# M&S Standards for FMN Hands-On Workshop

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## *ABSTRACT*

*NATO Modelling and Simulation Group 211 (MSG-211) developed a Research Technical Course titled "Modelling and Simulation Standards in NATO Federated Mission Networking." The course will be presented in 2023 and 2024 in hybrid format. This Educational Notes paper presents the course content for the topic "History of Standardized C2-Simulation Interoperability (C2SIM)," one of 16 topics presented during the overall course. The paper describes M&S Standards for FMN Workshop which is intended for an in-person, hands-on audience. The approaches described in this paper are intended to be illustrative, not exhaustive. As the engineering community works with M&S in FMN, expanded alternatives will be identified.*

## 1.0    INTRODUCTION

For the first of the hybrid offerings of MSG-211, Dr. Mark Pullen teamed with NATO organization partner Naval Postgraduate School Modeling Virtual Environments and Simulation (MOVES) is providing a hands-on workshop using the C2SIM and HLA software from previous CWIX activities [1]. Online participants could see the presentations, including execution of demonstrations and participant exercises, but only in-person participants could run the software involved and have assistance on-site if needed.

Workshop participants are expected to have attend the first two days of MSG-211, either in-person, online, or through recordings. The introductory class for the Workshop consisted of a review of those first two days. With regard to supporting Notes, that material is best accessed through the Notes for the first two days. This Note will describe what was presented and what hands-on activities were undertaken; however it is in the nature of those activities that a Note cannot pass on very much of the experience provided to participants; only a description of what they did is possible here.

### 1.1    Background Classes

The following sessions from the first two days provide a rich background for understanding M&S in FMN, but do not relate directly to this workshop:

1.1    Introduction to FMN

1.2    SISO, IEEE and NATO M&S Standards Overview

1.6    Overview of M&S as a Service

1.7    Benefits of M&S to military commands using FMN

2.1    MSG-201 activity support standardization of FMN

2.2    The SISO standards process

2.5    Ontology Walkthrough

## 1.2    Workshop Introduction and Standards Review

The first class in the Workshop covers administrative expectations and provided a summary of the M&S standards environment and the specific M&S standards recommended for FMN and these are:

- Command and Control – Simulation Interoperation (C2SIM);

- High Level Architecture for M&S (HLA);

- NATO Education and Training Network (NETN);

- Modelling and Simulation as a Service (MSaaS): the aspect of MSaaS recommended for initial FMN implementation is Cloud operations. These are beyond the scope of this Workshop.

## 1.3    C2SIM and HLA Operation

The second class in the Workshop covers detailed information on the C2SIM standards and supporting software, needed to complete the hands-on workshop. This began with a review of the three C2SIM ontologies: Core (classes needed for all C2-simulation interoperation), Standard Military Extension (SMX), and Land Operations Extension (LOX). This included a demonstration of the Protegé ontology viewer, showing how these three can be viewed as layers, with inheritance of classes from lower layers.

The ontology topic was followed by a deeper view of the Extensible Markup Language (XML) schema that is derived from the composite ontologies. The C2SIM Schema provides the necessary basis to define standardized messages among C2SIM implementations: object and system initialization, domains for Orders, Reports and Requests, system commands to synchronize operations of the simulations in a C2SIM Coalition, and acknowledgement messages where reliable transmission is required. All of this is required to comply with the IEEE FIPA formal communication rules, which are most easily achieved by using the client library for the C2SIM Reference Implementation Server. Use of the Oxygen XML Editor was demonstrated as a way of assembling C2SIM messages and validating them against the C2SIM XML Schema. The Initialization messages which are required to establish a running C2SIM Coalition were used as an example of editing XML. Treatment of C2SIM finished with inspection of the internal operation of C2SIM open source software. This began with the C2SIM Server and its Client Library and then proceeded to the C2SIM GUI Editor and C2SIM interfaces to simulation software.

The second class concluded with details of operating an HLA Federation using Runtime Infrastructure (RTI). This entailed a walkthrough of the steps in configuring and executing the Pitch pRTI.

## 1.4    Creating C2SIM Initialization, Order and Report Messages

The third class in the Workshop prepares participants to produce XML documents needed to run a C2SIM Coalition. As a first step to this it was explained that while the Universally Unique Identifier (UUID) used in C2SIM implementation normally consists of a hard-to-remember pattern such as 123e4567-e89b-12d3-a456-426614174000, for experimentation purposes we use a non-standard simple pattern (with the correct number of digits) that is easy to read and remember, such as 00000000-0005-0001-1000-000000000001.

The class proceeds by illustrating possible C2SIM Coalition organizations, using recent CWIX examples. This was followed by demonstration of the various functions of the C2SIM GUI, with a focus on assembling and editing C2SIM-schema-compliant XML files.

## 1.5    Running C2SIM Components Using Modified Order XML Documents

The final class in the workshop is intended to culminate in the intended hands-on experience for participants:

- Verify software on your workstation works.

- Verify server works.

- Edit initialization.

- Create an order by editing.

- Run your order in VRForces [2]:

  - Individually and all together.

- Run your order in SWORD [3]:

  - Also individually and all together.

The open source software used is available at https://openc2sim.github.io:

- C2SIM GUI

- c2simVRF interface to VR-Forces

- C2SIM Reference Implementation Server

Each participant is provided a separate, two-digit number. This was used to identify their version of the VR-Forces and SWORD Orders. The Opposing Force (OPFOR) had its own set of numbers. They could either be included in a friendly order or held for execution by Workshop staff, unknown to the friendly forces as in a normal military training exercise. State of the various simulations was shared using High Level Architecture (HLA) using the Pitch RTI, with the result that participants received "ground truth" (simulation values). We did not have a filter that might have send "perceived truth" via C2SIM while ground truth was shared over HLA. The participants had to select HLA 1516 Evolved on the VRForces launcher.

Participant desktops had icons for the simulation systems used in addition to folders with all data and software and shortcut icons to run the C2SIM GUI and the c2simVRF interface to VR-Forces (SWORD was executed separately at MASA and linked into the Workshop by HLA and C2SIM over VPN).

Here are the participant steps for verify software on your workstation works:

- Open C2SIMGUI.

- Working with C2SIM Orders:

  - Click start shortcut icon on desktop.

  - Use File menu to load Order TestOrder-V##.xml.

  - Review order text in the left panel vs map.

  - Then load and review Report C2simv1.0.0-PositionReport.xml.

Here are the steps for *verify server works*:

- Change the Server address in the C2SIMGUI Config to 192.168.3.229:

  - Restart GUI – you should see the entire OOB on GUI.

- With VR-Forces running, start c2simVRF interface:

  - Click start shortcut icon on desktop.

- • You should get a unit icon for COY-V## on VRForces GUI.

- • The Objects list at left should show its internal organization.

- Send VR-Forces an Order using the C2SIMGUI:

  - • Push the TestOrder-V##.xml in Orders:

    - • Each workstation has a unique order.

    - • They go to the C2SIM server.

    - • Positions have been chosen to not interfere.

  - • Your unit should move on VRForces##.

  - • Reports should appear on C2SIMGUI.

Here are the steps for *edit initialization*:

- • Use the Windows Notepad editor.

- • Look in Orders & Init – load "VRF 2022 initializev18.xml".

- • Note the ForceSide entries at start:

  - • Blue is NATOCoalition; other side is OPFOR; there is al Neutral.

- • Note the RED-OPFOR-V## corresponding to your COY:

  - • Its Side is OPFOR.

  - • Its Latitude and Longitude are near your COY but not the same.

  - • It is of DISEntityType MobileIrregular.

- • Note the XML for your COY Side, Latitude and Longitude:

  - • Your DISEntityType is Armor Company.

- • Near the end of file, note the SystemEntityList for your COY:

  - • It should be associated with UUID of your VRForces##.

Here are the steps for *create an order by editing:*

- • Use C2SIMGUI config to set AutoDisplayOrders to blank, so other student orders don't get loaded.

- • Edit your TestOrder-V##.xml in the C2SIMGUI:

  - • Positions have been chosen so they do not interfere with each other.

- • Edit the Location Latitude to 58.2.

- • Change the RuleOfEngagement to ROEFree.

- • Change last digits of Order ID and UUID to 1:

  - • Each order and task UUID is required to be unique.

- • Save JAXFront order as TestOrder2-V##.xml.

Here are the steps for *run your order in VR-Forces:*

- • PushJAXFront so your TestOrder2##.xml goes from JAXFront panel to the server.

- • Your VR-Forces should respond by moving your unit again.

- There will be an OPFOR unit at your destination location, shared via HLA:
  - Your COY should engage when near.
  - C2SIMGUI is set to show ground truth for both your COY and OPFOR.

Here are the steps for *run your order in SWORD*:

- Dr. Beatriz Garmendia-Doval of MASA participated in C2SIM evaluation with SWORD:
  - CWIX and MSG-145 Mini-Ex 2019
  - CWIX 2022 with MSG-201
- Most recently, she has developed a prototype SWORD implementation of C2SIM v1.0.2.
- She will demo SWORD C2SIM for us now.
- There is also a TestOrder-S##.xml in your workstation:
  - Each workstation has a unique UUID in the Order.
- You should now be able to Open and Push that Test Order into SWORD and see a sequence of Reports on the map.
- When everybody is ready, we'll all run this simultaneously:
  - You should see all orders and reports in your GUI even though there is only one SWORD system.
- Edit the task latitude to 58.9, change the order and Task IDs, and run it again using PushJAXFront.

Time permitting, it is intended to create a collective scenario and run it in VR-Forces, or as an alternative to run one or more orders from CWIX which were included in the participants' package. (We did not have time for these activities in either of the Workshops included with MSG-194.)

The Workshop closed with a discussion session. Participants agreed they had learned a considerable amount. They made suggestions for packaging the workshop software to make installation and use simpler.

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## 2.0   REFERENCES

[1]   Galvin, K., Pullen, J., Jense, H, van den Berg, T., Blais, C., Dechand, M., "Advancing Modelling and Simulation in NATO Federated Mission Networking, NATO Modelling & Simulation Symposium 2023, Monterey, California, October 2023.

[2]   MAK Technologies VR-Forces, https://www.mak.com/mak-one/apps/vr-forces last visited 7 September 2023.

[3]   MASA Group SWORD, https://www.masasim.com/en/sword last visited 7 September 2023.