermore, the simulated forces can expose characteristics of future weapon systems or forces structures, which connect the application domain of training with experimentation and analysis.

In order to achieve the training advantages mentioned, the commander and the staff shall use exactly the same C2 systems they would use in real operations. Furthermore, ordering as well as receiving reports from the forces in training ideally is identical to ordering and receiving reports in the real world. When giving a command, the commander should not have to be concerned about whether the execution will be conducted by human life forces, simulated forces, or – in the future – by robotic forces. However, military communication – like ordering and reporting – is often based on free text. As simulation systems cannot interpret free text, ordering simulated units (or robotic forces) directly by free text orders is out of question. Therefore, today's computer-simulated training often keeps large contingents of support personnel to act as workstation controllers and provide the interface between the training unit and the simulation by translating the free text orders into command lines that can be understood by the simulations. The group of workstation controllers is often as large as or larger than, the training audience. While this enables training opportunities at the corps and division echelon, it is resource-intensive and lacks the degree of fidelity that actual combat operations present to the commander and staff. The first (need for large group of supporters) cancels the principle cost effectiveness of simulation use and the second (additional interpretations and translations) disrupts the training effects.

When targeting the application domain of support of operations, the situation becomes even more critical. If simulation systems are used to evaluate alternative courses of action or to track the degree of conformance of an execution with the underlying plan, the use of support personnel as translators between the operational C2 language and the system required representation is not possible. Introducing new technologies, such as intelligent agents for agent-directed simulation[1] adds another layer of complexity.

BML has been envisioned to close these gaps [2, 3, 9, 25, 28, 29, 30]. The main idea is that in the future orders, reports, and other C2 related communication will be formulated in BML, which becomes the specification of C2 related information exchange valid for all participating systems. This is captured in the definition of BML [2]:

> *BML is the unambiguous language used to command and control forces and equipment conducting military operations and to provide for situational awareness and a shared, common operational picture.*

During the last decade, promising variants of BML have been developed through different approaches:

- The "bottom-up" approach utilizes "Model Based Data Engineering" (MBDE) and focuses on the importance of basic components being transactionals in the underlying data model representation. Using a data model representation that is accepted in the operational C2 community will hopefully facilitate the integration of BML application with fielded systems. The recommended model to start with is the Joint Command, Control and Consultation Information Exchange Data Model (JC3IEDM). MBDE supports the definition of initial transactional as well as model extensions and enhancements in case of need.
- The "top-down" approach focuses on the development of a formal grammar, the Command and Control Lexical Grammar (C2LG). It provides rules for the formulation of orders and reports, and has been used in NATO's MSG-048, Coalition BML, for the investigation of using a BML for C2 system – simulation system interaction.

Both approaches agree upon two fundamental insights: First, BML expressions have to be expressible by XML whereas these XML-coded BML orders and reports have to validate under a XML schema that should derive from the grammar underlying the BML. Second, BML expressions have to use the JC3IEDM vocabulary, where the JC3IEDM defines the terms used in the grammar.

Both approaches have been implemented using web service:

- The C2LG approach uses (Joint BML) JBML web services and its successor, the Integrated BML (IBML) web service. The former has been used in the 2007 I/ITSEC demonstration [5, 13, 14, 16], the latter in the 2008 I/ITSEC demonstration [4, 15], respectively. By these demonstrations NATO's MSG-048 illustrated an implementation of BML supporting the interaction of C2 systems and simulation systems of six different nations in 2007 and eight different nations in 2008.
- The MBDE approach uses web services that are directly derived from the JC3IEDM namespace. The web services allow the exchange of transactionals and compositions of transactionals.

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[1] The term agent-directed simulation (ADS) was introduced by T. Oren and L. Yilmaz to distinguish between different categories of agent and simulation systems, see http://www.eng.auburn.edu/~yilmaz/ADS.html

The approach has been used in NATO's MSG-027 demonstration and is currently applied in support of the US JFCOM Joint Rapid Scenario Generation efforts. It also supported demonstrations for the Net-centric Operations Industry Consortium (NCOIC) and collaborations with IBM Federal Service-oriented Architecture (SOA) events.

The research and development efforts on both approaches allow that a standard can and should be achieved in order to facilitate further improvements and a broad distribution. In the following, we will discuss the two approaches and their BML variants. We will look at the respective advantages of both approaches to harmonize them and propose the result as BML standard. We will start with the description of the model-based approach.

2. The Model-Based Approach

The model-based approach [23, 26, 27] utilizes Model-based Data Engineering (MBDE) [24]. It is therefore often referred to as MBDE approach. MBDE is based on data engineering principles as introduced in the NATO Code of Best Practice for C2 Assessment [12]. It is characterized by the use of a common reference model (CRM) as an initial specification of the information exchange in machine understandable form and a set of extension and enhancement rules. MBDE uses the CRM to identify information exchange specifications that are valid within the CRM. If an information exchange specification is operationally relevant but not valid in the CRM, MBDE specifies rules to modify the CRM. If the information exchange specification requires a higher resolution, the CRM must be enhanced. If the information exchange specification requires additional data elements or relations, the CRM must be extended. As such, the CRM is gradually improved with each participating systems that introduces new information exchange specifications.

The CRM captures the understanding of information to be exchanged in machine understandable form. Ultimate goal of the underlying engineering process is to capture – in addition to data and its relations – the governing constraints and guiding rules in machine understandable form. Constraints and guiding rules can be captured in form of axioms, which results in extensions of the CRM ontological based on ontological means.

Information exchange between machines must be unambiguous. Using a CRM, this translates into the requirement to exchange information in a way that a physical CRM implementation would remain consistent. This translates into the requirement that such information exchanges are captured as transactions. The minimally exchangeable pieces of information are therefore transactionals of the CRM. It is worth pointing out that these are logical structures. No data model implementation is needed. Even if two services are exchanging data, this data exchange must be governed by transactionals in order to be consistent with the CRM.

Another aspect of transactionals is that they can be used to encapsulate implementation details and ensure implementation specific adaptations of BML. The vision captured in the product nomination is the definition of constructs unambiguously defining at least "Who is doing What Where When and Why (5W)." Current research highlighted in the next section emphasizes the need for more constituents and flexibility of building sentences. While the standard aims to use JC3IEDM data elements to define these constituents, not every simulation system will be able to provide all necessary data. Transactionals defining the constituents can now be used to provide standard conform templates in which data that cannot be providing by participating systems is provided using federation specific constraints during the integration process. Another application domain of this feature is to use transactional templates to populate them with initialization data and than use them as pre-populated schemas during runtime: while BML can address a Who as a constituent with an unambiguous identifier (such as a unique name or another unit identification, such as provided by Global Force Management), the accessing web service uses the schema to provide the additionally needed information. This keeps the BML constituents lean while providing full data context for machine interpretations. It is worth mentioning that the same ideas can be used to adapt legacy systems to "speak" the common language.

While it is possible to gradually build up a CRM based on the alignment of information exchange specifications within the community, the use of a hub already containing basically agreed to definitions is the better option. With respect to coalition military operations, the Joint Command, Control, and Consultation Information Exchange Data Model (JC3IEDM), maintained and supported by the Multinational Interoperability Programme (MIP) [11], captures the information exchange requirements identified by the operational user group of MIP as necessary for NATO operations as standardized data elements. As such, it provides an accepted representation of operationally relevant data for battle management and is therefore recommended as the common reference model for the MBDE approach of developing a BML [26]. The JC3IEDM is furthermore explicitly mentioned in the SISO Product Nomination for the C-BML standard.

Using the JC3IEDM as the initial hub for the CRM, VMASC supported the development of a web-service based information exchange infrastructure that uses the logical model to identify valid information exchange specifications. Several academic and industry partners contributed to these developments that were applied for several demonstrations and that were used in support of the US JFCOM Joint Rapid Scenario Generation efforts, in particular to provide a set of Joint Tactical Data Services. As the information exchange specification is directly based on the namespace definitions of the JC3IEDM, the immediate use of JC3IEDM structured information is supported, such as using data from compliant data sources.

In order to define an initial BML version, the model-based approach has not only to deal with the information that represent military business objects in form of transactionals, but also with the informational content of orders and reports. MBDE supports the composition of transactional if the underlying data structures are logically related in the CRM. For the initial BML version, the use of the JC3IEDM structures was the logical choice.

The set of valid transactionals and valid compositions thereof form the initial BML using the model-based approach. Following the recommendations of the study group and the constraints of the product nomination to use the JC3IEDM as the initial CRM, the most obvious advantage of this approach is its ability to exchange information with JC3IEDM data bases, seamlessly.

The limits of the approach are defined by the structure of the JC3IEDM itself. The resulting language fulfills the demands that are made for a BML according to the BML definition if and only if the JC3IEDM allows the representation of orders and reports in an unambiguous way as well as according to the doctrines that hold for ordering and reporting. It is therefore necessary to extend and enhance the model. While MBDE defines how to extend and enhance the model, it does not define when to extend and enhance the model. What is needed is a structured approach driven by operational requirements that identifies valid BML expressions. Once this valid and operationally necessary BML expressions are identified, MBDE can be applied in order to extend and enhance the CRM – here the JC3IEDM – allowing to express these new information exchange specifications.

The recommended solution is to use the doctrine-based approach to analyze operational constraints and requirements as identified in field manuals, doctrine papers, and other expert publications to derive such structures .

3. The Doctrine-Based Approach

The doctrine-based approach had started from the doctrines that hold for ordering. Although BML is to be defined such that orders as well as reports can be formulated, it is reasonable to start with orders such that BML can be used to order simulated units. The NATO standard for order formulation is given by the STANAG 2014 “Formats for Orders and Designation of Timings, Locations and Boundaries.” According to STANAG 2014, an operation order consists of five paragraphs (Situation, Mission, Execution, Administration and Logistics, Command and Signal) (cf. [6]). Because the first major application of BML has to be the assignment tasks to simulated units, the most relevant paragraph of an operational order to be covered by BML is paragraph 3 “Execution.” This paragraph consists of four sections (a. Concept of Operations, b. Tasks/Missions to Manoeuvre Units, c. Tasks/Missions to Combat Support Units, d. Coordinating Instructions). In Section b. (as well as in section c.), tasks are assigned to units.

As a consequence, the doctrine-based approach to define a BML started by formulating a “tasking grammar” [17]. That grammar then had been broadened to allow the formulation of reports [18, 19] and the formulation of command intent [8], see also [7, 10]. The complete grammar for BML that had evolved from these parts is called Command and Control Lexical Grammar (C2LG). Thus, the doctrine-based approach also has been referred to by C2LG approach.

The expressions that can be generated by the tasking grammar must enable the assignment of tasks to units. Doctrinally, such assignments use the so-called “5W” format. The five Ws represent the “What,” the “Who,”, the “Where,” the “When,” and the “Why” of a task assignment. In the C2LG, linguistic principles about the construction of a language are applied to the 5Ws. The resulting general rule of the “tasking grammar” is given in (1).

(1) OB → Taskverb Tasker Taskee (Affected) Where StartWhen (EndWhen) Why (Mod) Label

In this rule format “OB” means basic order with the understanding that by a basic order one task is assigned to one unit that therefore is ordered to execute that task.

OB is extended to the given sequence. In the sequence, “Taskverb” denotes the kind of task that is ordered. “Taskverb” is the “What” of the 5W format. Next, “Tasker” denotes the one that assigns the task and “Taskee” the unit that has to execute it. “Tasker” as well as “Taskee” are kind of “Who”s. In principle, “Tasker” could be inferred because it normally is identical to the sender of the order, but in order to avoid misinterpretations and ambiguities and to simplify and facilitate the interpretation of the order line by systems, it has be added. “Affected” is also of type “Who” because it denotes a unit, namely the unit that is affected by the task. If the task is an attack or a block, Affected denotes a hostile unit, if the task is a support, then Affected is friend or neutral. Some tasks do not effect another unit, e.g., a march task. Thus, the appearance of Affected depends on the task as indicated by the round brackets in (1). It must also be remarked that although “Affected” is of type “Who”, in the doctrinal 5W-format, it is part of the “What”.

Of the rest of the terms of (1), Where, StartWhen, EndWhen, and Why do directly refer to one of the 5 Ws. There are two “When”s in the rule format because the assignment of a task to a unit needs a mandatory reference to when the execution of the task has to begin and an optional reference to when it has to end. In addition, the type of the Where in (1) also depends on the taskverb. Some tasks like a march or an attack include a movement; others like a rest do not. In order to constrain the BML expressions according to the linguistic principles to meaningful expressions (an application of linguistic theory that also helps to fulfill the demand that a BML has to be unambiguous), in the tasking grammar, the Where is either a RouteWhere or an AtWhere. AtWhere is used if the task does not involve a movement, otherwise RouteWhere is used. RouteWhere can be expanded to sequences of Wheres, e.g., to a sequence of an optional “Source” (to denote the spatial origin), a mandatory “Destination” (to denote the spatial destination), and an optional “Path” (to list intermediate spatial goals of the Taskee’s movement).

The “Mod” in (1) can be used to add modifiers. The current state of the C2LG allows three kind of modifying information to add under “Mod,” 1) the manner in which Taskee is ordered to execute the task, e.g. “*fast*”, 2) an instrument to be used for executing the task, e.g., references to vehicles or weapon systems, and 3) a formation in which the task is to be executed, e.g. “*wedge*.” The “Label” in (1) is the label for the task assigned. It can be used to identify this specific task, e.g., in reports about the task’s continuation.

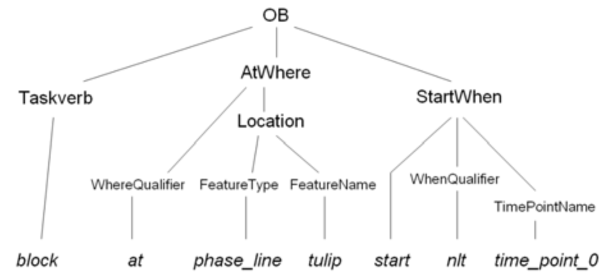

Figure 1: *The figure shows the structure assigned to “Block at phase line Tulip start not later than time_point_0” by the doctrine-based approach.*

In the C2LG, the terms in (1) like “Taskverb,” “Tasker,” “Taskee” etc. form the blocks, the expressions are built on. In Linguistics, such blocks, sequences of words within an expression that belong together, are called “constituents” [20, pp. 9ff.]. Figure 1 shows the structure that is given to the expression “*Block at phase line Tulip start not later than time_point_0*” This expression only is a fragment of a C2LG generated order expression (it only consists of Taskverb, Where, and When) but transfers the idea how the lexical items are grouped together by the C2LG respecting the doctrinal 5W format.

The constituents that can be built by C2LG’s rules are unambiguously identifiable by their position within an expression and by key words they begin with. E.g., the constituent “***in formation*** wedge” is identifiable as Mod of type formation modifier by its key words “***in formation***,” whereas the constituent “***start*** *nlt* (point-in-time)” is a StartWhen as can be recognized due to the key word “***start***” (the “*nlt*” is a temporal qualifier meaning “not later than”). In other words, the application of linguistic principles as well as the careful choice of word order restrictions and key words grants an unambiguous identifiability of the constituents. And this allows an injective mapping from the constituents to thematic roles [22, pp. 506ff.] like “Source” or “Destination.” On this basis, C2LG expressions can be interpreted by systems like simulation systems as intended.

The most obvious advantage of the doctrine-based approach is that the expression formulated in its BML version can be understood by humans. As this approach is based on the respective doctrines, military personal can intuitively use a C2LG-GUI to order simulated units as has been demonstrated by NATO RTO MSG-048 at I/ITSEC 2007 [5, 13, 14, 16] and I/ITSEC 2008 [4, 15]. These presentations also demonstrated the ability of the doctrine-based approach to express orders in a way that simulation systems could interpret the orders as intended.

The limits of the doctrine-based approach show up with respect to the interaction with the data model. Just as the model-based approach, the doctrine-based approach uses the JC3IEDM as reference model. C2LG's terminal symbols (the terms used as words by the C2LG) are JC3IEDM's attributes and their respective values. For example, "*nlt*," the temporal qualifier mentioned above, is a value of JC3IEDM's attribute "action-task-start-qualifier-code." The JC3IEDM provides meaning (semantics) for all these term that is agreed upon by MIP's nations. Thus, the use of the JC3IEDM in both approaches contributes significantly to their interoperability. However, the model-based approached is tied strongly to the JC3IEDM by using strong composites (according to the terminology of Diallo) in order to define order and report transactionals on the base of basic transactionals. In contrast, the doctrine-based approach is tied in a more slack manner to the JC3IEDM. In the terminology of Diallo, the BML expressions generated by the C2LG can be mapped into the JC3IEDM only by so-called "weak composites" which means mapping instructions have to be used and implanted because the structures of the JC3IEDM and the structures defined by C2LG's rules differ. In short, if order and reports are formulated in the C2LG version of a BML, it is harder to map their content (the information to be exchanged) to JC3IEDM structures.

4. Harmonizing the Approaches

As Tolk and Diallo point out, the approaches "are not really competitive, but mutual supporting" [23, p. 14]. Both approaches aim at a language that is based on the JC3IEDM for reasons of interoperability. The doctrine-based approach uses JC3IEDM's attributes and their values as terminals (lexical elements that form the language's vocabulary). The data model-based approach even uses information content elements to represent military business objects that are structurally derived from the JC3IEDM: "The information exchange is defined on scope, structure, and resolution of the JC3IEDM" [26, p. 9]. These elements are represented in XML such that the coded information can directly be exchanged with JC3EDM databases by a family of special web services all utilizing transactionals.

As a consequence from this difference, the concatenation of the represented military objects into orders and reports differs between the approaches. By the model-based approach, the basic transactionals are concatenated for exchanging orders and reports. The concatenation here is guided by the structure of the JC3IEDM as has been explicated in section 2. By the doctrine-based approach the military objects are represented in constituents. Their concatenation is guided by the 5Ws and doctrine as has been explicated in section 3.

The most important problem in using the doctrine-based approach is that all the military business objects referred to are referred to by name only. This means the respective names must be known to all the systems that communicate via a C2LG generated BML expression. For example, if a Taskee is ordered to advance to "phase line Tulip," a simulation system simulating the Taskee has to know phase line Tulip. Especially, if such an order is to be mapped into a JC3IEDM database, e.g., to be spread via data replication to other systems using a JC3IEDM database, these names might not provide sufficient information to allow the correct fill of several mandatory fields of the JC3IEDM data base which is necessary to grant the preservation of identity keys during that data replication [21]. In order to prevent the problem, it must be guaranteed that the names used in C2LG generated BML are introduced to all communicating systems together with all the information the data models need to know about the business objects baptized by that name. According to [26], the use of basic transactionals will circumvent this need.

The most important problem of the model-based approach is its dependence of the chosen common reference data model, or better said: the dependence on the completeness of this model regarding BML requirements. As recommended, this data model has to be initially the JC3IEDM in the case of developing a BML by the MBDE process. The chosen data model sets the condition for the concatenation of the basic transactionals to order transactionals and to report transactionals as well. As the JC3IEDM is the well accepted data model for exchanging operational information in the context of battle management, the question arises naturally, why it is problematic to use the structure proposed by this data model for the exchange of orders and reports. Indeed, the JC3IEDM works well for storing data about objects, especially data about positions and the different kinds of status of military organizations. This information is exactly what is needed for the exchange of an operational picture, and the correctness of the respective representations is what is under testing and evaluation in MIP [1].

However, the situation is quite different with respect to actions and tasks in general and ordering in particular. Although, JC3IEDM, version 3.1, from December

2006, has been supplied with tables for storing orders and although these tables allow a parting of an order according to the 5 paragraph format given by the STANAG 2014, the order parts are assumed to be free text. Therefore, storing an order in the JC3IEDM according to doctrine means that the data model's current business rules prevent the automatic interpretation of that order out of the data base, e.g., by a simulation system. Representing an order in a way such that it can – at least partially – be interpreted automatically, e.g., by using the table "action-task" for the ordered task and by additionally setting its attribute "action-task-category-code" to "order," violates doctrine: The resulting structure does not match the 5Ws. To illustrate this point, figure 2 shows parts of the structure that is assigned to the example of figure 1 by the JC3IEDM.

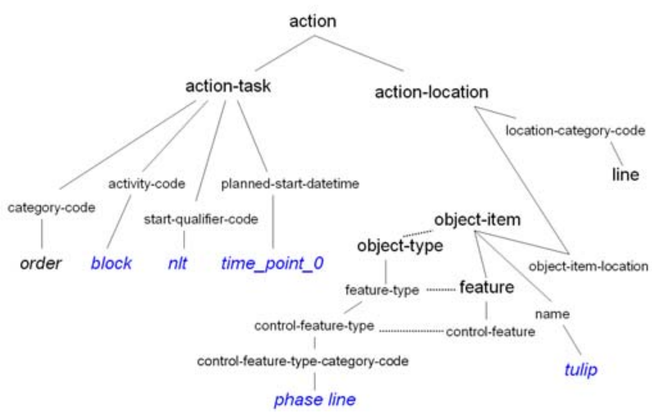

Figure 2: *The figure shows part of the structure assigned to "Block at phase line Tulip start not later than time_point_0" by the JC3IEDM.*

Here is one aspect of why it is dangerous to accept the structure of the JC3IEDM without required extensions and enhancement: The date-time-values for the starting time and the supposed end time of the ordered task as well as their temporal qualifiers in this case are provided as values of four independent attributes that all belong to "action-task", namely "action-task-planned-start-datetime," action-task-planned-end-datetime," "action-task-start-qualifier-code," and "action-task-end-qualifier-code." This means that according to the structure the JC3IEDM provides, the Whens are part of the What: The attribute that determines the kind of the task – "action-task-activity-code" – is an attribute of the same table as the ones for datetimes and temporal qualifiers. Besides, there is no structural indication that the datetime for the task's start and its qualifier (or the datetime and its qualifier indicating the task's planned end) belong together. The structure provide by the JC3IEDM is a data model structure. It is neither the structure demanded by doctrine nor appropriate in the sense of a structure that syntax (a grammar) assigns to a language expression [20, Chapter 1: Basic Concepts of Syntax]. Without additional rules and constraints, the JC3IEDM does not propose an appropriate structure for orders and reports. A model-based approach that copied this structure without additional extensions would result in a BML version with an inappropriate grammar. The doctrine-based approach is necessary to provide the guidance for necessary extensions.

Obviously, both the main problem of the doctrine-based approach which the exchange of information into and out from a JC3IEDM database as well as the main problem of the model-based approach with the structure can be avoided if a grammar is used that uses the rules of C2LG down to the level of constituents and fill in the basic transactionals of the model-based approach as terminals that represent all the information about the military business objects the C2LG constituents only refer to by name. This compromise takes the best from both approaches and covers the main problems perfectly. The structure assigned to the example expression by this compromise is given in figure 3.

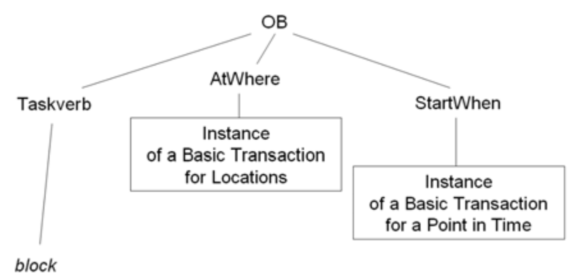

Figure 3: *The figure shows the structure assigned to "Block at phase line Tulip start not later than time_point_0" by the compromise BML.*

5. The Way ahead

The application of MBDE allows the definition of transactionals as described in the paper. These transactionals represent pieces of information that are interpretable by the machines using the targeted CRM. MBDE allows defining transactionals including pre-assigned values to connect data instantiations in data models with constituents. The main contribution of the model-based approach becomes therefore the *unambiguous definition of model-based transactionals* for definition purposes as well as for migration and implementation purposes.

C2LG is doctrine driven and supports machines and humans in various phases of the military decision process. C2LG derives constituents following a linguistic-engineering approach. C2LG is not constraint by implementation details of C2 systems, but is based on the evaluation of doctrine and results in a *formal language that specifies sentences and constituents* derived from operational needs.

By merging both approaches a doctrine driven method supported by state-of-the-art linguistic-engineering solutions defines implementation independent constituents that are mapped to machine interpretable transactionals of a CRM.

- The mapping of immediate interest to the C-BML PDG is the use of transactionals based on the JC3IEDM for the unambiguous definition of constituents of the C-BML as proposed by C2LG resulting from operational evaluations. This mapping also results in pre-populated schemas that make the implementation efficient, as overhead and verbose re-definitions are avoided.
- It is worth mentioning that mapping to other data models can be supported as well to facilitate the system specific implementation of C-BML interfaces.
- While C2LG defines the sentences of C-BML unambiguously (grammar and constituents), MBDE defines the words unambiguously (constituents and transactionals), using JC3IEDM as the CRM for C-BML definitions as requested by the product nomination.

The authors hope that the suggested harmonization of the approaches will support the standardization progress for C-BML under the leadership of SISO. This recommendation preserves the advantages of both approaches under discussion. It preserves the structure of BML expressions as suggested by the doctrine-based approach because this structure is the one used in the field for formulating orders and reports. The standard would also preserve the ability to exchange information among systems using a JC3IEDM data base as granted by the model-based approach. In addition, the MBDE provides means that allows for incorporation doctrine motivated changes into the JC3IEDM.

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