

# **Standardized C2-Simulation Interoperability (C2SIM)**

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# Overview

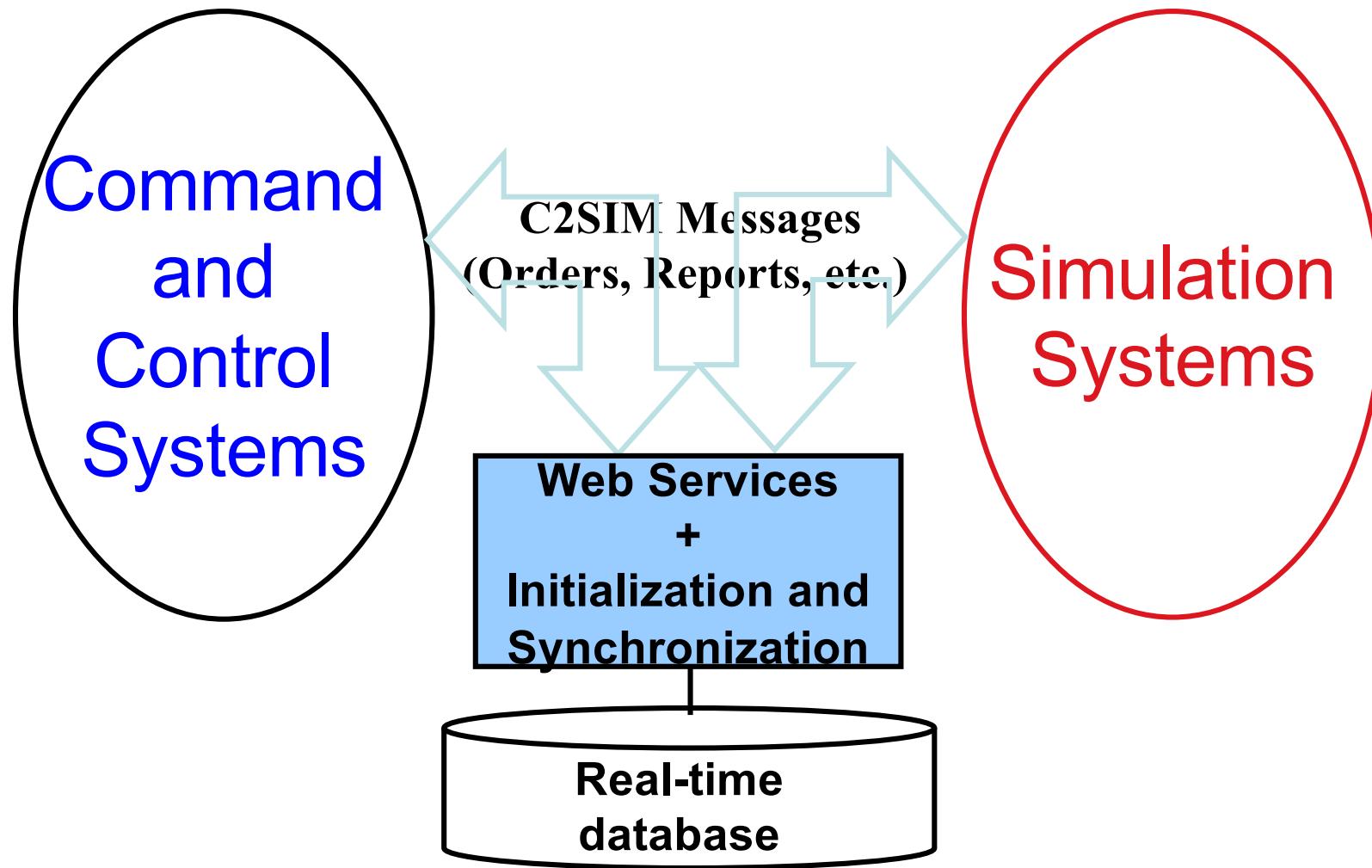
- **C2SIM Overview**
- **SISO and NATO Roles**
- **C2SIM Standard Synopsis**
- **C2SIM Validation in CWIX & MiniEx**
- **Conclusions**

# C2SIM Vision

**We are working toward a day when the members of a coalition interconnect their networks, command and control (C2) systems, and simulations simply by turning them on and authenticating, in a standards-based environment.**

**A C2SIM Coalition is a system of systems.**

# C2SIM Basic Architecture



# Interdependency of NATO and SISO

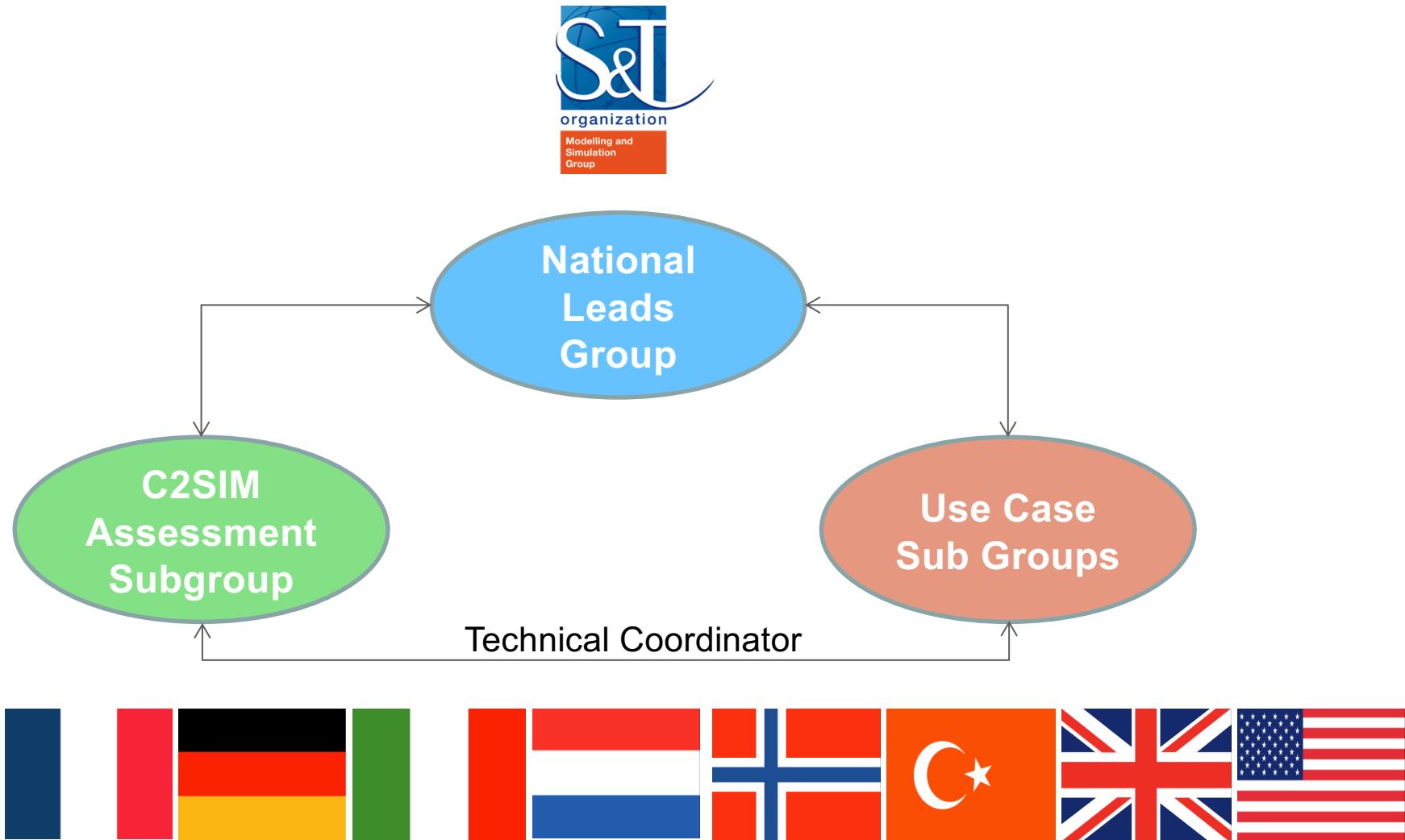
NATO MSG depends on SISO for open industry-based standards

SISO depends on NATO Technical Activities to field and validate C2SIM technology

# NATO MSG-145 Mission Statement

*Assess the C2SIM standard in development and implement extensions to the unified C2SIM Logical Data Model (LDM) for specific functional areas in order to demonstrate its usability to the simulation community and support the definition of a STANAG*

## MSG-145 – Organization



## Standard Assessment

- **Support the work of the SISO C2SIM PDG in assessing the Draft C2SIM standard, in providing recommendations and in proposing best practices**
  - Review the usability of the core data model
  - Experiment the mechanism of extending the core LDM
  - Check the usefulness of the land operation extension
  - Review the combination of initialization and tasking/reporting
  - Check the effectiveness and completeness of documentation
- **Standard validation: 6 nations CWIX 2019 C2SIM in MSaaS**



## Apply the Standard

- **Implement C2SIM standard and where necessary extend for a number of use cases**
  - Provide a distributed environment for test, evaluation and experimentation (C2SIM SandBox)
  - Adopt operational, conceptual and execution Scenario development process
  - Use NAF to express C2SIM exchange requirements
  - Develop extensions to the C2SIM LDM core for specific functional areas



Use Case  
Sub Groups

# SISO C2SIM STANDARD

## SYNOPSIS

# C2SIM Standard

- **SISO develops international, open standards**
- **Initial versions**
  - Military Scenario Definition Language (MSDL) supports initialization
  - Coalition BML (C-BML) provides for exchange of Tasking (orders and requests) and Reporting information
- **Unified standard under development as C2SIM**
  - C2SIM Core and Standard Military Extension (SMX) Ontologies
  - Initialization & Synchronization messaging
  - Tasking & Reporting messaging
  - Extension Mechanism and Land Operations Extension
  - Guidance document

# C2SIM Ontologies

- **Definition**
  - Set of concepts and categories in a subject area or domain that shows their properties and the relations between them
- **Core: data classes and properties that are needed by all C2 and simulation systems to interoperate**
  - Who, what, when, where
- **Standard military extension (SMX): classes and properties that are needed by all military C2 and simulation systems**
  - Mostly more properties for core classes, e.g. Entity has a ForceSide
- **Land Operations Extension (LOX): classes and properties that are needed by ground C2 and simulation systems**
  - Separate standard; example for other new extensions

# C2SIM Messaging

- **Standard header for all C2SIM messages**
  - Implements FIPA formal communication rules
  - Handled by standard library to ease implementation
- **Standard message bodies for various required content**
  - Object and System Initialization information
  - Domain Messages: Order, Report and Plan information
  - System Commands: Synchronize initialization and execution
  - Acknowledgement: Confirm information receipt where needed

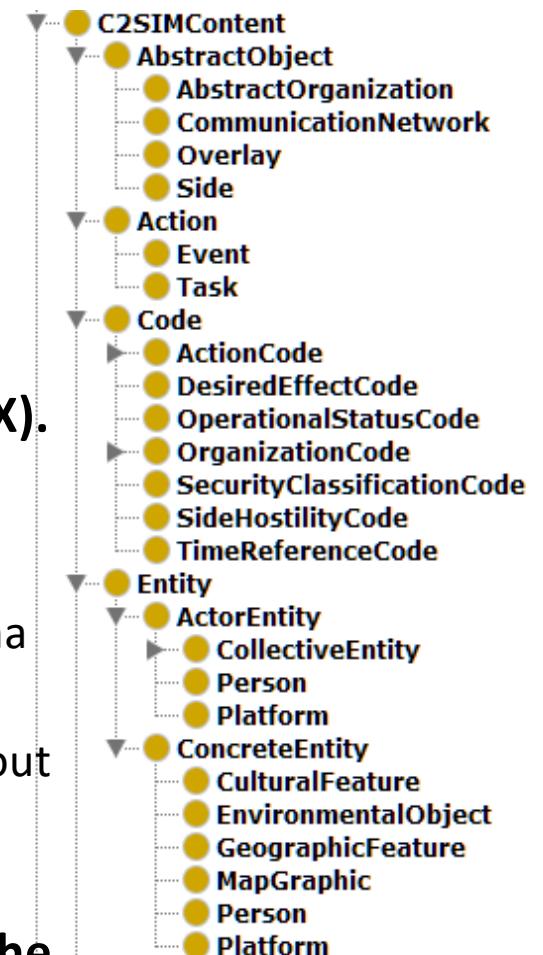
# Reference Implementation Server and Client Library

- **Implements C2SIMv9 draft standard XML schema**
- **Supports a *Coalition* of C2 and Simulation systems interoperating**
- **Aggregates initialization data and serves it to all systems**
- **Passes control messages to start/pause/stop execution**
- **Distributes orders and reports based on subscription**
- **Logs all messages for playback and analysis**
- **Translates between C2SIM and legacy formats (MSDL/C-BML)**
- **Compatible client library simplifies implementation (Java & C++)**

# Ontology to XML Schema transformation



- Starting with the C2SIM ontology, generate an XML schema document suitable for use by the community (e.g., for CWIX).
- Develop a transformation process that does not need to be modified if the ontology changes.
  - That is, the transformation will auto-generate the target schema directly from the ontology.
  - When the ontology changes, the transformation process, without modification, will just need to be re-executed to generate the desired XML schema document.
- Provide a foundation for one or more implementations of the transformation process.

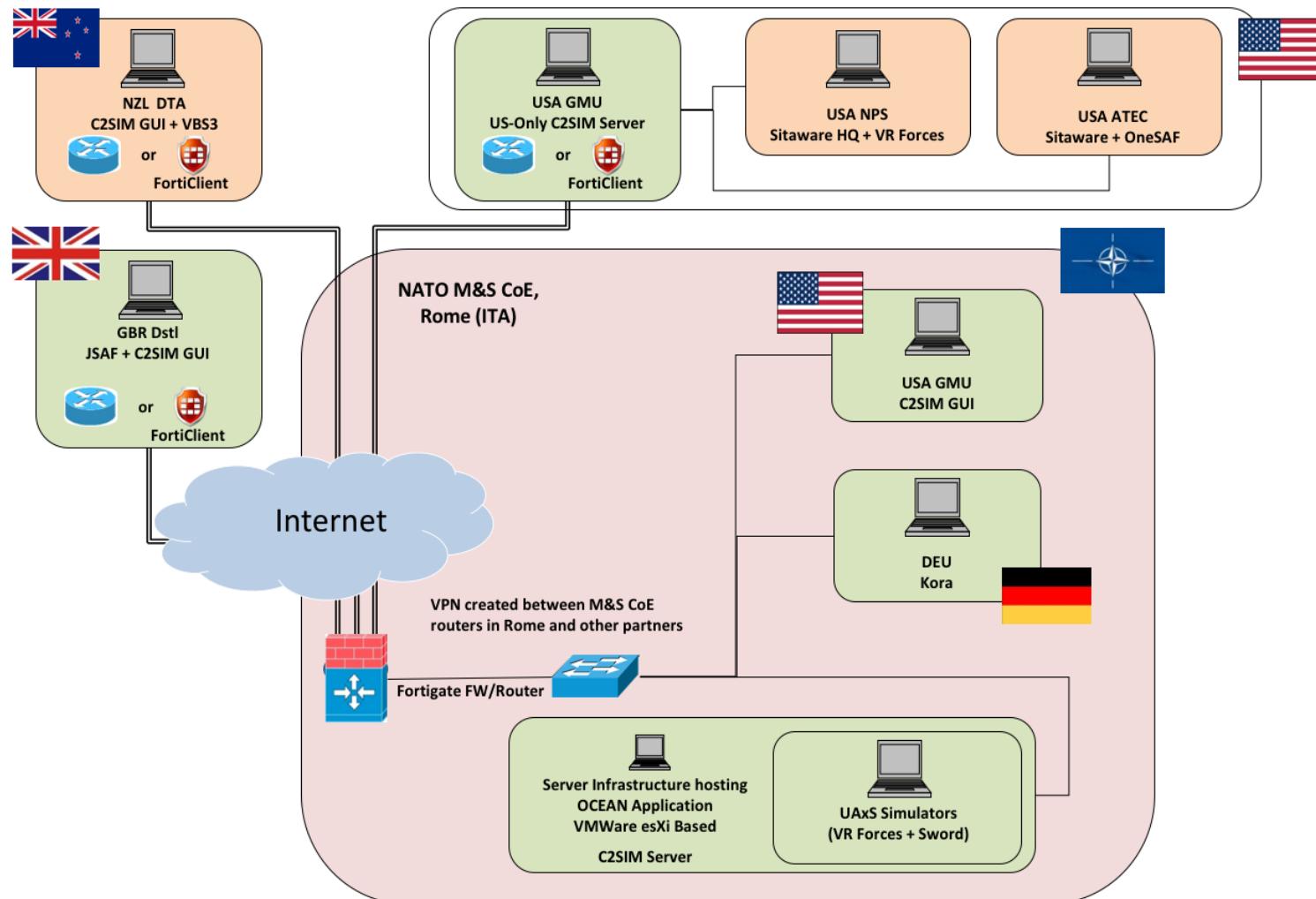


# C2SIM Validation in CWIX and MiniEx

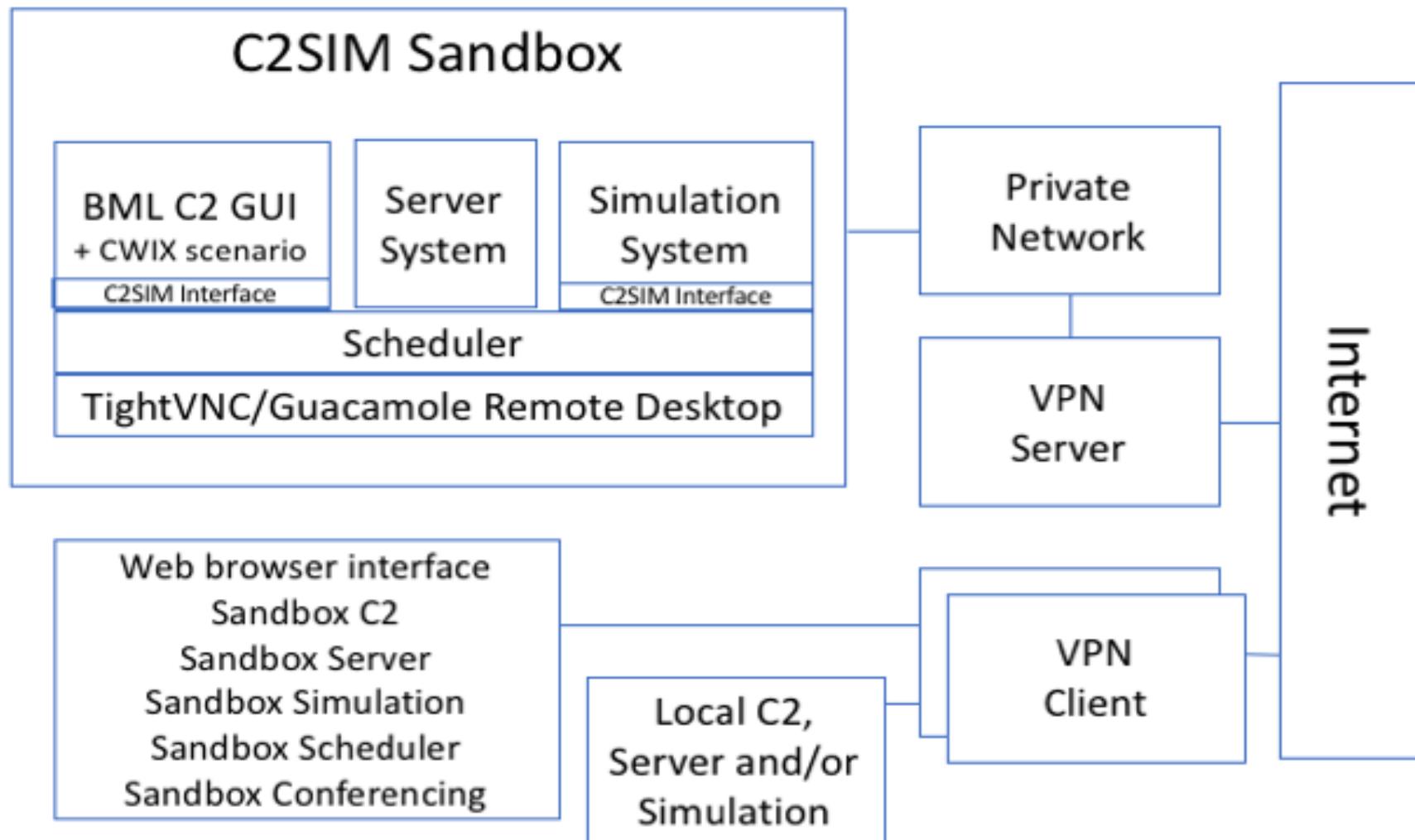
# CWIX 2019

- **NATO Coalition Warrior Interoperability eXploration, eXperimentation, eXamination eXercise**
- **Focus on testing: do the systems interoperate**
- **January to May 2019 six MSG-145 national teams interfaced simulations, server and editor to C2SIMv9**
  - France: MASA/Sword (used by MSCOE Rome)
  - Germany: iABG/KORA
  - Italy: VTMAK VRForces Autonomous Systems Plugin
  - UK: JSAF legacy simulation as air component
  - USA1: VTMAK VRForces external interface + SitaWare
  - USA2: OneSAF + SitaWare
- **Systems interoperated via Internet VPN; used GMU Editor**

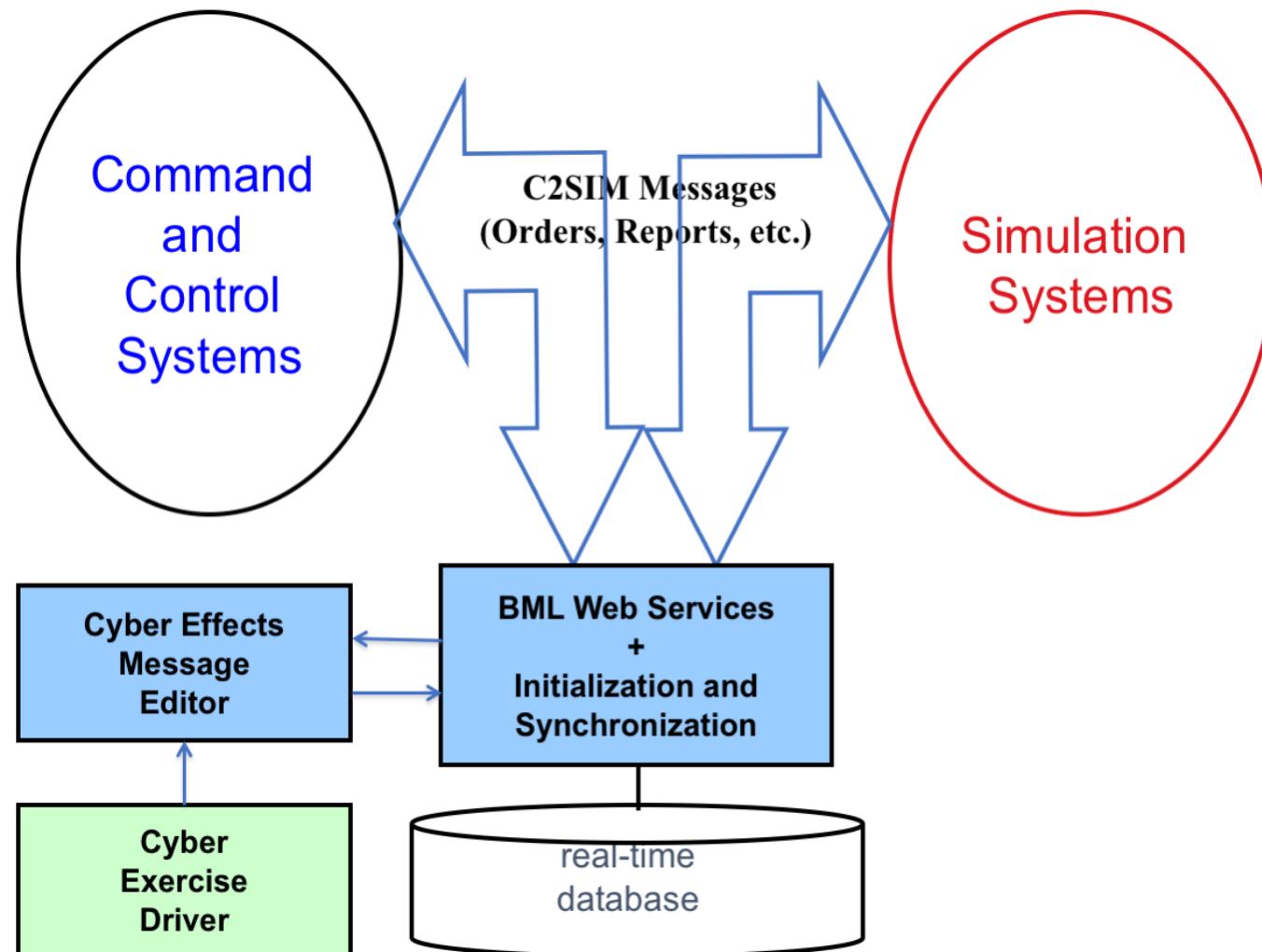
# CWIX 2019 C2SIM Networks



# C2SIM Sandbox Run By GMU and MSCOE



# C2SIM with Cyber/EW Effects



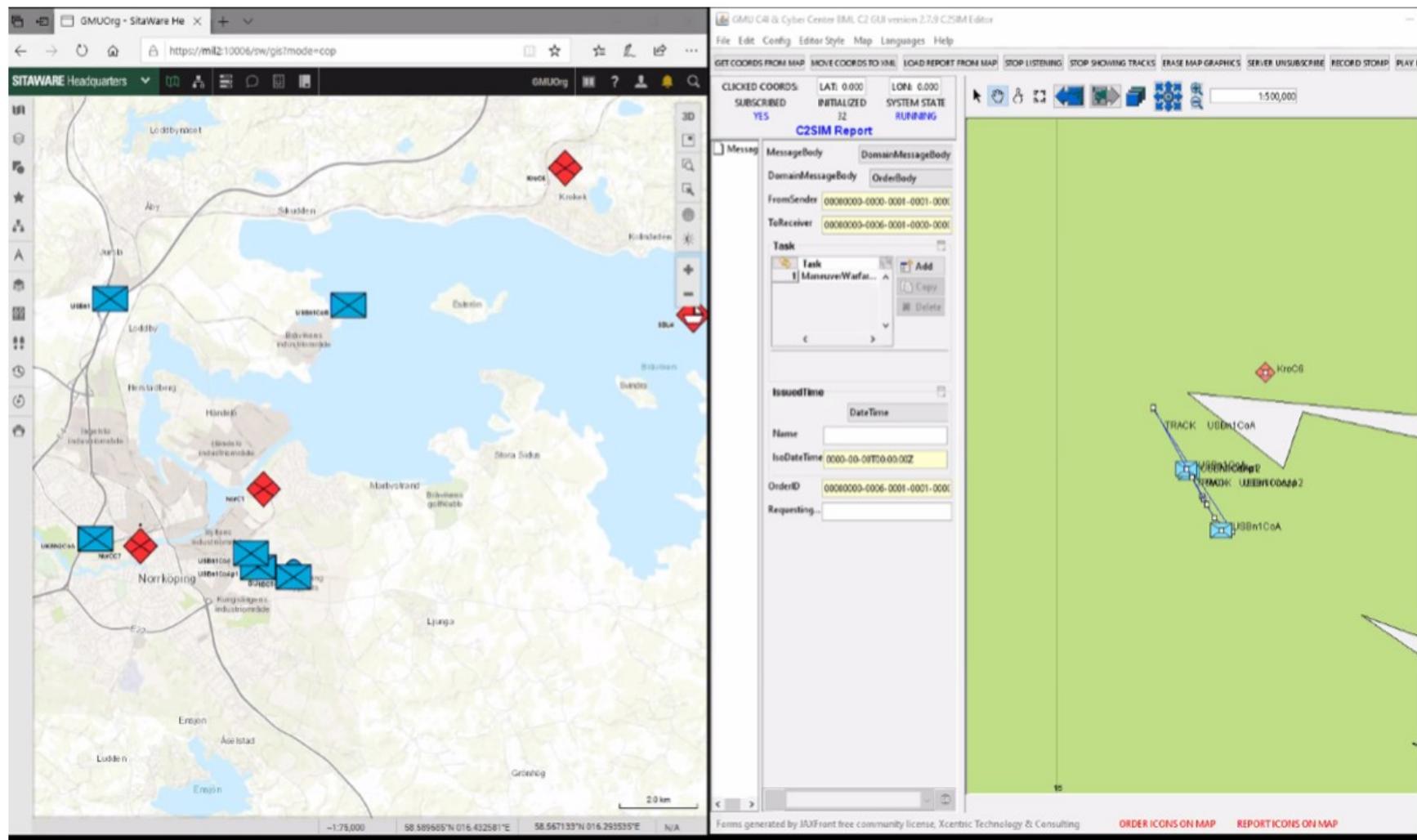
## MSG-145 Mini-Exercise

- **Distributed planning exercise with six nations**
  - CWIX teams plus New Zealand with VBS3
- **Intended to verify military utility of C2SIM**
  - Successful CWIX testing showed systems can exchange data effectively using C2SIM
  - Exercise used six simulations interoperating
  - C2 function filled by GMU Editor (+ SitaWare SA in USA)
  - MSCOE ran Autonomous Systems Extension
- **Participants agreed C2SIM is functional and not difficult to implement**
  - Ready for balloting as soon as issues exposed by implementation are resolved (target Oct 2019)

# MSG-145 C2SIM Scenario

- NATO ground forces deploying in Bogaland to assist the Bogaland government in countering the increasingly aggressive activities of the WASA, the indigenous people of the Norrköping region.
- The WASA are receiving assistance from external nation-states. Information Operations and aggressive military activities have been initiated using the WASA as a surrogate.
- The WASA have been expanding their presence across the region along Highway E4 from Linköping to Norrköping, with the intent to move into Stockholm.
- To support operations, the WASA are using Braviken Bay for logistics operations. Additionally, they are seeking to create a new port at Oxelösund to begin their movement northward to Nyköping.
- As the WASA grows in strength, the Bogaland government requested NATO support to stop WASA's extensive usage of Braviken Bay and counter their movement towards Stockholm along Highway E4 north of Linköping.

# Execution as Seen in SitaWare and Editor



# Conclusions

- **C2SIM provides powerful new capability for coalition training and planning**
  - Standards from SISO
  - Implementation and validation from NATO
- **MSG-145 has conducted 2019 experimentations, demonstrations and testing with team from AUS–DEU–FRA–GBR–ITA–NZL–USA**
  - CWIX 2019
  - Mini Exercise
  - CAX Forum

# QUESTIONS





# BACKUP

# KORA German Simulation

**KORA <2>**

Start Ground Air Sea Distaff Evaluation Simulation Messages View Extras Archive

Orbat: BLAU

Name	Level	Comb
BLAU	0 %	
ALLIANCE	XXXX	0 %
JFTHQ	XXX	0 %
LANDCOM	XX	0 %
INF	X	0 %
USABTL		0 %
USAKP		0 %
USA1	°°	0 %
USA2	°°	0 %
USA3	°°	0 %

Orders: Orders of USA3

Order: Begin

1 Mov

**Info: USA1**

1	2	3	4	5	6	7	8	9	10	11	12	
X												
Situation	Messages	Orders	Personnel	Supplies	Subord							

Fuel: 100 %  
Water: 99 %  
Food: 100 %

Coordinates: 33V-WE7185095453  
Employment time: 0 h  
Combat Strength: 0 %  
Strength: 100 %  
Order: Stby  
Behaviour: Reserve

**Info: USA2**

**Info: USA3**

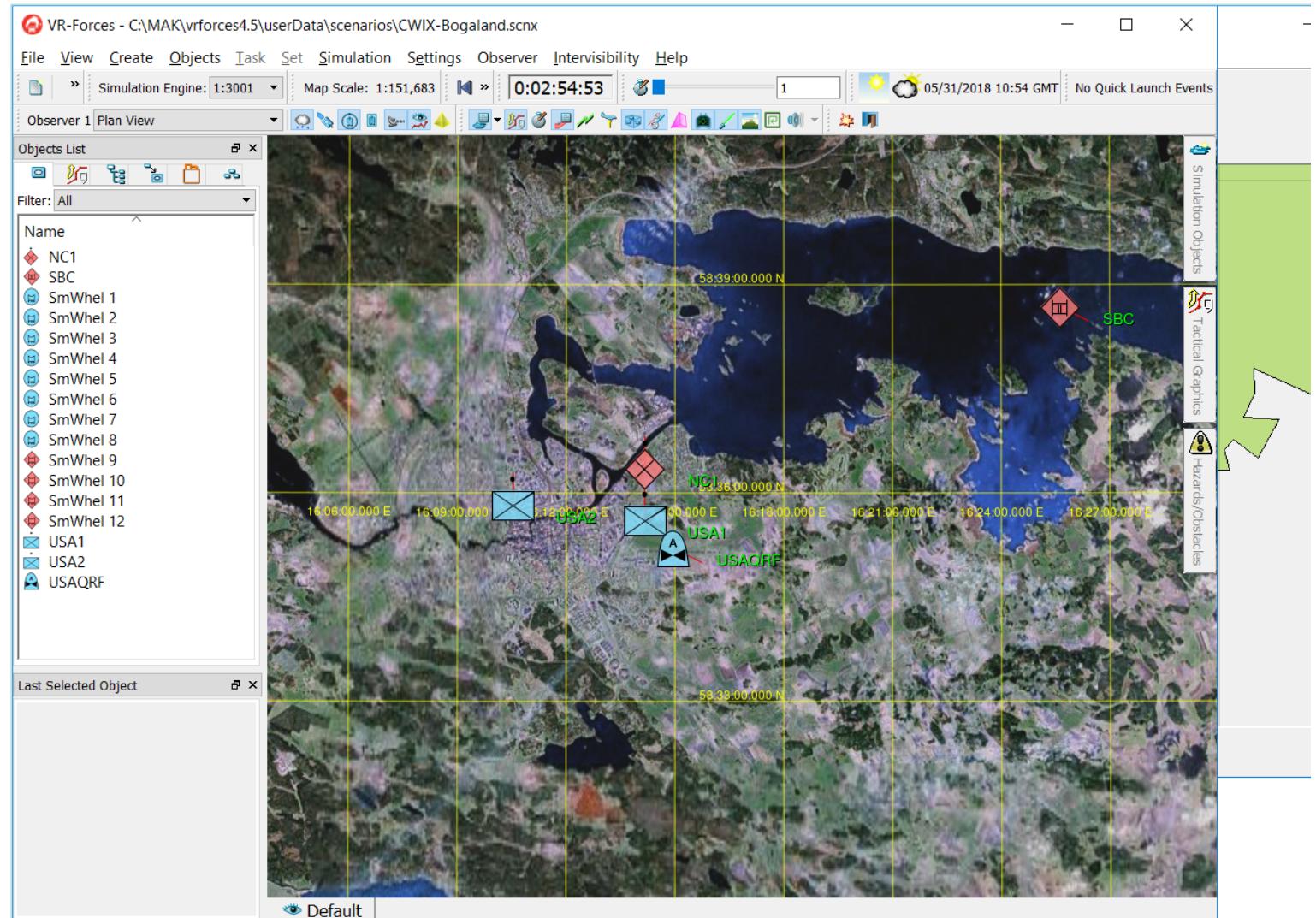
**Order**

Unit: USA3  
Order no.: 1  
Order: Mov  
Behaviour:  
Condition: immediately  
Time:  
After order no.:  
Width: 0.5 km  
Impact settings: Weapons free  
Destination node:  
Upon arrival:  
Coordinates: Center line

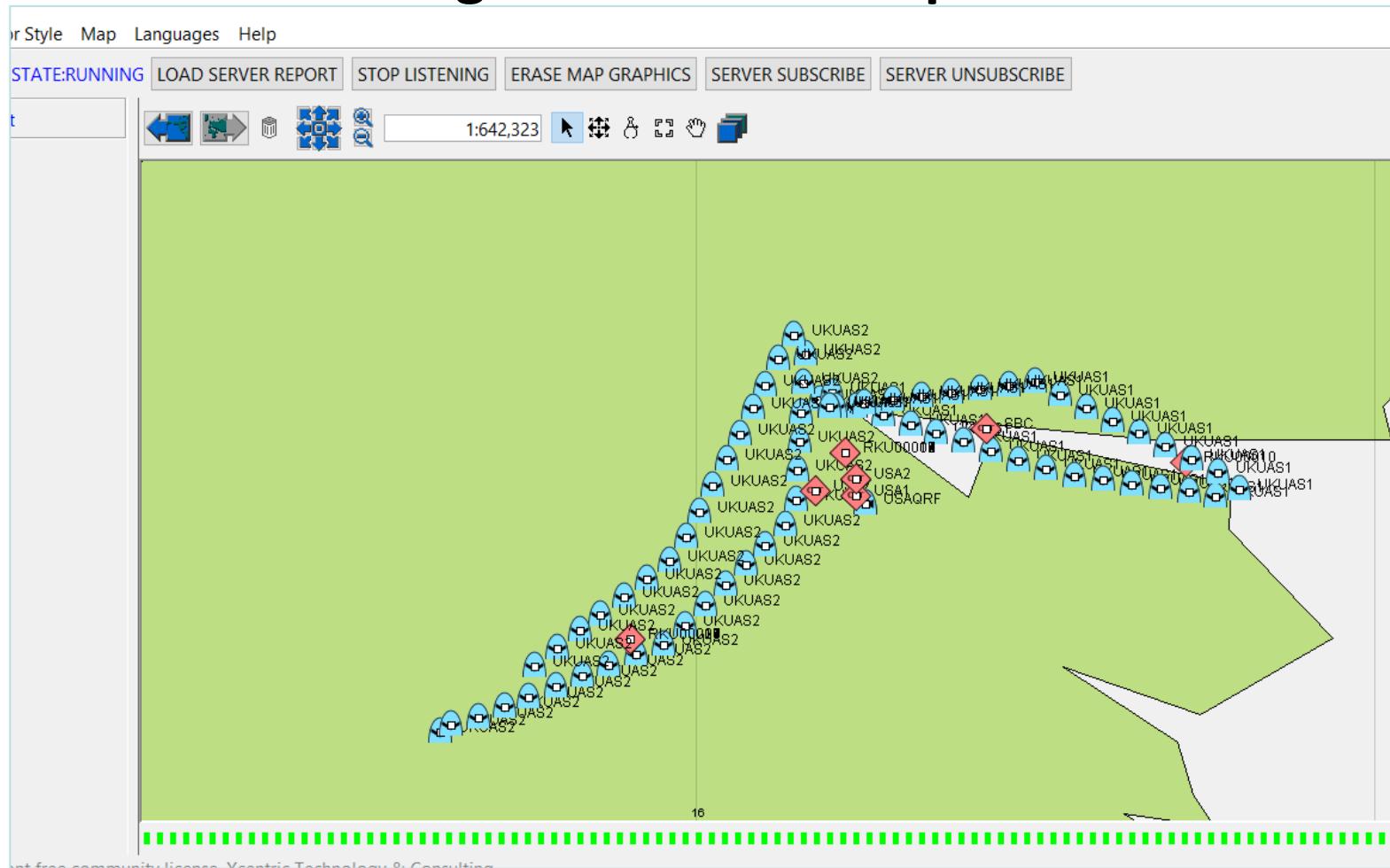
1 33V-WE4510079600  
2 33V-WE6800091899

GARS: 393NJ11 33V-WE6045375782 1:150.000 ACO/ATO:/0 FR CWIX18 Time: 200516-00

# VR-Forces Commercial Military Simulation



# GMU Open Source BMLC2GUI Editor showing JSAT UAS recon patterns



## Rules/Restrictions for the Transformation Process

- The rules and restrictions apply both to how the content of the C2SIM ontology is transformed as well as what XML schema constructs are allowed in the generated schema
- Transformation rules largely prescribe what XML schema structures are generated from certain ontology constructs, such as:
  - RDF Datatype statements, both string patterns and numeric types
  - OWL DatatypeProperty and ObjectProperty statements
  - Classes with a collection of defined OWL individuals
  - Classes defined by property axioms
  - Subclass inheriting from and extending a parent class
  - Handling of cardinality constraints and existential/universal restrictions