

A Methodology for Doctrine in Modeling and Simulation: Battle Management Language (BML) and the Mission to Means Framework (MMF)

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ABSTRACT: *In collaboration with the US Army and selected US Naval and US Air Force projects, the Defense Modeling and Simulation Office developed the Missions and Means Framework (MMF – a framework for explicitly specifying the military mission and quantitatively evaluating the mission utility of alternative warfighting Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) services and products.. The MMF provides a disciplined, repeatable procedure for explicitly specifying the mission and assessing mission accomplishment. Its “mission statement and assessment” procedure accounts for the tangible, physical objectively measurable factors (traditional Testing & Evaluation) as well as the intangible, cognitive ultimately subjective factors (traditional warfighter expertise) that constitute mission success.*

An essential part of the MMF is the ability to perform studies and analysis based on doctrinally correct missions. Battle Management Language (BML) provides an explicit task description of these missions, These missions can be derived from actual operational sources with BML and represented in a detailed format appropriate for simulating operations for the MMF.

This paper describes both how BML can be used to enable the MMF, particularly in the area of simulating operations. The MMF provides a robust mission decomposition methodology, which conceptually can supply BML with a doctrinal foundation. In that BML has been developed to address Command and Control (C2) to Simulation interoperability problems, this paper gives a case study in how interoperability solutions can be used in various applications.

1 Introduction

The Mission to Means Framework (MMF) is an emerging analysis methodology driven by operational requirements [8]. It is unique in that it can measure the contribution of Command and Control technology as compared to traditional capabilities of weapons systems and units. Integral to the deployment of the MMF is to develop a simulation infrastructure that supports the MMF.

While multiple simulations will eventually support the MMF, there must be a common representation of C2

that is consistent with the MMF methodology. The MMF analysis starts with a “mission”. This mission is decomposed. If a simulation will be employed to execute the resulting decomposed missions, it must utilize “executable” task descriptions to obtain proper unit behavior.

BML is being developed [1] as an unambiguous language used to

- command and control forces and equipment conducting military operations and,
- provide for situational awareness and a shared, common operational picture.

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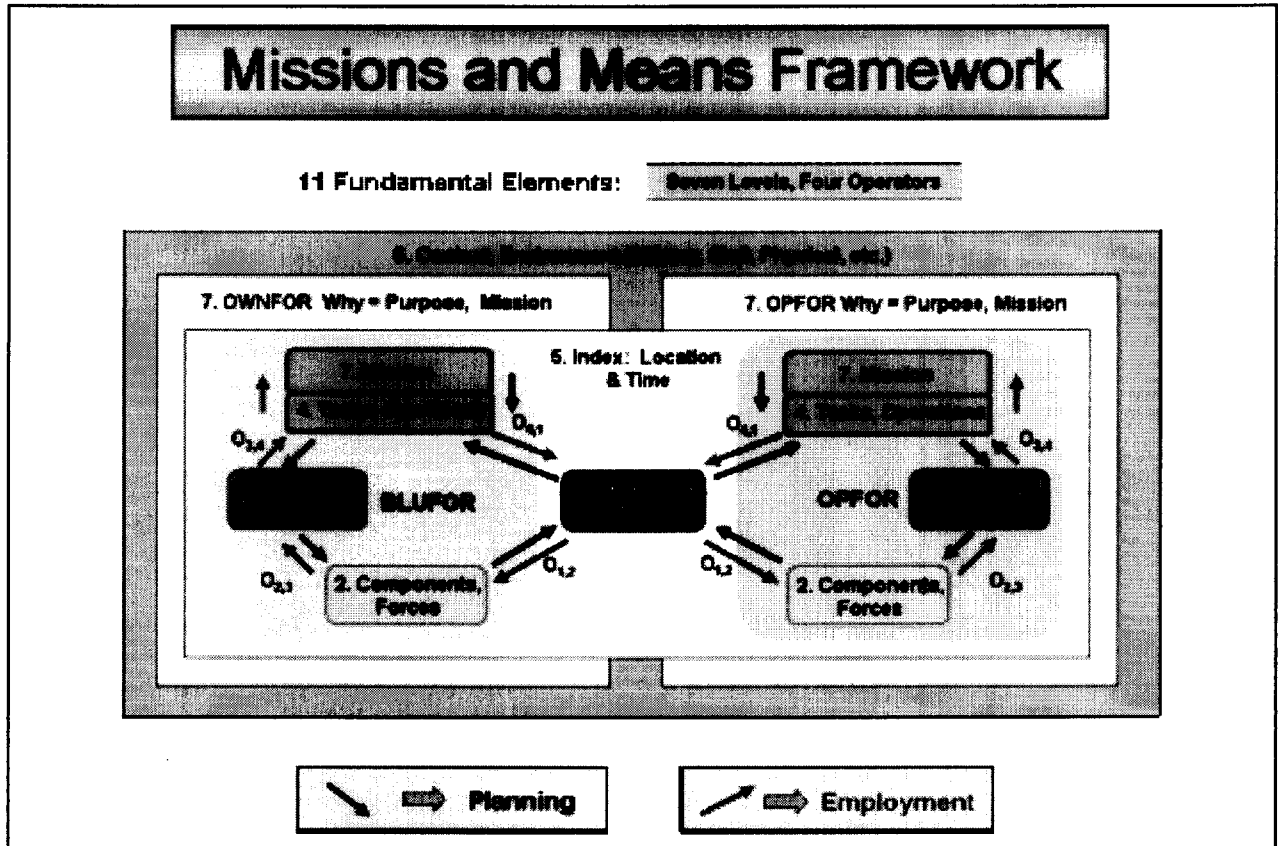


Figure 1: Mission to Means Framework

It can be seen as a standard representation of the “digitized commanders intent” to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding.

A prototypical implementation of a BML was developed and demonstrated at the beginning of 2003. While the first prototype was U.S. Army centric, an initiative under the Extensible M&S Framework (XMSF) is currently transforming the BML prototype into a Joint and Coalition solution based on open standards. This second prototype demonstrates a Web enabled or Extensible Battle Management Language (XBML) “extended” by applying the concepts of the XMSF. In addition, air operations will be added to the XBML prototype. The end state for XBML will be a methodology for developing standard doctrinal terms and allowing these to be accessed as Web services. In the future Global Information Grid (GIG), each Service could have its own “BML” web service, linked to a Joint overarching BML.

A BML study group has just been formed to deal with various standardization issues, including devising a “Coalition Battle Management Language (CBML).”

This paper will describe both MMF and BML and relate the two. The MMF is an analysis framework very relevant to C2 interoperability and Simulation interoperability BML is an enabling technology. Considering both MMF and BML together illustrates and brings out the current state of the art in both modeling C2 and developing interfaces to operational systems .

2 Mission to Means Framework

MMF is more fully described in [2, 8].

“The Missions and Means Framework (MMF) uses 11 fundamental elements to organize and specify military operations. As shown in Figure 1, mission content is organized into seven groups (hereafter called Levels):

- Level-7. Purpose, Mission
- Level-6. Context, Environment
- Level-5. Index, Location/Time
- Level-4. Tasks, Operations
- Level-3. Functions, Capabilities

Level-2. Components, Forces

Level 1. Interactions, Effects

In addition, the following four transformations (hereafter called Operators) are included:

O1,2x: transforms Level-1 interaction specifications into Level-2 component states.

O2,3x: transforms Level-2 component states into Level-3 functional performance.

O3,4x: transforms Level-3 functional performance into Level-4 task effectiveness.

O4,1x: transforms Level-4 task sequences into Level-1 interaction conditions.

Also shown in Figure 1 is the MMF's multi-sided nature. The OPFOR coalition influences the outcome of OWNFOR's mission prosecution. The MMF is a symmetric representation of an asymmetric (perhaps decidedly asymmetric) conflict.

Level-7 specifies the overall mission and its' purpose as assigned to the commander. It is associated with the Level-6 Environment and Context and Level-5 Location/Time Index specification packages, which collectively represents the "Missions" part of the MMF. Level-1 through Level-4 and the four Operators are collectively the "Means" by which Missions are accomplished (hence, the name Missions and Means Framework).

BML primarily provides interoperability for the MMF Level 7, as will be described below.

2.1 Layered Decomposition

The MMF uses a layered decomposition. Recommended practices are as follows: **Level-4 Tasks, Operations** should be layered by the **Universal Joint Task List (UJTL)** level-of-war (Figure 2). This is the same depiction as formulated in recent BML Papers (SIW 113), except that it is focused on the higher levels. **Level-2 Components, Forces** should be layered by echelons, again consistent with BML. **Level-3 Functions, Capabilities** layers are designed to provide efficient interfaces for the O_{2,3}E and O_{3,4}E execution. **Level-1 Interactions, Effects** layers are designed to provide efficient interfaces for O_{4,1}E and O_{1,2}E execution. BML is current using the Command and Control Information Exchange Data Model (C2IEDM) to represent this information.

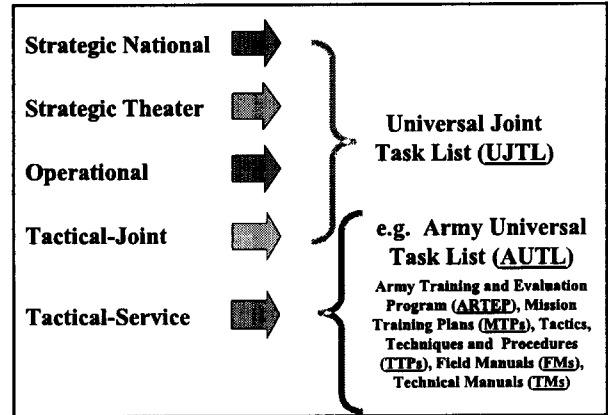


Figure 2. Task Semantics by Level of War

2.2 Mission, System, and Solutions Analysis

Evaluation of a system or System of Systems (SoS) using MMF is accomplished using a capabilities-based evaluation where the materiel solution, when combined with doctrine, training, leadership, organization, personnel, and facilities (Figure 4), provides a set of capabilities that enables the warfighter to perform critical tasks, in support of accomplishing a mission. The capabilities-based approach provides the means to organize the concepts, focus the evaluation on what is most important, and provide a framework for consolidating all of the information to determine the totality of what the system or SoS can bring to the problem and, ultimately to the Joint fight.

The two-sided missions and means framework provides a structured way to describe key elements of military operations that are essential to understand in order to successfully model and simulate those operations. The framework provides the necessary structure to support a disciplined, repeatable procedure to explicitly specify the mission and assess mission accomplishment. Used in conjunction with automated knowledge acquisition and integration tools such as JTIMS, the MMF framework supports the operator's ability to capture the products of key portions of the top - down planning and decision making process in data element form, rather than just text and graphics, whether manually generated or machine generated.

The use of the MMF in support of a project or evaluation enables the development of performance metrics that can be used to evaluate the system or SoS and is based on analysis of tasks in the mission context. The tasks are those identified in the Universal Joint Task List (UJTL) (CJCSM 3500.04C (2002)), Service Task Lists (STL - AUTL, UNTL, AFTL, MCTL (draft)), and, as required, mission training plans. This provides for analysis based on Service and Joint approved databases and as necessary, approved

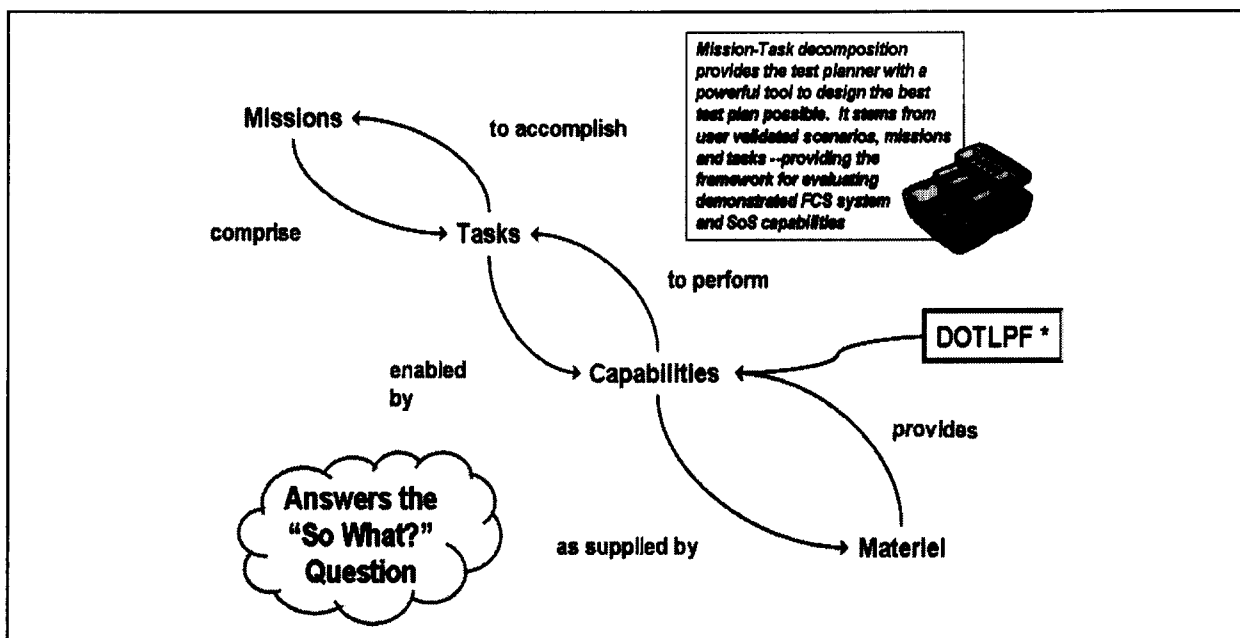


Figure 3: MMF use

mission templates and Mission Essential Task Lists. This process therefore is also compatible with and complements the *Joint Capabilities Integration and Development System (JCIDS – CJCSI 3170.01D)*. As a specification is developed, we expect that BML will substantially contribute to these task descriptions.

The goal of the use of MMF is a single, consistent list, mapping missions (tasks) to system capabilities, usable and useful to all stakeholders. As illustrated by Figure 3, the missions to tasks decomposition uses the same approach as warfighter planning and ultimately generates materiel needed for training (or other) products. It allows the end user to unambiguously explain in their vernacular how capabilities enable tasks and provide valuable, explicit rather than implicit, insights to the acquisition community. Knowing what materiel is the source of the capabilities also helps to test design efficiency for the evaluation and training communities. One does not have to prove the materiel's ability to enable every task; once a capability is proven, the mapping of capabilities to tasks illustrates those tasks that are enabled and how and where materiel properly contributes to mission success. With the use of MMF, all stakeholders have the opportunity to know the standards to which tasks must be accomplished, assisting in driving appropriate performance requirements to ensure materiel provides capabilities in an operationally realistic environment.

3 Battle Management Language

BML supports complete and unambiguous specification of C2 information, directly linked to doctrine. BML must represent doctrine, identify appropriate doctrinal sources, elaborate doctrine into a standardized authoritative representation, and specify the rules for how the representation communicates information. This is all complementary to the MMF.

BML is more fully described in [1,4,5]

To accomplish this, the BML must incorporate doctrinal terms, graphics, tactics, etc. in a form that allows the intricate relationships of these abstract concepts to be linked to the physical aspects of the warfighter's environment (organizations, features, persons, facilities, and materiel). The representation must include the necessary entities along with well-defined relationships. This then allows the basic vocabulary, semantics and syntax to be unambiguously defined as well as related to each other in a methodology. This implies developing structured message formats that can be parsed into existing and future operational messages as well as formats that communicate with simulations.

BML must blend structure that allows automation of the language, and ease of use for the military professional. It should not be a radical change from the language the commander and staff currently use, but instead an evolution that provides a means to gain structure while remaining transparent to the user. It

must be based on doctrine and linked to the doctrinal sources, both to ensure standard use/understanding, and to foster concise and precise use of the language. The technology components of BML must support the “train as you fight” concept and therefore exist in a single format, at least as far as the military professional user is concerned. The output of the automated system is dependent on whether the intended audience is a human, a software “intelligent agent” or a autonomous robot.

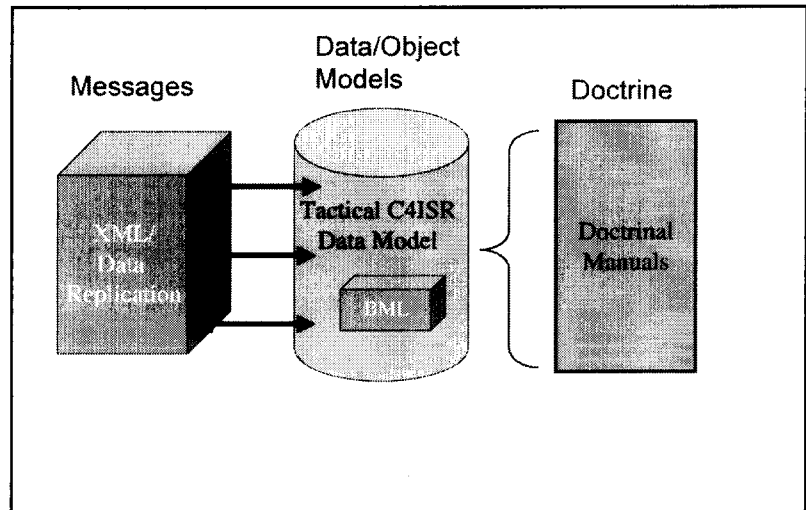


Figure 4: BML Concept

This is an abstract concept of what BML should be. However, BML is intended, once developed, to be implemented to support C2 mission applications. BML is being built based upon work that has gone before, EAGLE BML and CCSIL [6, 7].

Figure 4 shows graphically our BML implementation concept. This consists of:

- A C2 Database (used by a C2 application). BML must be imbedded and integrated into the C2 Database.
- A Doctrine Repository, with doctrine accessible to the C2 application. The more strongly the BML terms are tied to how live forces are trained and employed will enable how well BML will perform.
- A technology to disseminate BML terms from the Doctrine Repository and a technology for exchanging BML messages.

implementation of BML.

Several advantages result from this approach.

- Building the vocabulary into the database focuses on the semantic level and leaves room for alternative implementations on the lower levels of interoperability, such as using Internet technologies utilizing XML tag sets.
- The terms, as they are used in messages, can be linked to their doctrinal definitions to assist users (senders and receivers) in understanding the precise intent of the author. This can be extremely helpful in those areas where a term has multiple definitions or there are subtle differences in the meanings of different terms.
- As efforts continue to align the data models

Figure 5 shows the scope of the BML methodology. This paper shows how BML can be extended from a service specific implementation to an approach linking coalition, joint and service elements. It is important to note that there may be different BML “dialects”. A populated BML for the Army will be different from a populated BML for the Air Force due to the difference in how they employ their forces. But the way that a BML language is constructed must be standard so BML information can be exchanged and understood.

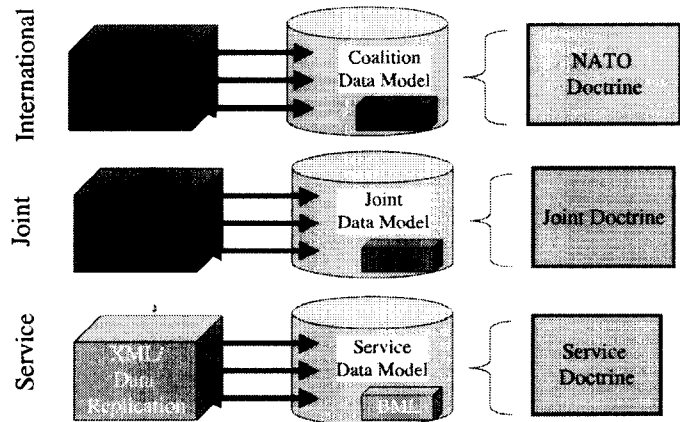


Figure 5: BML Methodology

A key aspect of BML is that with the vocabulary and its associated relationships built into a database, Graphical User Interfaces (GUI) and other applications can be constructed that allow

between simulations and C2 systems, this approach, since it involves building BML into the Data Model, will lead to better alignment/adoption of a single BML for both domains.

- Ensuring that the database includes the graphics as well as the terms will assist in transitioning from course of action development and analysis tools linked to the database to producing the operations order. It enables this as either an auto fill of structured formatted messages, or as a GUI-based representation of the current situation and operational objectives.

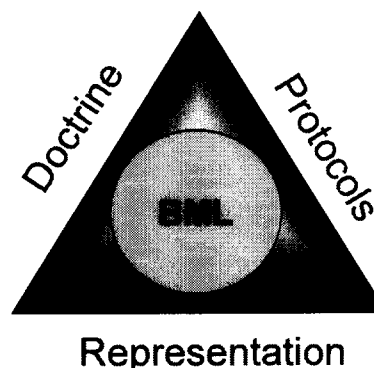


Figure 6: BML Views

4 Utilizing BML in the MMF

BML can be seen to consist of three views: a doctrine view, a representation view, and a protocol view. This is shown in Figure 6. In this case, the doctrine view is particularly relevant, as it forms the link to the MMF and Level 7 – the Purpose/Mission.

4.1 BML – Doctrine View

Every term used within BML must be unambiguously defined and must be rooted in doctrine. In other words, the doctrine view must be a dictionary comprising the term and its unambiguous definition as well as the source of this definition.

So far, the U.S. Army's new Field Manual 1-02 was used to augment the term definitions of the C2IEDM definitions. In addition, the Air Tasking Order (ATO) and Air Coordination Order (ACO) as used within the U.S. are analyzed and used to obtain the most current definitions. The general military dictionaries Joint Publication 1-02 and the AAP 6 contribute more terms. One idea that should be taken into consideration is the use of references to synonyms and homonyms of a term as well as a reference for languages other than English to facilitate coalition operations across language borders.

4.2 BML Integration into the MMF

As the MMF is being developed, there is also much work in Mission Decomposition that could form the basis for the BML standard in various areas (Land, Sea, Air, etc.). The MMF is developing various specifications, which should be complementary to BML. Some of these specifications, such as the Functional Description of the Battlespace (FDMS) [3] are very similar, but not focused towards executable tasks.

In the area of C2 Modeling and Analysis, both BML and the MMF are unique in their use and recognition of doctrine as an essential element.

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JOHN KEARLEY is a Program Manager at Dynamics Research Corporation (DRC) for several requirements analysis and training programs. He is the PM for Application of the Mission and Means Framework to develop Joint Training Requirements at the US Joint Forces Command (USJFCOM) Joint National Training Capability Joint Management Office (JNTC JMO), for the Universal Naval Task List at the Navy Warfare Development Command, and for Navy Mission Essential Task List (NMETL) support to Commander, Fleet Forces Command (CFFC). He retired from the US Navy after twenty-six years, serving as a Surface Warfare Officer in command-at-sea and on the Atlantic Fleet, operational, and type commander staffs. He is a graduate of the US Naval Academy and also holds a MBA from Old Dominion University.