NATO MSG-048 C-BML Final Report Summary

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ABSTRACT: *The NATO Modeling and Simulation Group Technical Activity 48 (MSG-048) was chartered in 2006 to investigate the potential of a Coalition Battle Management Language for multinational and NATO interoperation of command and control systems with simulation systems. Its work in defining and demonstrating a basic capability for this purpose has been reported in previous SIW papers. This paper addresses Phase 3 of the Technical Activity, which validated the BML paradigm by interoperation of multiple C2 and simulation systems in experimental support of operational military users. The new capability was the basis for a week-long event at Manassas, Virginia in November 2009, which was supported by a previous collaborative integration using the Internet. The experimental configuration combined six national C2 systems and five national simulations along with middleware from two other nations, including an updated BML server that implements the publish/subscribe paradigm for BML and a C2 Lexical Grammar interface that was used by several nations. BML provided a common C2-simulation linkage without humans in the information exchange loop. This paper describes the integration of national C2 and simulation systems, along with the successes and lessons learned. The results support further development of the BML concept and should inform the work of the SISO C-BML Product Development Group. We conclude with a projection of the work of MSG-085, the successor to MSG-048, which will focus on operational and standardization issues.*

1. Introduction

Requirements for interfacing C2, simulation and robotic systems have been established for nearly a decade [1]. Simulation-to-simulation standards such as Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) have been developed by standards organizations including the *Simulation Interoperability Standards Organization* (SISO). In parallel, the *Multinational Interoperability Programme* (MIP) has elaborated the Joint Consultation Command and Control Information Exchange Data Model (JC3IEDM) for the exchange of military information across C2 systems. However, there has been relatively little work toward the development of standards for ensuring interoperability between C2, simulation and robotic systems. Consequently, many application specific interfaces have been developed and maintained. In many instances, additional simulation operators are required to pass data manually from one system to another.

To address the need for standardizing information exchange among C2, simulation and robotic systems (see figure 3) SISO formed the Coalition Battle

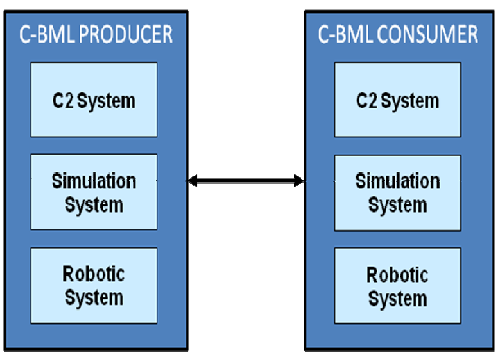

Figure 1 – C-BML Producers/Consumers

Management Language Study Group in 2004, which led to the formation of the C-BML Product Development Group (PDG) in 2006. Initially, the PDG indicated the Command and Control Information Exchange Data Model (C2IEDM) – predecessor of the JC3IEDM – as the underlying data model upon which C-BML would be based.

Figure 3 presents the relationship of C-BML to existing standards for C2-C2 such as the JC3IEDM and standardized message formats such as the Allied Data Publication 3 (ADatP-3) and C2-robotic system interoperability standards such as the Joint Architecture for Unmanned Systems[1] (JAUS) and STANAG 4586.

[1] http://www.openjaus.com/support/jaus-documents

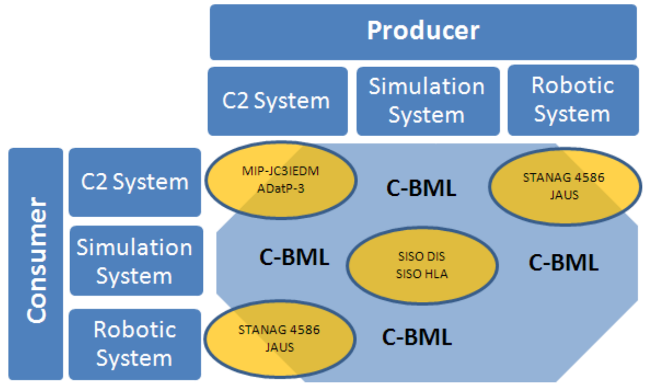

Figure 2- C-BML relationship to other Standards

As depicted in figure 3, the C-BML Information Exchange Structure & Content Specification defines a set of digitized expressions that represent military information such as orders, plans, requests and reports.

The C-BML Services Specification specifies requirements for exchanging these expressions across systems.

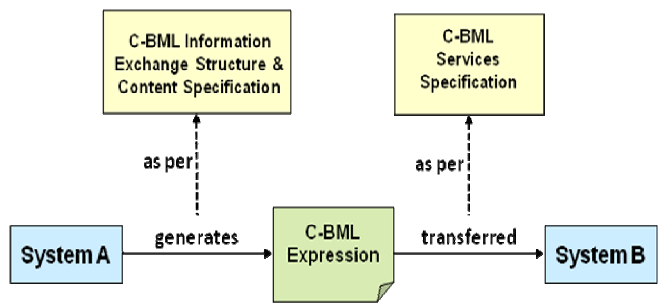

Figure 3 - SISO C-BML Specification Overview [14]

1.1. MSG-048 (C-BML) Technical Activity Overview

The primary objective as stated in the initial Technical Activity Proposal (TAP) [8] and subsequent Program Of Work (POW) was to evaluate the available specification of a Coalition BML (from Simulation Interoperability Standards Organization (SISO) or Nations)[2] and to assess operational benefits to C2 and M&S communities. A further objective stated in the POW was to recommend a C-BML specification for standardization consideration by NATO. This led to work conducted in the following main areas:

1) *Establish requirements for the C-BML standard*

[2] Since a SISO C-BML specification or implementation was not available at the time the experimentation work was conducted, the MSG-048 utilized a version of BML based on contributions from nations such as the Command & Control Lexical Grammar (C2LG) [5] and the Joint Battle Management Language (JBML) [9].

2) *Assess the usefulness and applicability of C-BML in support of coalition operations through experimentation and*
3) *Educate and inform the C-BML stakeholders concerning the results and findings of the group.*

This paper summarizes the main points and conclusions presented in the MSG-048 Technical Activity (TA) Final Report [2] [3]. The organization of this document is based on the work areas described above. After a description of C-BML, some of the driving requirements for C-BML are discussed. Then, an overview of the experimentation programme is presented, including the associated lessons learned. This is followed by a summary of the MSG-079 C-BML Workshop and the final TA recommendations.


```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<OrderPush>
  <OrderPush>
    <Task>
      <AirTask>
        <TaskeeWho>
          <UnitID>CA-UAV</UnitID>
        </TaskeeWho>
        <What>
          <WhatCode>CLARSP</WhatCode>
        </What>
        <Where>
          <WhereID>14010000784100000427</WhereID>
          ...
           GENCOORDINATE
          ...
           <WhereLocation>
              <GDC>
                  <Latitude>40.062195</Latitude>
                  <Longitude>47.57694</Longitude>
                 <ElevationAGL>3000.0</ElevationAGL>
              </GDC>
           </WhereLocation>
         ...
         </Where>
        <StartWhen>
          <WhenTime>
            <StartTimeQualifier>AT</StartTimeQualifier>
            <DateTime>20091022141229.359</DateTime>
          </WhenTime>
        </StartWhen>
        <AffectedWho><UnitID>OMF195-B12</UnitID>  </AffectedWho>
        <TaskID>14099999000000000019</TaskID>
      </AirTask>
    </Task>
 <OrderIssuedWhen>20091022141443.000</OrderIssuedWhen>
 <OrderID>14099999000000000030</OrderID>
   <TaskerWho>        <UnitID> 1-HBCT  </UnitID>   </TaskerWho>
    ...
   <TaskOrganization>  <UnitID> CA-UAV </UnitID>  </TaskOrganization>
   </TaskOrganization>
  </OrderPush>
</OrderPush>
```


Figure 4 – Example BML Expression - Order [3]

2. C-BML Description

C-BML previously has been described in terms of complimentary views: doctrine, representation and protocol [4]. The "doctrine" view refers to the military knowledge and wisdom concerning how to conduct military operations. Consistent with figure 3, the "representation" view deals with the set of elements required to construct the expressions that are consistent with doctrine while the "protocol" view deals with how expressions are transported and exchanged by systems.

Constructing expressions requires a set of *production rules* provided by a grammar. See references [5][6] for discussions on the use of formal grammars for generating computable C-BML expressions. The 5W-paradigm (*who-what-where-when-why*) forms the foundation for C2LG which in return provided the basis for definition of the BML[3] expressions that were generated and exchanged during the MSG-048 experimentation events.


```xml
<?xml version="1.0" encoding="UTF-8"?>
<BMLReport>
  <Report>
    <CategoryOfReport/>
    <TypeOfReport/>
    <StatusReport>
      <GeneralStatusReport>
        <ReporterWho>
          <UnitID>FRA-6611</UnitID>
        </ReporterWho>
        <Context>MyContext</Context>
        <Hostility>FR</Hostility>
        <Executer>
          <Taskee>
            <UnitID>FRA-6611</UnitID>
          </Taskee>
        </Executer>
        <OpStatus>OPR</OpStatus>
        <WhereLocation>
          <GDC>
            <Latitude>40.600643157959</Latitude>
            <Longitude>46.8854713439941</Longitude>
          </GDC>
        </WhereLocation>
        <When>20090814030514.977</When>
        <ReportID>7</ReportID>
        <Credibility>
          <Source>AOBSR</Source>
          <Reliability>A</Reliability>
          <Certainty>RPTFCT</Certainty>
        </Credibility>
      </GeneralStatusReport>
    </StatusReport>
  </Report>
</BMLReport>
```


Figure 5 – Example BML Expression - Report [3]

2.1. BML Examples

This section describes some example expressions, similar to those used during the MSG-048 2009 Experimentation Event. These expressions are intended solely for the purposes of illustrating the basic constructs and information elements that comprise BML

[3] In this paper, the term BML makes reference to the general class of Battle Management Languages and does not indicate the use of the C-BML standard being developed by SISO.

expressions and are based on the simplified schema that was utilized for the purposes of the experimentation event.

In figure 4 an example BML expression illustrates the use of the 5Ws. In this example, the expression represents a FRAGO issued to a MALE UAV following a request for Close Air Support. The Ws are highlighted in yellow. Figure 5 is an example of a *General Status Report* and includes information concerning the reporting unit, the unit being reported on, time when that report was made and details concerning the report *pedigree* (e.g. credibility, reliability, certainty...).

2.2. C-BML Characteristics

The C-BML language defines a set of valid, parsable, unambiguous expressions that can be exchanged among C2, simulation and robotic systems. It cannot be assumed that free-text and annotations will be interpreted correctly by these systems. The following sections highlight some of the characteristics and requirements that define and describe C-BML.

2.2.1. Common Interface

C-BML should allow for C2, simulation and robotic systems to utilize a common interface for the exchange of expressions.

2.2.2. Expressiveness

C-BML must support the expression of all relevant actions to be performed by real, simulated or robotic forces that receives those expressions. This includes the capability to express the NATO 5-paragraph Operational Order (OPORD) [7] and tactical messages.

2.2.3. Unambiguous and Parsable

The unambiguous nature of C-BML expressions allows for a mathematical representation that supports automated processing of information. Ensuring that C-BML expressions are parsable will allow for reducing the need for human intervention (e.g. the swivel-chair).

3. C-BML Benefits

This section presents some of the expected benefits of employing a C-BML-enabled approach across the military enterprise.

3.1. C2 Application Domains

Figure 6 groups military activities or use-cases into a set of command and control application domains. C-BML-enabled capabilities could be employed to varying extents in support of virtually all of these application domains. Perhaps one of the most obvious and arguably more easily achievable use-cases are those involving training and mission rehearsal since many training systems already utilize simulation technologies and in many instances have already started address interfacing issues. In support of actual operations, mission planning, Decision Support Systems (DSS), and Situation Awareness (SA) capabilities also could benefit from common interface and computability offered by C-BML.

Figure 6- Command & Control Application Domains [3]

3.2. C2 System Product Life-Cycle & Workflows

Figure 7 presents the use-cases and application domains

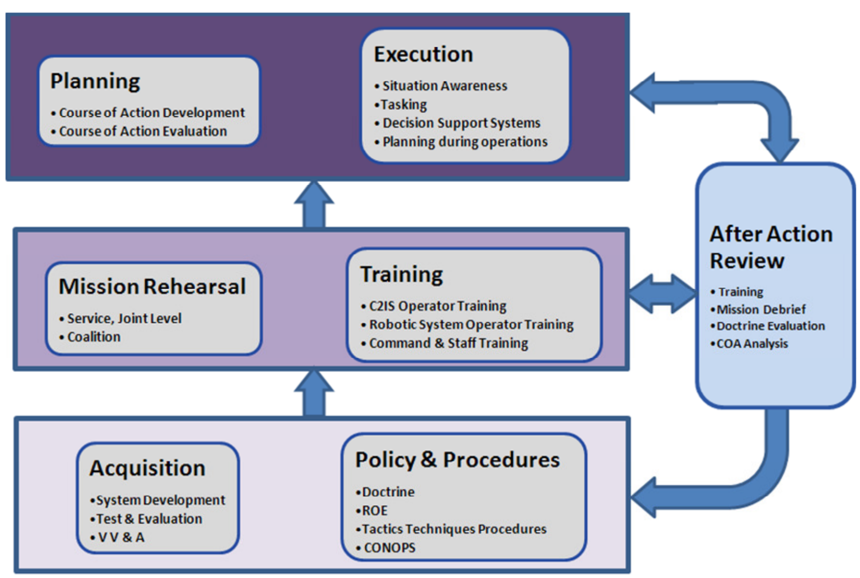

Figure 7- C2IS Product Life-Cycle & Workflows [3]

from the previous figure in the context of a generic C2 system product life-cycle. The three layers represent: (1) Acquisition (2) Training and (3) Mission Execution, respectively. Note that After Action Review (AAR) is shown here as a cross-cutting application domain since it can be used in support of the three types of activities for:

- Reviewing operations in theater
- Evaluating trainee proficiency or exercise results during training scenarios
- Developing C2 systems and assisting policy and procedure makers to make use of experience and lessons learned in theater and also, in some instances, modifying doctrine and/or rules of engagement, as required.

C-BML-enabled capabilities could be useful in the acquisition process in general, for example, in the inception of next-generation C2 systems involving higher levels of automation and autonomy.

4. Requirements for C-BML

Part of the MSG-048 TA resulted in the internal Substantiation of Requirements Report [10]. This report, along with the requirements that were elaborated during the execution of the experimentation program, form the basis for the requirements presented below. These requirements are broken down into operational and technical considerations.

4.1. Operational Considerations

4.1.1. Multiple-doctrine, Multi-Force, Multi-Service

C-BML will need to support multiple doctrines: across services and across nations. C-BML will also need to support multi-national force and coalition operations.

4.1.2. Multiple Domains

In addition to land-based operations, C-BML also will need to support air, maritime and joint operations. Currently, the JC3IEDM has been mandated as the underlying data model for C-BML by the SISO PDG. JC3IEDM has its origins in the area of land operations. However, if C-BML is to be adopted by a broader community then there are also requirements to ensure that the expressiveness of C-BML is sufficient to construct the necessary set of expressions used non-JC3IEDM based systems.

For example, the NATO Integrated Command and Control[4] (ICC) System has been developed for the NATO Combined Air Operations Centre (CAOC). This system utilizes the Allied Data Publication 3 (ADatP-3) to generate Air Task Orders (ATO) and Airspace Coordination Orders (ACO) that can be shared with other systems such as Global Command and Control System–Joint[5] (GCCS-J) that utilizes Over the Horizon-Gold (OTH-Gold) message types, often employed in the maritime domain.

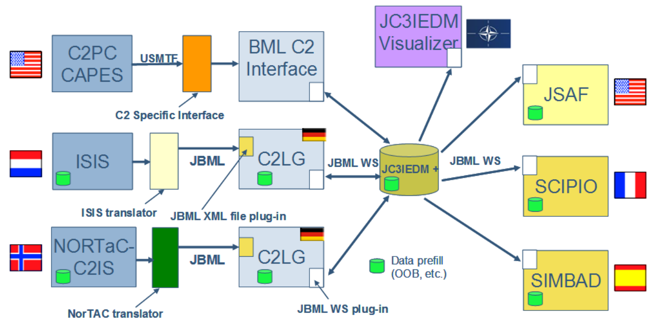

Figure 8 - 2007 Demonstration Overview [3]

It is essential that requirements to support systems from other domains are also considered when developing the C-BML standard.

4.1.3. Types of Expressions

In general, it is agreed that C-BML will specify a set of production rules for generating military expressions such as Orders, Reports and Requests. More specifically, support will be required for 5-paragraph Land Forces OPORDs, WARNOs, FRAGOs, Naval OPORD [7] as well as ATO/ACO will need to be expressible as per ADatP-3, standardized under STANAG 5500 [13].

A large number of report types must also be supported, including the following categories of reports: intelligence (INTREP), situation reports (SITREP), status reports (STATREP) and others. A detailed list of the reports is out of the scope of this document.

Other information elements that C-BML will need to support include Rules of Engagement (ROE), Order of Battle (ORBAT), Task Organization (TASKORG) weapons and sensor performance, logistics data, geospatial and cultural data and communications infrastructure data.

4.2. Technical Considerations

This section discusses some of the technical requirements associated with constructing, exchanging and storing C-BML expressions. For a more detailed discussion, see references [3][10]. In some instances, the

[4] http://jitc.fhu.disa.mil/gccsiop/interfaces/icc.pdf

[5] www.dtic.mil/cjcs_directives/cdata/unlimit/3151_01.pdf

requirements go beyond the scope of the standard and address C-BML messaging infrastructure functionality.

One of the underlying assumptions concerning C-BML is that it can be implemented using a Service-Oriented Architecture (SOA) approach [12] and will support network-centric operations and network-enabled capabilities such as the NATO Network-Enabled Capability[6] (NNEC).

4.2.1. C-BML Language Requirements

Consistent with NATO's adoption of XML as part of the standardized message formats for military information exchange, C-BML should be XML-based [13].

The C-BML language should be independent of Information Exchange Mechanisms (IEM).

C-BML is required to be computable and must therefore be based on a formal grammar.

4.2.2. C-BML Service Requirements

Services that will support the exchange of C-BML expressions must include basic support for the following:

- Validation
- Acknowledgement
- Error-handling

Additional support may be required for:

- Storage of C-BML expressions
- Filtering/Notification mechanisms

4.2.3. System Initialization

As specified by the C-BML PDG activity, initialization of simulation systems is to be accomplished using the Military Scenario Definition Language (MSDL) [14].

In the context of training exercises, initialization of C2 systems may also be required. Similarly, the start-up procedure of a BML-enabled architecture requires coordination and procedures.

5. MSG-048 Experimentation Programme

The MSG-048 Experimentation Programme was comprised of two demonstrations in 2007 and 2008 and a final experimentation event in 2009.

5.1. 2007 Demonstration Overview

The 2007 demonstration took place at I/ITSEC[7] where six nations (DEU, ESP, FRA, NLD, NOR, USA) demonstrated the promise of using C-BML for tasking and supported the issuing of orders by C2 systems to constructive simulations, as shown in figure .

5.2. 2008 Demonstration Overview

The 2008 demonstration, shown in figure , built upon the 2007 demonstration by adding the capability of the simulations to send reports back to the C2 systems and introduced an air component, controlled via ICC, and an additional simulation [3].

5.3. 2009 Experimentation Overview

Unlike the 2007 and 2008 demonstrations, the 2009 experimentation event shown in figure 10 was conducted with active and retired military personnel and involved participation of eight nations (CAN, DEU, FRA, GBR, NLD, NOR, USA). The goal of this event was to expose military end-users to an integrated C-BML-enabled capability and to record their feedback concerning the usefulness and efficiency of the approach.

Compared to the 2008 demonstration, this event added a new element in the form of a Canadian UAV simulation,

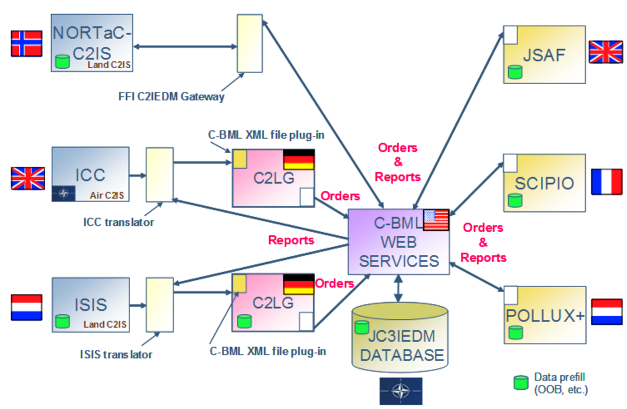

Figure 9 - 2008 Demonstration Overview [9]

which displayed some characteristics of a robotic element. The event included three vignettes for training, mission rehearsal and planning. Despite the technical

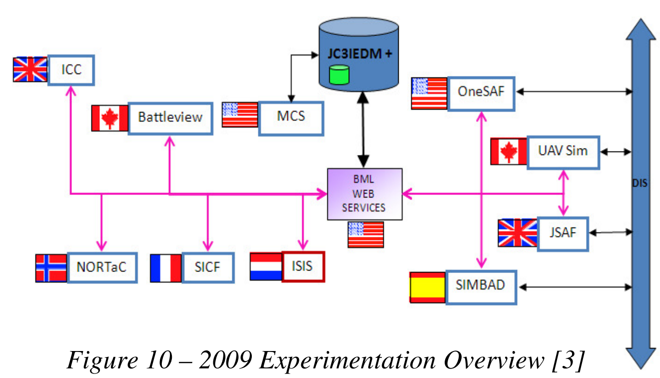

Figure 10 – 2009 Experimentation Overview [3]

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[6] https://transnet.act.**nato**.int/WISE/Informatio

[7] Interservice/Industry Training, Simulation and Education Conference and Exhibition

challenges involved in integrating a large number of systems and processing large numbers of transactions, the capability demonstrated the great potential for using C-BML for effective C2-simulation interoperability for military applications.

The results of this event form the basis for many of the lessons learned and recommendations presented in the following sections.

5.4. MSG-079 (C-BML) Workshop

The MSG-048 Committee organized a workshop that took place in Farnborough UK in February 2010. This event was attended by approximately 60 participants from 12 nations representing industry, government and academia. In addition to 3 keynote presentations, 25 presentations were made covering a wide range of C-BML-related topics, as shown in

.

Numerous discussions took place between presentations and fuelled a healthy debate concerning the future of C-BML and the steps that need to be taken to take the C-BML technology to a level of maturity consistent with operational deployment. The recommendations from the Workshop Technical Evaluator have been integrated into the MSG-048 Final Report and are presented in the following section.

Table 1- MSG-079 C-BML Workshop Sessions

Day 1 - Feb 24th 2010	Day 2 – Feb 25th 2010
BML Operational Requirements	Perspectives on BML
MSG-048 (C-BML) Overview	C2-Simulation Interoperability
BML in Theory and Practice	JC3IEDM and BML
BML Coalition Developments	Other BML Research Activities

6. Lessons Learned

This section describes some of the lessons learned from the MSG-048 activities.

6.1. Technical Lessons Learned

6.1.1. C-BML Procedures and Agreements

During the experimentation, the need for various procedures and agreements was found to be necessary for the configuration, start-up and actual exchange of C-BML expressions, including:

- Procedures for correct handling of different classes of orders.
- Procedures to control overall reporting rate to a number established by needs of the application. This is due to the fact that the simulations can produce output at rates higher than the C2 systems and server can support.
- Technical agreements for critical system parameters be established early and adhered to.
- Technical Agreements for validation of Critical system components.

6.1.2. Exchange of C-BML Expressions

The following lessons learned can be noted concerning the exchange of C-BML expressions:

- For faster-than-real-time simulation, message delivery rate from simulations should be independent of simulation speedup in order to avoid overloading C2 systems and server.
- Bundling of reports is a useful mechanism.
- Mechanisms are needed for synchronization, traceability, and debugging of all system components.
- The server should have a mode that is capable of validating all transaction messages.
- The variety of architectures possible under BML can be expected to lead to a range of communication needs; as message rate increases, a notification service or publish/subscribe capability becomes important.
- Timely report delivery is important to a Common Operating Picture; infrastructure to achieve this should also provide for filtering reports by rate and content.
- The C2LG grammar and JC3IEDM database were valuable for constructing and storing expressions, respectively.

6.1.3. Experimentation Management

During the course of the experimentation activity, several useful and innovative approaches were applied to the process of development and testing of the experimentation capability. The following lessons learned can be noted:

- Collaborative Internet meetings and testing were important to effective system development; a shared repository and synchronous Internet audiographic conferencing were key enablers.
- Distributed development can work well but it requires a centralized System Engineer to function as a “Technical Group Secretary” to maintain a single point of technical coordination and maintain a coordinated development schedule.

6.2. Operational Assessment

- BML was endorsed by all SMEs as valuable for training, mission rehearsal and analysis of plans; a

BML STANAG should be developed, after more experimentation.

- Further experimentation with BML is required and could be improved by some changes: capabilities for coordinating tasks, more staff role players, and a simpler scenario.
- Ideally, all participants should use their own national C2 and simulation systems.

7. Recommendations

This section presents recommendations from the following sources: (1) from the MSG-079 C-BML Workshop Technical Evaluation Report and (2) the recommendations based on the lessons learned as described in the MSG-048 Final Report. In some instances, mention is made of the follow-on activity, MSG-085, since the latter Technical Activity was approved before the end of the redaction of the final report and prior to the MSG-079 Workshop.

7.1. MSG-079 C-BML Workshop Recommendations

This section summarizes the recommendations from MSG-079 C-BML Workshop [15] was organized by the MSG-048 Technical Activity, consistent with the MSG-048 Programme of Work:

- *MSG-085 should consider creating and organizing a C-BML Community of Interest (CoI.)*
- *The C-BML CoI should investigate means to facilitate communication and collaboration between C-BML stakeholders.*
- *The C-BML CoI should liaise with industry and national partners to promote a common understanding of C-BML and its benefits.*
- *Establishing an international standard for C-BML is a high priority and should be supported by the C-BML CoI through active involvement in C-BML standardization activities and this should be the focus of the C-BML CoI.*
- *The C-BML CoI should ensure coordination with the SISO MSDL PDG with the objective to align both standards.*
- *NATO should consider initiating a C-BML STANAG development activity to leverage and build upon the SISO C-BML standardization activity.*
- *The C-BML CoI should promote increased interaction with the operational community in the development of the SISO C-BML standard.*
- *A significant number of C2 systems neither JC3IEDM nor C2IEDM based, therefore it is essential for the C-BML (future) standard to position itself independently of MIP standards*[8].
- *The C-BML specification should be decoupled from the transport mechanisms and be IEM-agnostic.*

7.2. MSG-048 Final Report Recommendations

The following are the recommendations made by the MSG-048 TA concerning the future employment of C-BML.

7.2.1. C-BML Development and Employment

This section highlights the recommendations for the benefit of software developers, systems architects and integration specialists.

Recommendation *– More work is required to ensure that C-BML can support air and naval operations and joint operations (e.g. Close Air Support).*

Recommendation *– A grammar is required to ensure an unambiguous C-BML. MSG-048 recommends the continued development of C2LG in concert with C-BML.*

Recommendation *– There is a need for procedures and services for the initialization and run-time coordination between systems employing C-BML. MSG-085 should address this issue and explore the use of MSDL to address initialization issues* (see below).

7.2.2. Coordination with SISO

Recommendation *– The MSG-085 TA should consider for use in the experimentation programme available open-source SISO C-BML compliant implementations.*

Recommendation *– SISO MSDL should be evaluated as a means for initializing simulation systems in the context of the MSG-085 experimentation programme.*

Recommendation *– After its first release of a balloted standard, NATO should consider SISO C-BML and MSDL for adoption as a STANAG.*

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[8] This recommendation does not question the usefulness and benefits of utilizing the JC3IEDM as the underlying model for the C-BML Information Exchange Structure and Content Specification, per the SISO C-BML PDG recommendation. However, it highlights the need to maintain a loose coupling between the two to facilitate and promote the use of C-BML by a larger community – including, for example, C2 systems that are not JC3IEDM-based and that are utilized for air, naval or joint operations.

7.2.3. Coordination with the MIP

The MSG-048 recommends the formation of a liaison and/or group communicate with the MIP on behalf of the C-BML community in association with the following recommendations:

Recommendation *- The MIP should consulted by the C-BML community to validate the proper and optimal use of the JC3IEDM.*

Recommendation *– The MIP should be consulted by the C-BML community to identify their plans to revamp and/or replace the MIP-DEM to determine its applicability as a C-BML IEM.*

7.2.4. Coordination with the Operational Community

Recommendation *– MSG-085 should establish a continuing involvement with the operational community to ensure the operational relevance of C-BML.*

Recommendation *– MSG-085 should conduct experimentation in coordination with the operational community in order to develop and test more mature capabilities, as they become available.*

Recommendation *– MSG-085 should consider a NATO training exercise as the basis for part of the experimentation programme.*

7.2.5. Promoting the Use of C-BML

In February 2008, George Mason University organized a BML Symposium in Manassas Virginia that promoted awareness concerning the usefulness of BML to a broad community. One year later, the MSG-079 C-BML Workshop also played a significant role in raising awareness and achieving a consensus on important issues such as the high priority and sense of urgency of an international standard for C-BML. In light of the recognized importance of such workshops and symposiums, the following recommendation is made:

Recommendation *– MSG-085 should organize workshops and demonstrations to promote the benefits of employing C-BML-enabled capabilities and to raise awareness of stakeholders.*

8. Conclusions

This section provides conclusions on the current status of C-BML and the way forward.

8.1. C-BML Standardization Status

This paper reports the findings and recommendations of the MSG-048 TA concerning the current state-of-the-art of C-BML. There has been much progress in understanding how C-BML can be used most effectively and in identifying the areas where more work is required in support of developing the standard and with the goal of deploying C-BML technology enabled solutions.

8.2. The Way Forward - MSG-085

Thirty participants representing eleven nations were present at the June 2010 MSG-085 C2-Simulation Interoperation Technical Activity kick-off meeting in Paris.

The objectives of this activity, as stated in the Technical Activity Proposal [16] are as follows:

1. Clarify the C-BML scope and requirements in the form of a set of operational and technical use-cases
2. Reach a consensus on a set of digitized expressions for orders (e.g. OPORD, FRAGO, WARNO, ATO, ACO etc...) and reports.
3. Assess and leverage open-source C-BML reference implementations
4. Address C2 system and simulation initialization requirements including the complementary use of MSDL and C-BML
5. Ensure the operational relevance of C-BML by actively seeking input from the operational community, including end-users

The fifth objective will involve demonstrating the operational benefits of using a C-BML-enabled approach to the C2 and simulation communities through a series of experiments leading up to an operational exercise.

9. References

[1] Carey, S., M. Kleiner, M. Hieb, and R. Brown, “Standardizing Battle Management Language – A Vital Move Towards the Army Transformation,” IEEE Fall Simulation Interoperability Workshop, Orlando, FL, 2001

[2] Heffner, K., Pullen J. and Khimeche L., "MSG-048 Technical Activity Experimentation to Evaluate Applicability of a Coalition Battle Management Language in NATO", NATO Modelling and Simulation Group Conference, Utrecht, Netherlands, September 2010

[3] MSG-048 (C-BML) Technical Activity Final Report, NATO Research and Technology Organization, July 2010

[4] Blais, C., K. Galvin and M. Hieb, "Coalition Battle Management Language (C-BML) Study Group Report," *IEEE Fall Simulation Interoperability Workshop*, Orlando FL, 2005

[5] Schade, U. and M. Hieb, "Development of Formal Grammars to Support Coalition Command and Control: A Battle Management Language for Orders, Requests, and Reports", *11th International Command and Control Research and Technology Symposium*, Cambridge, UK, 2006

[6] Hieb, M. and U. Schade, "Formalizing Command Intent Through Development of a Command and Control Grammar," *12th International Command and Control Research and Technology Symposium*, Newport, RI, 2007

[7] NATO Military Agency for Standardization (2000). Standardization Agreement 2014: Formats for Orders and Designation of Timings, Locations and Boundaries.

[8] MSG-048 Technical Activity Proposal (C-BML), 2005

[9] Pullen, J., M. Hieb, S. Levine, A. Tolk, and C. Blais, "Joint Battle Management Language (JBML) - US Contribution to the C-BML PDG and NATO MSG-048 TA," *IEEE European Simulation Interoperability Workshop*, June 2007

[10] MSG-048 Draft Report - Substantiation of requirements for a NATO C-BML, April 2008

[11] STANAG 5500 - NATO Message Text Formatting System (FORMETS), ed.4, Allied Data Publication-3 (ADatP-3)

[12] Phase 1 Specification for: Coalition Battle Management Language (C-BML), Jan 2008

[13] Müller K., NATO and XML, XML Europe Conference, June 2000

[14] SISO Military Scenario Definition Language (MSDL) SISO-STD-007-2008, Oct 2008

[15] Draft MSG-079 C-BML Workshop Technical Evaluation Report, NATO RTO June 2010

[16] MSG-085 Technical Activity Proposal for C2-Simulation Interoperation, 2009

Author Biographies

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