Lessons learned from NMSG-085 CIG Land Operation demonstration

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ABSTRACT: *This paper presents the experience gained during demonstrations carried out between Denmark, France, Germany, the Netherlands and Spain under the umbrella of the NMSG-085 / CIG Land Operation group. The demonstration, also presented in this paper, focuses on command post exercise training. It highlights the benefits of the use of standards to save LOCON resources and time during exercise preparation. The demonstration combines surrogate and operational C2 systems (SIR provided by France, SITAWARE provided by Denmark, C2LG-GUI provided by Germany, and TALOS provided by Spain) with simulations (SWORD provided by France, VR-Forces provided by the Netherlands).*

The demonstrations addressed first the use of an effective initialization process based on the MSDL standard. MSDL was enriched (extended) for these demonstrations; the rational and content of the enrichment are also presented in the paper. Second, the demonstration deals with the execution of an operational scenario derived from the VIKING 2011 training exercise. Hence, it highlights the use of C-BML for two new military areas: logistics and artillery. Corresponding C-BML schema improvements are introduced in the paper. In addition, the demonstration intends to show that C-BML is also relevant for C2 to C2 exchange.

1. NMSG-085 background

The interoperation between C2IS and M&S systems is a common theme in the transformation of modern military forces. This is required to support the military enterprise in the execution of business activities and mission threads such as operational training, information sharing and decision support. This implies the ability to seamlessly integrate C2IS and simulation systems and to provide the means for a meaningful and unambiguous information exchange.

The NMSG-085 provides guidance and input in support of the finalization of the C-BML standard and its alignment with MSDL, see [1] and [2]. In addition, NMSG-085 will ensure that the standards support the operational use-cases as collected from the nations and NATO stakeholders, and thus allow for C2-simulation interoperation.

During Spring 2012, the NMSG-085 organization has moved to a Common Interest Group (CIG) approach, in order to provide a simple and efficient mean to propose MSDL/C-BML improvements based on themes of national interest. 5 CIG have been created: (I) Infrastructure, (II) Land Operations, (III) Autonomous Air Operations, (IV) Maritime Operations and (V) Joint Mission Planning.

This paper presents the lessons learned from the CIG (II) Land Operations activities that lead to several demonstrations at NMSG-085 meeting #9 (Fairfax) and I/ITSEC 2012 NATO booth (Orlando).

2. CIG Land Operations overview

CIG Land Operations has been created to specify, develop and demonstrate improved C-BML capabilities for land-focused training, and define operational initialization process.

2.1 Objectives

The goals for the land-focused training were identified thanks to the lessons learned from past experimentations, as presented in paper [4].

In particular, the 2012 efforts focused on the following objectives:

- (O1) Enhance land maneuver logistics (sustainment of fuel and personnel)
- (O2) Request/order/report for Artillery Support
- (O3) Extend the list of tasks that C-BML is able to support with low intensity missions
- (O4) Exchange with legacy C2 systems with respect to operational interfaces that comply with CP flow of information
- (O5) Refine Initialization process of systems

2.2 Participation and systems used

CIG Land Operations has involved 5 nations

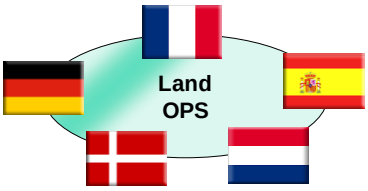

Figure 1: CIG Land Operations Participation

Each nation has been involved in 2 or more activities:

- Operational Activity Support: DEN, FRA, NLD, SPA
- Infrastructure Support: DEU
- Technical Activity Support: DEN, DEU, FRA, NLD, SPA
- Documentation: FRA

Each nation has participated in the demonstration with several systems:

- Germany
  - C2IS surrogate: C2LG-GUI
  - Communication Infrastructure
- Denmark
  - C2IS: SITAWARE
  - Simulation: SWORD
- France
  - C2IS: SIR
  - Simulation: SWORD, APLET
- The Netherlands
  - Simulation: VR-FORCES
- Spain
  - C2IS: TALOS
  - Simulation: TALOS -SIM

Figure 2: Systems responsibilities

2.3 Timeline and methodology

The activities of CIG Land OPS have started in February 2012 and lasted to the end of November 2012 for the demonstration.

Figure 3 shows the CD&E (Concept, Development & Experimentation) approach that has been used.

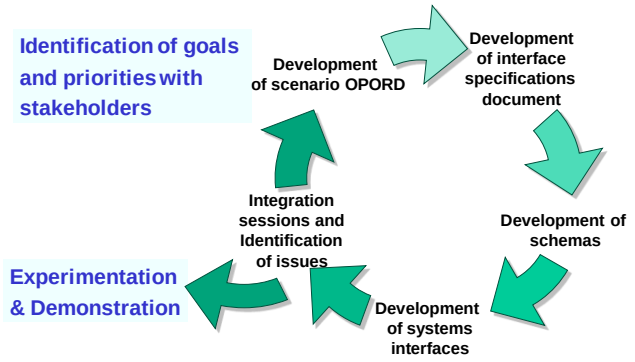

Figure 3: CD&E approach

Two face to face integrations have been made: one in September during NMSG-085 meeting #8 (at Istanbul) and the second one in November during NMSG-085 meeting #9 (at Fairfax). Remote integrations sessions were also necessary before each face to face integration. Also, regular conference calls have been made to share work progress and solve technical issues.

2.4 Collaborative tools used

Several collaborative tools enabled the CIG group to work efficiently, to do two remote integrations, and to do the first demonstration that included distant sites.

CASSIDIAN services (Arkadin anytime) has been used for conference calls.

MASA group servers have been used to host *FKIE* BML server and SWORD simulation server.

Skype has been used for chat during remote integrations.

Teamviewer has been used for the first demonstration, to display screens of distant systems in the main audience room. It has also been used to record every display of systems during the first demonstration.

LogMeIn has been used to create a VPN over internet, in order to connect the HLA federates.

3. CIG Land Operations demonstrations

Several demonstrations showed the achievements related to the pre-defined objectives:

- First demonstration (at Fairfax) during NMSG-085 meeting #9: Battalion Command Post training (1 hour)
- Second demonstration (at NATO booth) and third demonstration (at NMSG-119 workshop) during I/ITSEC 2012: Battalion Command Post training (15 minutes)
- Fourth demonstration (at NATO booth) during I/ITSEC 2012: Battalion Command Post planning (15 minutes)

All demonstrations share the same scenario, but have different architectures.

3.1 Scenario

The operational scenario was developed by Spain, The Netherlands and France, based on the Viking 2011 scenario.

The scenario involved the TF V (Task Force V) containing 3 companies (STF A, STF B, STF C), a recce platoon (PLT E), a mortar platoon (PLT F) and an artillery battery. The figure below shows the order of battle, with the C2 system (green boxes) used for the different command posts.

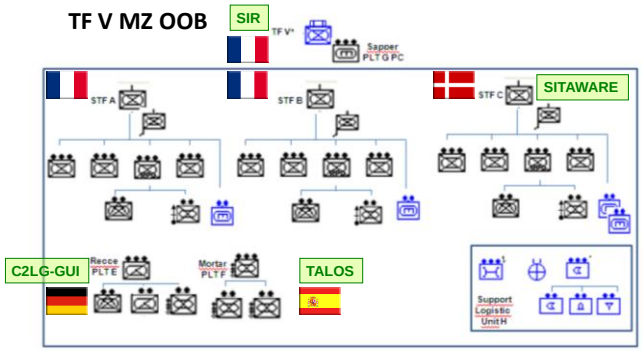

Figure 4: TF V Order of Battle

After disembarkation at Oxelösund and movement to the waiting area (WA), the scenario guidelines for TF V were to seize and secure Skavsta airport (APOD). The operational order made by the TF V Battalion command post has several phases. Each one has been used to show achievements of different objectives.

Figure 5: OPORD Phase 1 – Movement to APOD

Phase 1 starts with progress along axe M1, M2 and M3 and ends with units deployed near APOD. During this phase, the flow of information between regular C2 systems and simulation has been shown (objective O4), with 'Acknowledgement' messages sent by simulation (containing a warning about an unmanaged task in the simulation) in response to the OPORD message (containing an intentional error).

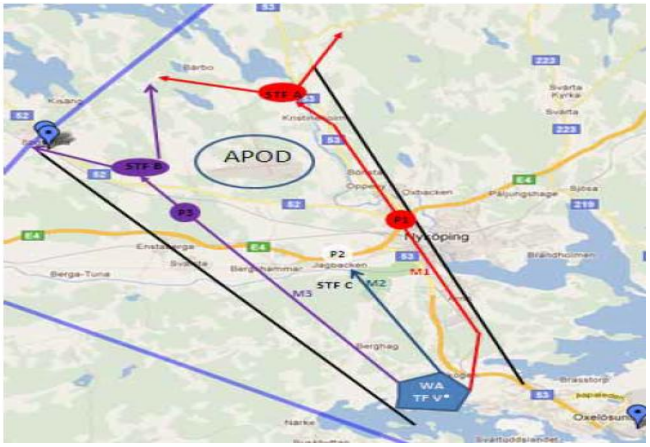

Figure 6: OPORD Phase 2.1 – Deployment to AOR

Phase 2.1 starts with control and isolation of our area of responsibility (AOR) and ends putting check points along road E4. During the progression of combat units, the trainees had to start a drone reconnaissance (low intensity mission, objective O3) in order to identify enemy units and strength on the APOD, and execute a call for fire procedure using mortars or artillery (objective O2).

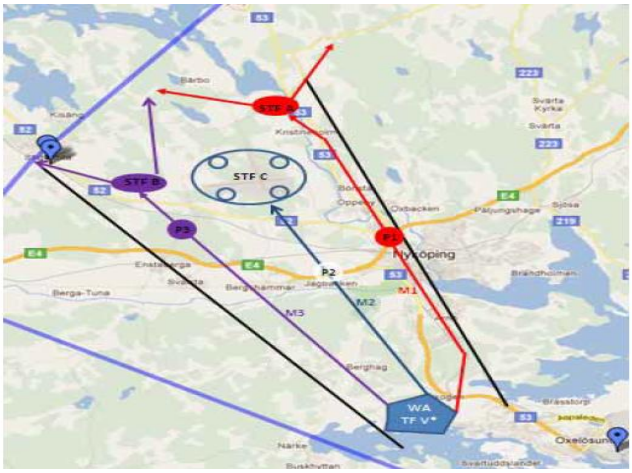

Figure 7: OPORD Phase 2.2 – Control the APOD

Phase 2.2 starts with APOD authority contacts and ends with APOD controlled. At the end of the maneuver, Battalion commander ask for a logistic reports and display the global logistic situation (objective O1).

3.2 Command Post Training Organization

The next figure shows the training organization including the units, their roles, with the systems and people involved.

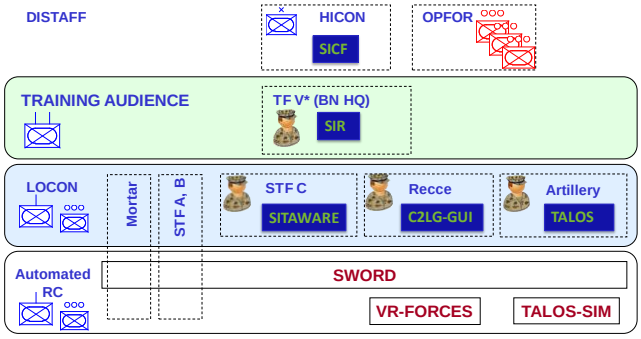

Figure 8: Command post training organization

The training audience was the Battalion command post, using SIR system (regular French C2).

The low controller (LOCON, or the secondary training audience) provide the interface between the trainees and the simulations. All subordinates units of TF V (except STF A and B) are represented in this cell: the STF C company with SITAWARE (regular Danish C2 system), the Recce platoon with C2LG-GUI (German C2 surrogate), and the Artillery unit with TALOS (regular Spanish C2 system). For those units, only their subordinates are represented in the simulations.

There is no officer in the LOCON for STF A and B companies as well as for the Mortar units. They are directly represented in SWORD simulation and hence are part of the automated RC (Response Cell).

Several simulations are used in the response cell:

- SWORD (MASA Group): it provides the whole ground operational environment with command agent allowing to order company and section/platoon
- VR-Forces (The Netherlands): it is used to display a disaggregated view (recce vehicles) of the battlefield around the airport
- TALOS-SIM (Spain): it provides the means to compute artillery fires and send HLA detonations interactions.

3.3 Cloud architecture and local architecture

Several architectures have been used, depending on the use-cases (training / planning) and the availability of resources on each site.

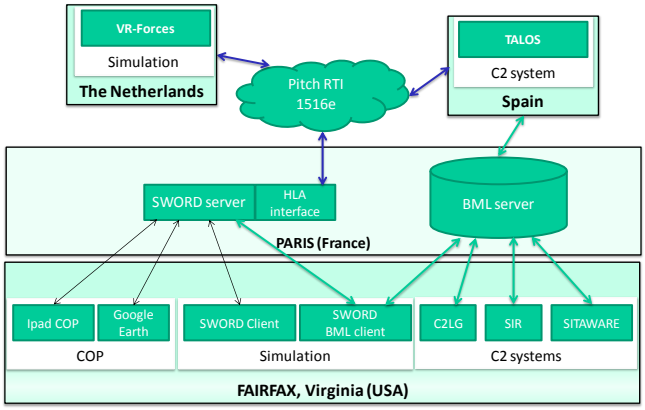

Figure 9: Cloud training architecture at Fairfax

The figure 9 shows the architecture used for the first demonstration during NMSG-085 meeting #9 of the Battalion Command Post training. It's a cloud architecture that connects several sites. FKIE C-BML server and SWORD simulation server were hosted in France. The Netherlands and Spanish C2 systems were hosted in their respective countries and manipulated by local operators, to save travel costs. Simulation systems were connected through HLA using NETN FOM version 2.0.8 2010, Pitch RTI 1516 and *LogMeIn* VPN. TALOS and VR-Forces were remotely displayed to the Fairfax audience, thanks to *Teamviewer*.

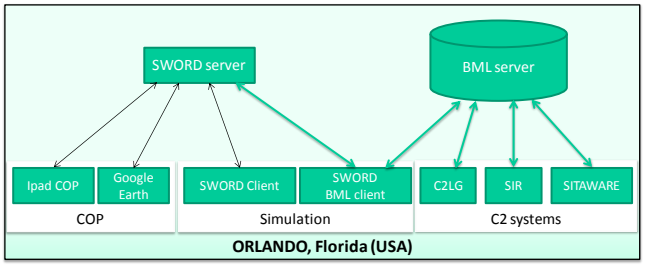

Figure 10: Local training architecture at Orlando

The second and third demonstrations were also about the Battalion Command Post training, but with only one simulation (SWORD) and without artillery capability. For those demonstrations, the local architecture presented in figure 10 has been used.

3.4 Initialization use-case

The initialization of the overall systems is critical. The consistency among them is the cornerstone to guarantee a smooth running of the demonstration. The objective was to save time and reduce inconsistency between systems, including all the logistic data expected from the objectives.

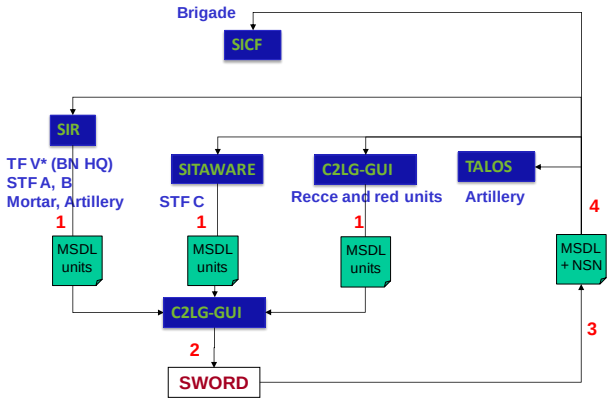

Figure 11: Initialization process for training

Hence, it was decided to implement the process depicted in figure 11:

- Step 1: All systems send one MSDL file containing the Order Of Battle of the units they managed, down to their N-2 (subordinates of subordinates), with the definition of units types.
- Step 2: C2LG-GUI merges those files into one MSDL file containing the global and coherent Order Of Battle.
- Step 3: SWORD get the global Order Of Battle with unit's types, and define the logistics data of each unit according to their match with the simulation database. The logistic data for equipments, resources, fuel and personnels are based on the NSN (NATO Stock Number) definition.
- Step 4: The global Order Of Battle containing logistic data is imported in every C2 system.

This process saved a lot of time in the C2 systems initialization, by avoiding the manual definition of the logistic data of each unit, and by leveraging the fact that simulation already has those definitions.

3.5 Command Post training demonstrations

The three demonstrations for the CP training follow the operational scenario (§ 3.1) and can be explained with the flow of information in figure 12. BML orders and reports

have been used during all the three phases of the scenario. BML call for fire has been used only in phase 2.1 of the scenario.

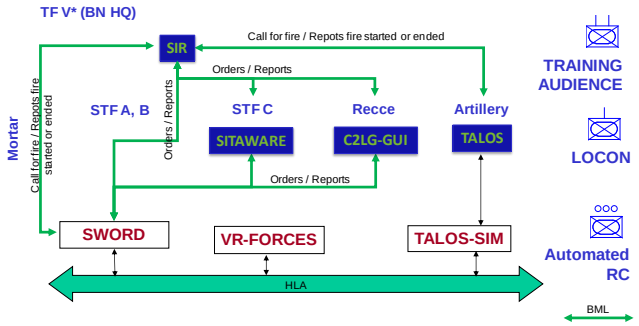

Figure 12: Information flow for training

BML Orders and reports

SIR sends the Order to all its subordinates, and receives in return Acknowledgements from them. SITAWARE and C2LG, as part of the LOCON, send them manually (LOCON officers' job). SWORD, as part of the Automated RC, sends the Acknowledgements automatically for STF A and B.

The STF C officer builds and also sends the order for its subordinates (STF C platoons), to the simulation SWORD. The Recce platoon officer does the same thing for its subordinates, the recce squads.

SWORD simulation sends BML reports for unit's positions, status and perception. With the same NSN used in the initialization process, SWORD sends reports for logistic data about equipments, resources, fuel and personnels. SWORD sends automatically those reports only as representing the units for which it receives orders. All C2 systems (SITAWARE, C2LG and SIR) retrieve their expected reports, and STF C sends manually (LOCON officer's job) the consolidated BML reports with SITAWARE.

Thanks to all those reports, trainees on SIR can follow and analyze the tactical situation as well as logistic data tables.

HLA federation

During the 1st demonstration, an HLA federation has been setup between VR-Forces (simulating disaggregated Recce vehicles), TALOS-SIM (simulating the artillery fires) and SWORD (simulating all others units).

TALOS-SIM was able to compute artillery fires and send munitions detonation to the HLA federation.

VR-Forces was used to have disaggregated models of units inside the airport area where the Call for fire occurred. The concerned units were a Recce group and some enemy units. When the Recce group entered the disaggregation area, SWORD disaggregated it, and VR-Forces took the control of these Recce vehicles and simulated theirs behaviors.

This capability could have been used to train an artillery observer (mounted in a recce vehicle) with a 3D stealth. But because CIG Land OPS didn't have a 3D stealth available, the scenario was played with the 2D view of VR-Forces, and with the call for fire sent by the Battalion commander (instead of the observer). In this way everything could be handled coherently.

BML Call for fire and reports

The "call for fire" part of the demonstrations was handled different at Faifax (1st demonstration with artillery) than at Orlando (2nd and 3rd demonstrations with mortar).

The 1st demonstration at Faifax involved the Artilley chain of command, with the Spanish TALOS system. The Battalion commander received a voice request from one of its subordinates, and makes the request with its C2 (SIR) to the Artillery unit. The officer (LOCON) of the Artillery unit uses TALOS to answer with an Acknowledgement, and to command and execute the artillery rounds. At the beginning and the end of the fire rounds, TALOS sent also BML reports that were displayed on SIR in the table of requested fires.

The 2nd and 3rd demonstrations at Orlando involved the Mortar of the Battalion, which was played directly by the simulation at the Automated Response Cell level. The same sequence as in the 1st demonstration is used, except that every action is done automatically by SWORD simulation.

3.6 Command Post planning demonstration

The planning demonstration of the Battalion Command Post has been shown with the APLET simulation, and the two C2 systems SITAWARE and C2LG playing different role in the Battalion Command Post. APLET simulation is a Course of Action analysis (CoAA) simulation and serves for the demonstration as a decision support tool.

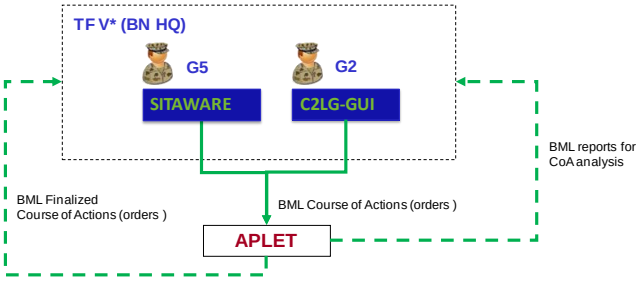

Figure 13: Information flow for planning

The G5 and G2 cells build the course of actions for blue and red forces on their regular C2 systems for the overall scenario (§ 3.1), but without artillery or mortar support.

APLET simulates those two courses of actions and send back to the C2 systems the computed tactical situations with BML reports (unit's positions, status, perception and logistic data). Those situations highlighted the critical events, the timing of maneuver, the losses and the logistic consumption of units. To resolve the issues and drawbacks identified, an enhanced course of action has been build that includes observation and artillery support. The results of this new confrontation showed a change in the outcome of the mission.

4. CIG Land Operations achievements

All of the presented achievements are described in the interface specification document produced by the CIG Land Operations.

4.1 Infrastructure services

A new BML server has been used, developed by FKIE.

By using the same WSDL interface as the GMU SBML server 2.5, it has saved costs by avoiding the update of C-BML interfaces in C2 systems and simulation systems.

By also changing the JC3IEDM storage to a simple XML file storage, the FKIE server has also saved maintenance costs of SBML scripts (mapping with JC3IEDM not needed), while it has enabled the enhancements in the C-BML and MSDL schemas needed to fulfill CIG objectives.

The FKIE server was then able to provide new functionalities to exchange C-BML messages expected and presented in next paragraph 4.3. For example, the FKIE server defined new JMS (Java Messaging Service) topics to distribute C-BML messages over systems: allRequest, allACK, allWHR (Who Holding Reports, for the logistic).

4.2 MSDL enhancements

The MSDL schema used was the same as the one used in COMELEC 2011 and presented last year in paper [5]. This "enhanced MSDL" schema was able to:

- Define unit types with JC3IEDM dictionaries
- Define symbols (for units, boundaries, etc.) with NATO APP6 standard
- Define holdings of units, for the logistic domain, by using the NSN (NATO Stock Number) codes.

The NSN is a 13 digit number and is divided into 3 parts, as shown in the example below.

1005	**13**	**1234567**
NATO Supply Classification Code (NSC)	NATO Code for National Codification Bureau (NCB)	Non-Significant Number
1005-13-1234567		
NATO Stock Number (NSN)		

The use of NSN codes has enabled the CIG Land OPS to enhance the logistic domain by keeping the same schema, and only by defining the set of used NSN codes, that were shared in the interface specification document. For fuel, food and water, their real NSN codes (existing in legacy databases) has been used.

For the personnel, a classification of human beings has been proposed (by a French Army Major) for the 4 digits of NSC code, and based on the RIC codes which are used to describe force capacities within NATO.

4.3 C-BML enhancements

The C-BML schema used was developed from the one used for VULCAIN demonstration during Eurosatory 2012, and presented in paper [3].

During SIW Fall 2011, the CBML Drafting Group phase 2 introduced a proposal to add a header describing message structure to the C-BML schema. It was required during the VULCAIN and CIG Land OPS demonstrations to comply with the operational flow of information, in which the messages are sent from one unit (real organization with a C2 system, or simulated unit) to another unit (real or simulated).

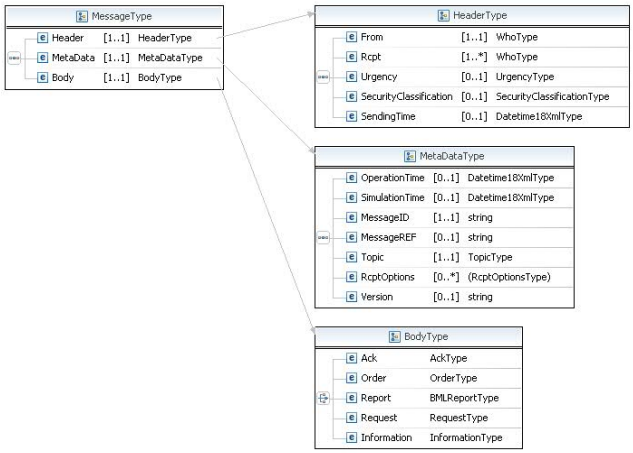

Figure 14: C-BML message structure

The proposed C-BML message structure is made of three parts:

- Header: contains information used by transport mechanisms
- MetaData: contains information used by recipients, to "understand" properly the expressions and to link several messages (message ID and REF).
- Body: contains all possible C-BML expressions inside a 'choice' element.

The C-BML expressions existing inside the IBML schema were mostly kept, with minor modifications (like a reorganization of the paragraphs in the order). Several new message bodies have been developed:

- Operational message 'Roger' / 'Apercu': The C-BML Acknowledgement message reports the status of orders, and is sent by each subordinates receiving the order (simulation can warn when an order failed for a missing boundary or an unrecognized task 'What').
- Call for fire (Neutralize, Destruction, Illuminate, Obscur): The C-BML task request can be used when a unit need a support (artillery fire), and request it to its superior or to the supporting unit. The message can be sent from a simulated unit to a C2 system, or from a C2 system to a simulated supporting unit like in the CIG Land OPS demonstration (SIR to TALOS or SIR to SWORD). The Task Request contains the definition of a single task.
- Start Firing / Suspend firing: The C-BML task command request can be used to start or resume, suspend or cancel a requested task (the artillery observer cancelling a call for fire previously made because of some civilians lately detected).
- Firing reports: The C-BML tasks status reports can be used to state the progress (In progress, Completed, Cancelled, etc.) of a requested task. During CIG Land OPS demonstrations, TALOS and SWORD send those reports and were shown on the SIR.

5. Challenges and findings

Several issues were identified when preparing and executing the demonstrations. This paragraph explains how CIG Land OPS handled them. The first issue is about the preparation of the demonstration. The next 3 issues deal with the C-BML standard. The last 2 issues are about the systems and their execution.

HLA

HLA was not the focus of CIG Land Operations, and to avoid spending too much time in Pitch booster configuration with 3 sites, the VPN *LogLeIn* has been used instead.

Task parameters

The parameters needed for each task is not standardized in the C-BML schema. And it shall not be written in the stone of a standard, because expected missions parameters for one simulation may depend on the task verb, the hierarchical level of the tasked unit and its unit type. For example in SWORD, the RECCE task needs only a route (line) when a combat platoon is tasked, but the RECCE task needs an objective area and two boundaries when a combat company is tasked. Missions parameters may also vary from one simulation to another one (different models with different parameters for different purposes). Missions parameters may also vary from one C2 to another one (because of different doctrines).

But to exchange tasks between systems, with tasks automatically processed, a C-BML federation agreement was defined in the interface specification document. The federation agreement captures mainly the tasks geometry ('Where' definition and control features) expected for each task verb.

In the C-BML Phase 2, this issue will be addressed more deeply with the grammar definition.

Task geometry

The task geometry issue is different than the previous issue because it deals with the meaning of the geometry attached to a task. The APP6 symbols embed the meaning of the

geometry (a block 'T' mission is made of a front line where the unit should stand and wait for the enemy – upper part of the T – and a back location – bottom point of the T). But the current C-BML schema is not designed to support APP6 symbols for action tasks, and it contains a limited set of codes describing the role of a geometry attached to a task. To continue with the Block mission example:

- SIR defines it with an area or an oriented line where the unit should block the enemy
- SWORD requires an area
- MS2525B (used by SITAWARE) and APP6 (used by APLET) define it with a 'T' symbol

This issue has been resolved for CIG Land OPS demonstration by capturing the C-BML federation agreement.

To ease in the future the coupling of two C-BML compliant systems, C-BML may propose a solution that enables some automatic conversions between the tasks geometries expected by the systems. Those automatic conversions can be done by the systems themselves, or maybe by the infrastructure if the conversions are very simple and don't depend on the tactical situation.

Observation reports

During implementation of the C-BML gateway for SIR system, an issue has been identified inside the observation reports dealing with Detected or Recognized observations. Those observations describe the unit's type and its level, but doesn't provide the unit's identifier (only known when the observation is an Identification), or a track identifier. Without an identifier, when a unit would observe the same enemy unit twice, the C2 gateway will have to generate a new ID for this detection, and two objects will be displayed on the SIR system instead of one. The recommendation is to add a track identifier in the observation report.

C2 systems overwhelmed

The C2 systems can be overwhelmed by the C-BML messages sent by simulation, when simulation runs faster than real time. To avoid that, the simulation must time regulate messages generation.

Systems are very sensitive with time

During integration, two issues were identified:

- Future DTG (Date Time Group) messages are cancelled and thus not displayed by C2 system
- Past DTG orders are cancelled by the simulation and thus not displayed

While it was not a problem for CIG Land OPS demonstrations, it shall be taken into account in the future. The initialization of systems may share a consistent DTG that may also be updated during the scenario execution.

NB: The proposed message MetaData structure has already those parameters (OperationTime and SimulationTime), but they were not used.

6. Lessons learned and Way Ahead

The CIG Land OPS objectives were successfully achieved.

However, one lesson learned is that all the operational requirements shall be tracked, and linked with the schema, in order to use it correctly when C-BML interfaces are developed inside the systems. Interface specification document provides currently such information, but a federation agreements document should be specified.

The demonstrations showed also that C-BML is relevant and eases C2 to C2 exchanges, when the C2 systems haven't an existing interface like MIP interfaces.

About business constraints, the existing free remote technology was of a great help, to perform integration tests very easily and to save the travel budgets.

Finally, the automation of the linkage between C2 and simulation systems has proven that it is nowadays possible to reduce the manpower required to operate simulations (like with STF A and B companies). Nevertheless, it works only with command agent simulations.

Thinking to the future, and to increase the operational relevance of C-BML, the following capabilities should be addressed in next demonstrations:

- Enable Reinforcement of simulated units during operations execution
- Generate realistic messages flow
- Model communication networks for realistic messages exchange between systems
- Enable time management

7. Literature

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