# Standardisation of Command and Control Systems and Simulator Interfaces, and the Definition of Scenarios

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**ABSTRACT:** *The emergence of numerous command and control (C2) systems and simulators necessitate the standardisation of interfaces and the definition of scenarios to facilitate their efficient co-existence. This paper comments on the activities of the Simulation Interoperability Standards Organization (SISO) in this area and the applicability to South Africa. It specifically addresses Battle Management Language (BML) as a means to establish a common operational picture between C2 systems and simulators as well as the use of Military Scenario Definition Language (MSDL) to provide a standard mechanism for sharing Military Scenarios independent of the application generating or using scenarios. It concludes with comments on the feasibility of establishing these as standards within the Command and Control and Simulation environment in South Africa.*

## 1 Introduction

Various command and control (C2) systems and simulations exist independently within the South African defence environment. While each C2 system or simulation is aimed at providing solutions to specific problems posed at different system levels, it is difficult to envisage that these systems or simulations will operate unilaterally within the joint or combined environment. Current simulation definition formats and interfaces that are used within the South African environment are non standard and closely coupled to the simulations they support. This close coupling severely limits the sharing of scenarios as well the interconnection of the various simulations that exist.

The Simulation Interoperability Standards Organisation (SISO) has established two Product Development Groups that address Battle Management Language (BML) and the Military Scenario Definition Language. BML is used as a means to establish a common operational picture between C2 systems and simulators. MSDL is used as a mechanism for sharing military scenarios independent of the application generating or using the scenarios.

BML is the unambiguous language used to command and control forces and equipment conducting military operations and provide for situational awareness and a shared, common operational picture [1]. MSDL is intended to provide a standard definition language for defining military scenarios independent of the application generating or using the scenario [2]. Both languages have defined data models, with BML extending the Command and Control Integrated Data Exchange Model (C2IEDM) [3] as its logical data model and MSDL developing an XML based schema. The C2IEDM is a data model applicable to C2 as well as to modelling and simulation issues and is maintained by the Multilateral Interoperability Program (MIP). There are common elements between the two languages, and both development groups collaborate to develop compatible standards.

This paper provides an overview of each of these languages and comments on the feasibility of employing them as a standard within the South African defence industry. A case study will be used to demonstrate the need for standardisation.

## 2 Current Simulator interfaces and Scenario Definition Formats

The integration of two C2 simulators is described in [6]. The simulators that were integrated were the Virtual

GBADS Demonstrator (VGD) and BattleTek. VGD is a suite of software, developed by the Council for Scientific and Industrial Research (CSIR), which supports both constructive and virtual simulations of many-on-many engagements. BattleTek is a constructive simulator developed by CyberSim to support war simulation exercises on the different levels of tactical command [6].

The integration required the initial exchange of scenario information, as well as the exchange of tactical information at during simulation execution. In this integration, the scenarios were created independently within each simulation environment, each using its own format to store the scenario information. LinkZA was used as an interface protocol between the two simulators. LinkZA is a tactical data link standard that supports the exchange of tactical information between C2 systems for the command and control of joint operations [4].

VGD has also been integrated with the Air Picture Data System (APDS). APDS is a C2 system developed by, Grintek Integrated Defence Systems (GrIDS) to display an integrated situational awareness picture aimed at satisfying civil and defence related needs. In this integration, the Asterix protocol [5] was used to accept aircraft tracks from APDS, and create virtual aircraft within the VGD simulation environment. Again, scenarios were created and stored independently within each environment.

A three dimensional (3D) visualisation tool developed as part of the VGD suite currently uses an interface based on XML. This interface consists of a set of predefined XML elements and attributes that specify the state of an entity at a given time. The tool provides a means to visualise an engagement in an immersive virtual environment. Although the 3D visualisation tool was developed as part of the VGD suite of software, it has been written as a stand alone application and is a resource that can be shared between the defence industries.

It was recommended in [6] that standardisation of the scenario definition format should receive attention. This will allow scenario definitions to be created and shared instead of using multiple copies created in different formats.

Furthermore, the exchange of simulation control information is not supported by LinkZA. In this integration [6], no time synchronisation between the simulators was performed, but if such simulation control functions need to be exchanged, then LinkZA cannot be used without defining special messages. The problem with defining special messages for exchanging simulation control is that this approach limits interoperability and it was therefore recommended in [6] that a unified framework be adopted for C2 modelling in the South African context.

The existing scenario definition format used by VGD is described in detail in [8]. A brief overview of this format follows here. The existing scenario definition format used by VGD is based on an XML encoding scheme. A simplified XML encoding scheme is used consisting of elements with attributes and child elements. Element content is not used to simplify reading and decoding of XML elements. Although the encoding scheme is well-formed, it does not result in valid XML documents since no explicit XML schema is used. This is not necessarily an optimal choice, since it requires careful use of the format in terms of structure and content [8]. Interoperability is also limited as a result. Table 1 shows the existing elements addressed by the current format. The existing scenario definition format only specifies the configuration of a fixed set of entities and does not provide the capability to convey new information. It is thus referred to as a format, rather than a language.

Table 1: Existing Scenario Definition Format Elements [8]

| Category | Description |
|---|---|
| Metadata | Captures version information and author details. |
| Defended Assets | Indicates position, type, criticality and boundaries associated with each asset. Multiple assets may be defined. |
| Battery | All equipment, including effectors, sensors and operator terminals are captured. It includes organisation, type, affiliation and areas of responsibility. Configurations and activations to some external systems are included as well. |
| Threat | All aircraft, irrespective of affiliation are specified here. References are made to flight profiles, stored in a separate configuration. This allows “libraries” of threat profiles to be used and reused. |
| Air zones | To define prohibited and restricted air zones that aid target hostility classification (tactical doctrine). Tunnels and lanes are also included in this section. |
| Areas | These are effectively overlays that are scenario specific for visualisation and planning aid. |
| Sectors | Segments of circles that are used during C2. |
| Line of sight maps | Scenario specific pre-generated line of sight maps used for planning and visualisation. |
| Visualisation specifics | Visualisation parameters that are scenario specific. |
| Terrain | Terrain definition for the scenario. |
| Execution | Configuration for the distributed or non-distributed execution of a scenario. |

## 3 MSDL Overview

MSDL intends to serve the international command and control and simulation domains with data representation and file format standards to define military scenario information that can be read by MSDL compliant live, virtual or constructive simulations (Figure 1) [9].

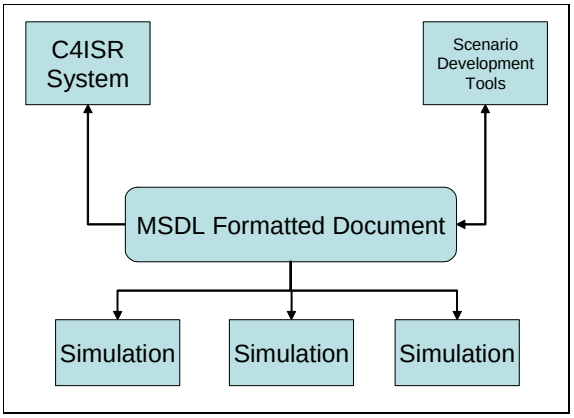


Figure 1: Scope of MSDL

MSDL uses the 5W concept (Who, What, When, Where and Why) to support the identification, storage and description of military entities, activities that can be performed by these entities and the relationships between these entities.

A short overview of the elements covered by MSDL is presented in Table 2.

Table 2: Primary MSDL Elements (adapted from [1])

| MSDL Element | Description |
|---|---|
| Options | Used to specify task organisations, data standards and application specific options. |
| Plans | Contains scenario descriptive information and executable courses of action. |
| Environment | Covers scenario time, terrain and weather data. |
| Force Structure | All participating forces are defined with their respective structures, including associations. |
| Task Organisations | To define equipment and units. Equipment generally relates to simulated entities and units to the simulated forces. Communication network and unit-equipment relations are also specified. |
| Installations | Identifies military installations and symbol modifiers. |
| Overlays | Dedicated and custom (user-defined) overlays are supported. It provides a mechanism to link tactical graphics to specific layers that may be displayed. |
| Tactical Graphics | Provide for the definition of control measures in MSDL. Graphics can be linked to specific overlays. |
| MOOTW Graphics | Similar to tactical graphics but to for non-war operations, such as peace keeping. |
| Threat | To specify non-military threats that links with MOOTW. |

### 3.1 Mapping a Current Scenario Definition Format to MSDL

As a case study, each item in the existing scenario definition format presented in Table 1 (as used by VGD) was considered and mapped against a corresponding suitable definition in the MSDL language. The result of this mapping is presented in [8] and summarised in Table 3.

Table 3: Mapping the existing VGD Scenario Definition Format to MSDL [8]

| Existing Format Element | Explicit MSDL Support | Comment |
|---|---|---|
| Metadata | No | Extend MSDL. |
| Defended Assets | No | Extend all relevant MSDL elements. In the interim use a referenced, external file. |
| Battery | Mostly | Some vital parameters cannot be encoded. |
| Threat | Partial | Aircraft can be defined, but flight path definitions not explicitly supported. Anchor points (tactical graphics) may be used with Waypoints from MIL-STD-2525B. |
| Air zones, tunnels, lanes, areas and sectors | Yes | Used in conjunction with MIL-STD-2525B. Translation between symbology and area types necessary. Associated user-defined overlay names are indicative of the area type or meaning. |
| LOS maps | Yes | Similar to Areas. |
| Visualisation specifics | No | Non-critical and simulator specific, store in an external, referenced file. |
| Terrain | Yes | Data source specified as free text name. |
| Execution | No | Non-critical and simulator specific, store in an external, referenced file. |

## 4 BML Overview

BML intends to serve the international command and control, simulation (live, virtual and constructive), and robotic domains with doctrinal, data representation and protocol standards to communicate strategic, operational, and tactical orders to superiors, peers and subordinates (Figure 2). While BML is intended to be an interoperability standard between C2 systems and simulations, there are also operational benefits as well. BML formally defines an unambiguous common joint doctrinal language enhancing the conduct of joint as well as combined operations.

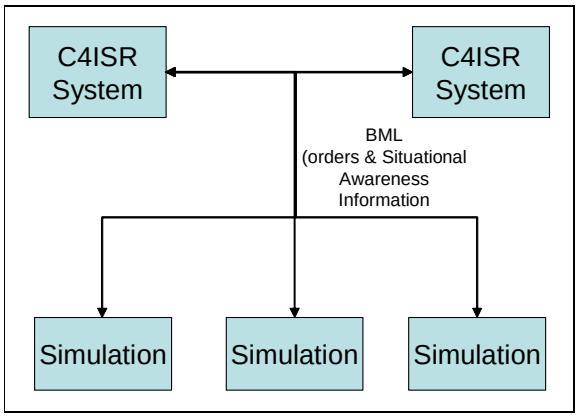


Figure 2: Scope of BML

BML must formalise concepts such as the "Who, What, When, Where and Why" (5W) information needed to command and control forces. These principles have led to three views shown in Figure 3 being defined [11].

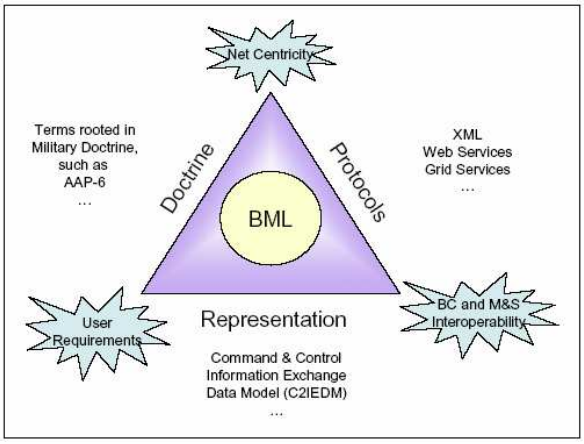


Figure 3: BML Views: Doctrine, Protocol and Representation [10]

Every term within the language must be unambiguously defined and rooted within military doctrine. BML must allow different doctrinal viewpoints of services or nations to be defined and this is conveyed by a glossary of terms and definitions. The Representation View structures and relates the terms defined in the doctrine in such a way that they result in the description of executable missions and tasks. The Protocols View standardise the way the description of the executable tasks is transported from the BML implementation to the target system (C2 or simulation). In the emerging net-centric operational environment, web based standards offer candidate protocols, and in particular, XML is considered to be a currently accepted standard for data description [10].

### 4.1 BML – Doctrine View

The doctrine view is glossary comprising of terms and their unambiguous definitions, as well as the source of these definitions, and is aligned with the manuals and handbooks used to define doctrine. The view provides for a definition of doctrine, and so does not implement a single doctrine only, but rather allows different doctrinal viewpoints of services or nations to be defined. The purpose of the doctrinal view is to define different doctrines in a standard from.

### 4.2 BML – Representation View

The representation view structures and relates the terms defined in the doctrinal view in such a way that they result in the description of executable missions and tasks. The Representation view structures, describes and orchestrates these tasks into missions. Furthermore, the representation must comprise military means, which can be real units or platforms, or simulated entities.

The prototype development for BML currently uses the C2IEDM as the underlying data model.

### 4.3 BML – Protocols View

Communications protocols are needed in order to communicate the necessary data between C2 systems and simulators. The protocol view standardises the way the description of executable tasks is transported from the BML implementation to the target system, be it a C2 device or a simulation.

The use of XML as a standard for data description is widely accepted by the C2 community, as well as the simulation community. XML forms the foundation for the protocol view.

### 4.4 Pros and Cons of BML

BML is a well-defined language for representing a commander's intent and conveying orders to operational forces, be they live, constructive, or virtual. BML provides a standard (semantics and syntax), unambiguous, automated means to exchange individual data elements, representing battle management entities, among C2 systems and simulations, facilitating interoperability between the various C2 systems and simulations that exist within the South African C2 and simulation environment.

The principle risk in the BML standards approach is that a standard data exchange model must be adopted within South African C2 and simulation environment, rather than each party in the industry using a unique data representation.

## 5 Conclusion

An attempt has been made to translate the existing scenario definition language to an MSDL compatible format [8]. While Table 3 shows that it is feasible to map an existing scenario definition format to MSDL, some elements of the existing format (such as the defended asset) are not considered by MSDL. It is appreciated that MSDL may not have been aimed at tactical air defence engagement scenarios, but rather higher-level simulations. These simulations, such as war-gaming and theatre-level simulations, often rely on aggregated entities, rather than detail tactical information, in scenario definitions. In order to support MSDL-based scenario definitions in the C2 tactical simulation environment in the interim, external referenced scenario elements and customised overlays have to be employed with appropriate MIL-STD-2525B symbols.

A translation effort similar to that carried out on MSDL needs to be performed with BML. The existing interface protocols need to be mapped to elements within BML.

Both MSDL and BML are emerging specification and are still under development. It is recommended in [6] that a unified framework be adopted for C2 modelling within South Africa as C2 modelling and simulation is still in its infancy within South Africa. Adopting MSDL and BML as interoperability standards allow the South African C2 modelling and simulation communities to not only standardise on an internationally accepted interoperability standard, but also to actively contribute towards the development of the standard.

## 6 References


[1] Coalition Battle Management Language (C-BML) PDG, Simulation Interoperability Standards Organisation (SISO), Viewed 24 April 2007. <http://www.sisostds.org/index.php?tg=articles&idx=More&article=439&topics=102>.

[2] Military Scenario Definition Language (MSDL) PDG, Simulation Interoperability Standards Organisation (SISO), Viewed 24 April 2007. <http://www.sisostds.org/index.php?tg=articles&idx=More&article=440&topics=103>.

[3] Multinational Interoperability Programme (MIP), "The C2 Information Exchange Data Model (C2IEDM main)", Greding, Germany, December 2005.

[4] "Combat Net Interoperability Standard DODI/CMI/00009/2001", Doc. No. CNIS-500-001-B01, Rev. 2, South Africa, 12 June 2003.

[5] Mayer, E., "ASTERIX – The Emerging World-Wide Standard in the Surveillance Domain", COMSOFT GmbH, Karlsruhe, Germany.

[6] Nel, J. J., W. H. le Roux, O. van der Schyf and M. Mostert, "Modelling Joint Air Defence Doctrinal Issues with a LinkZA-based Integration of two C2 Simulators – A Case Study", Military Information and Communications Symposium of South Africa (MICSSA), Pretoria, July 2007.

[7] Simulation Interoperability Standards Organisation (SISO), "Specifications for: Military Scenario Definition Language (MSDL)", Orlando, April, 2005.

[8] le Roux, W. H., "Investigation into the Usability of MSDL in South African C2 Tactical Simulations," Submitted to European Simulation Interoperability Workshop, Genoa, Italy, June 2007.

[9] Simulation Interoperability Standards Organisation (SISO), "Military Scenario Definition Language (MSDL) Study Group Final Report". SISO-REF-015-2006. 10 January 2006.

[10] Simulation Interoperability Standards Organisation (SISO), "Coalition Battle Management Language (C-BML) Study Group Final Report". SISO-REF-016-2006-V1.0. 31 July 2006.

[11] Tolk, A. and C. L. Blias, "Taxonomies, Ontologies, and Battle Management Languages – Recommendations for the C-BML Study Group", Simulation Interoperability Standards Organisation (SISO), Spring Simulation Interoperability Workshop, San Diego, CA, April 2005.

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