

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

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# Overview

- **C2SIM Overview**
- **SISO and NATO Roles (video)**
- **C2SIM Standard Synopsis**
- **C2SIM Validation in CWIX & MiniEx**
- **C2SIM Demonstration**
- **C2SIM and MIP**
- **Conclusions**

# C2SIM Vision

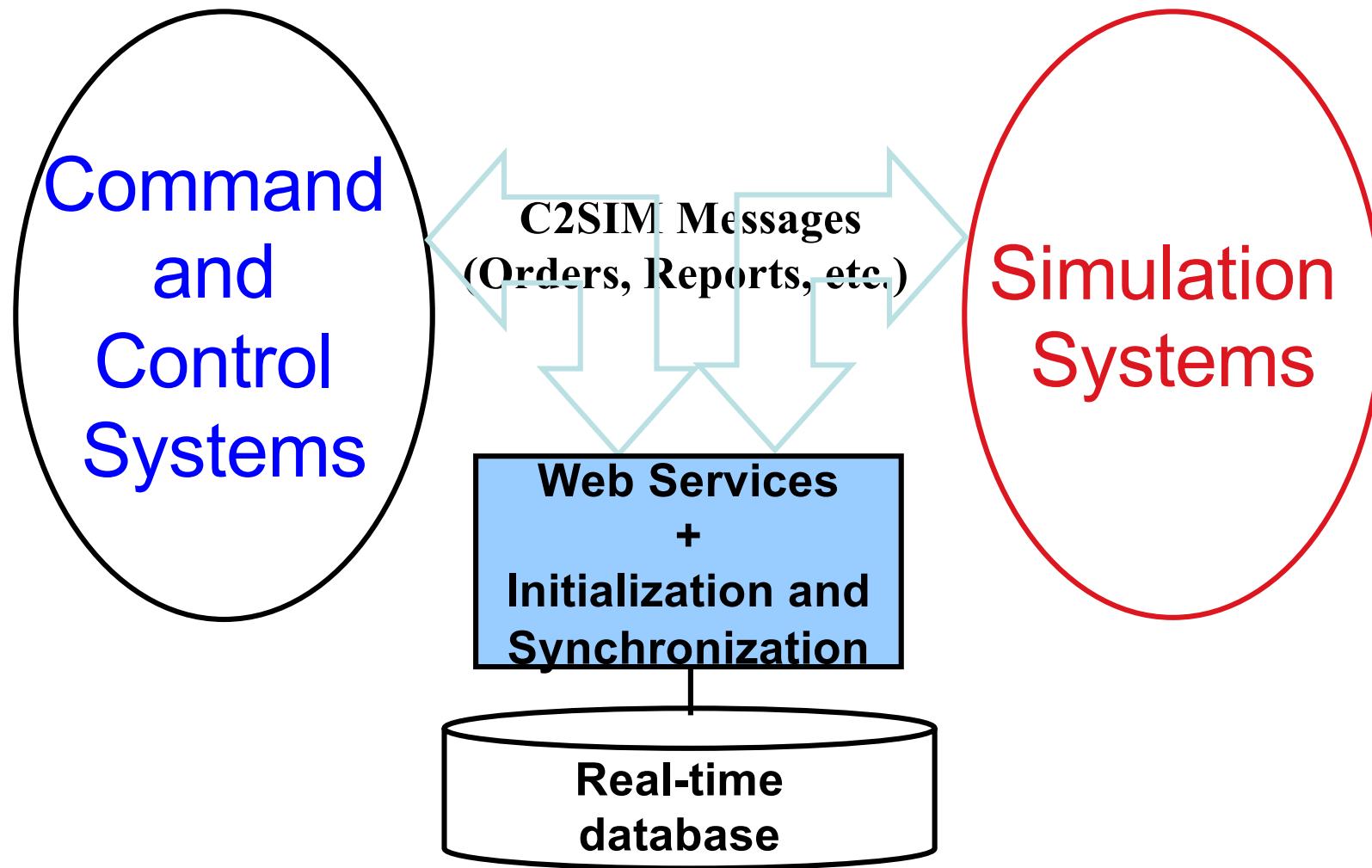
**We are working toward a day when the members of a coalition interconnect their networks, command and control (C2) systems, and simulations simply by turning them on and authenticating, in a standards-based environment.**

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

# Video Introduction to C2SIM

[https://www.youtube.com/watch?v=3L\\_Hhxuh6Zc](https://www.youtube.com/watch?v=3L_Hhxuh6Zc)

# 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*

# **SISO**

# **C2SIM STANDARD**

# **SYNOPSIS**

# C2SIM Standard

- **SISO develops international, open standards**
- **Initial versions of C2-simulation interop standards**
  - Military Scenario Definition Language (MSDL) supports initialization
  - Coalition BML (C-BML) provides for exchange of Tasking (orders and requests) and Reporting information
- **Unified second-generation standard recently completed: C2SIM**
  - C2SIM Core and Standard Military Extension (SMX) Ontologies
  - Initialization & Synchronization messaging
  - Tasking & Reporting messaging
  - Extension Mechanism and Land Operations Extension
  - Guidance document
  - All of these accepted in SISO balloting 29 March 2020
- **All of the above rely on definitions from the JC3IEDM**

# 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

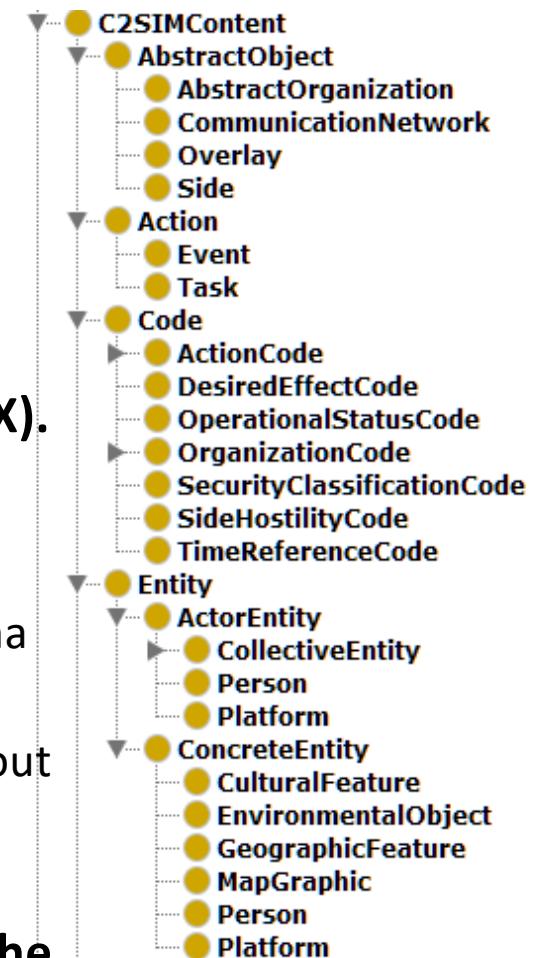
# Reference Implementation Server and Client Library

- 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

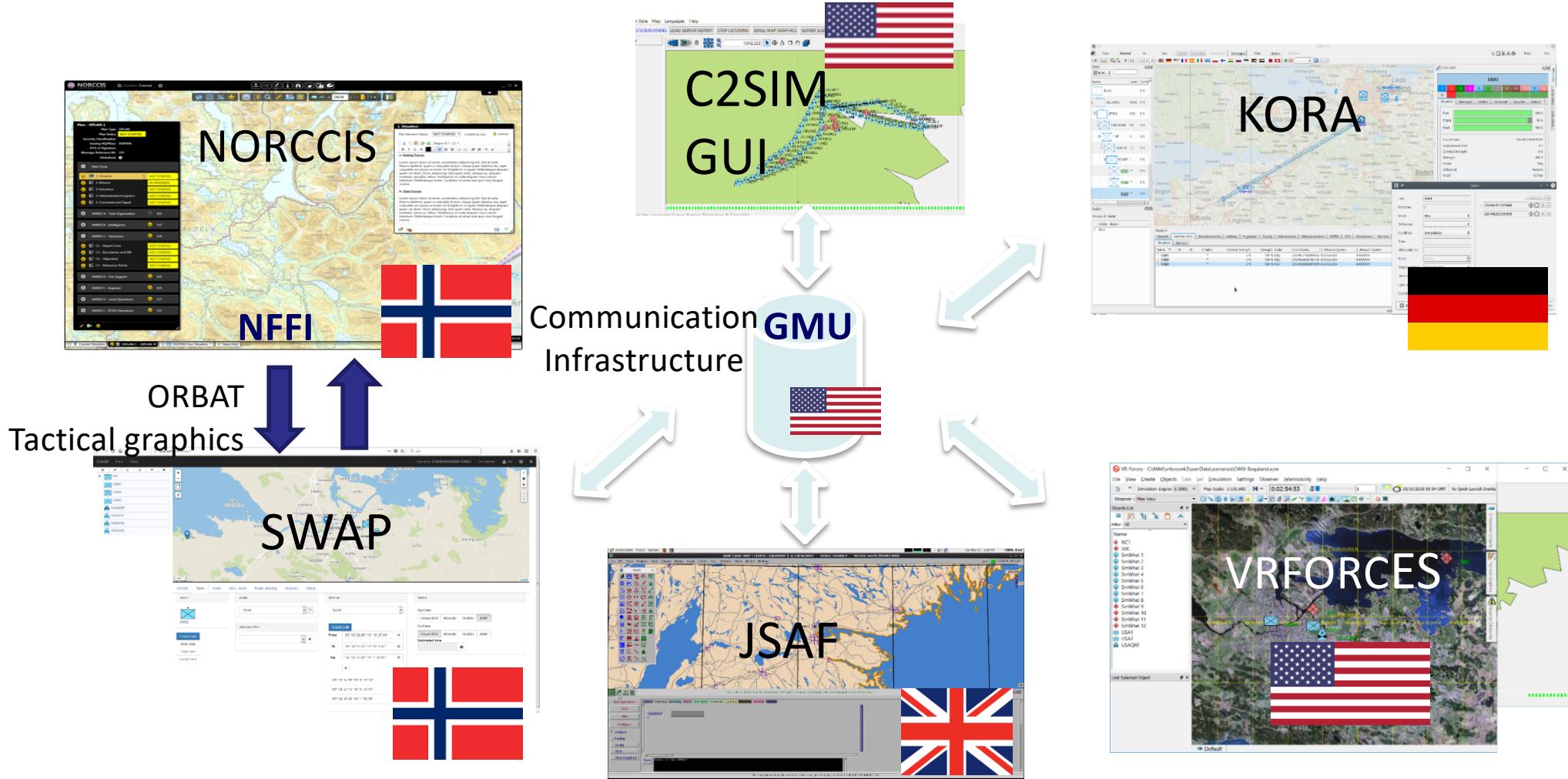


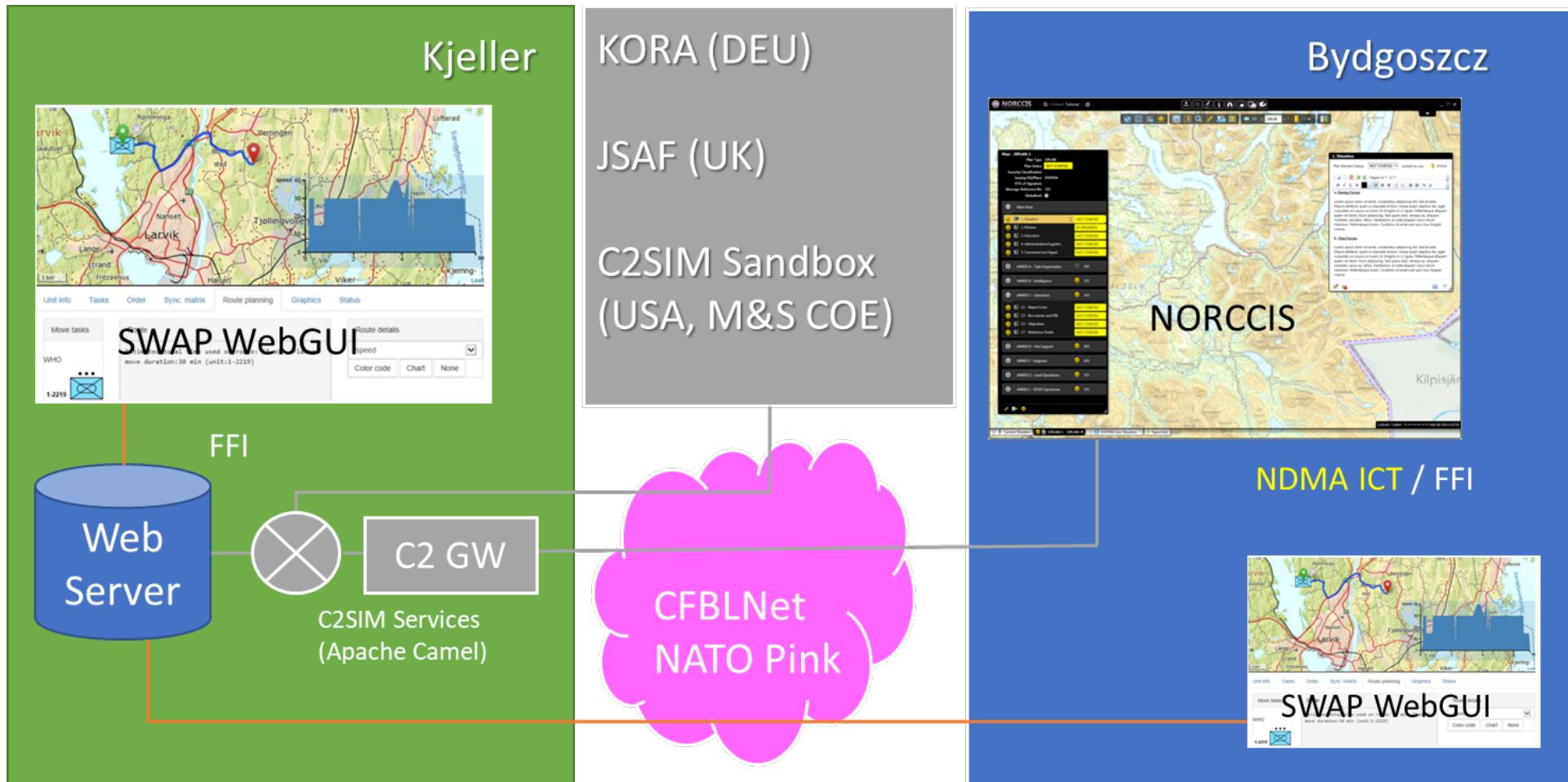
- Starting with the C2SIM ontology, generate an XML schema document suitable for use by the community (e.g., for CWIX).
- Develop a transformation process that does not need to be modified if the ontology changes.
  - That is, the transformation will auto-generate the target schema directly from the 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

# MSG-145 C2SIM CWIX 2018





- Develop Task Organization and Tactical Graphics using NORCCIS
- Develop executable Order using FFI SWAP WebGUI
- Simulate Order with GMU C2SIM Sandbox

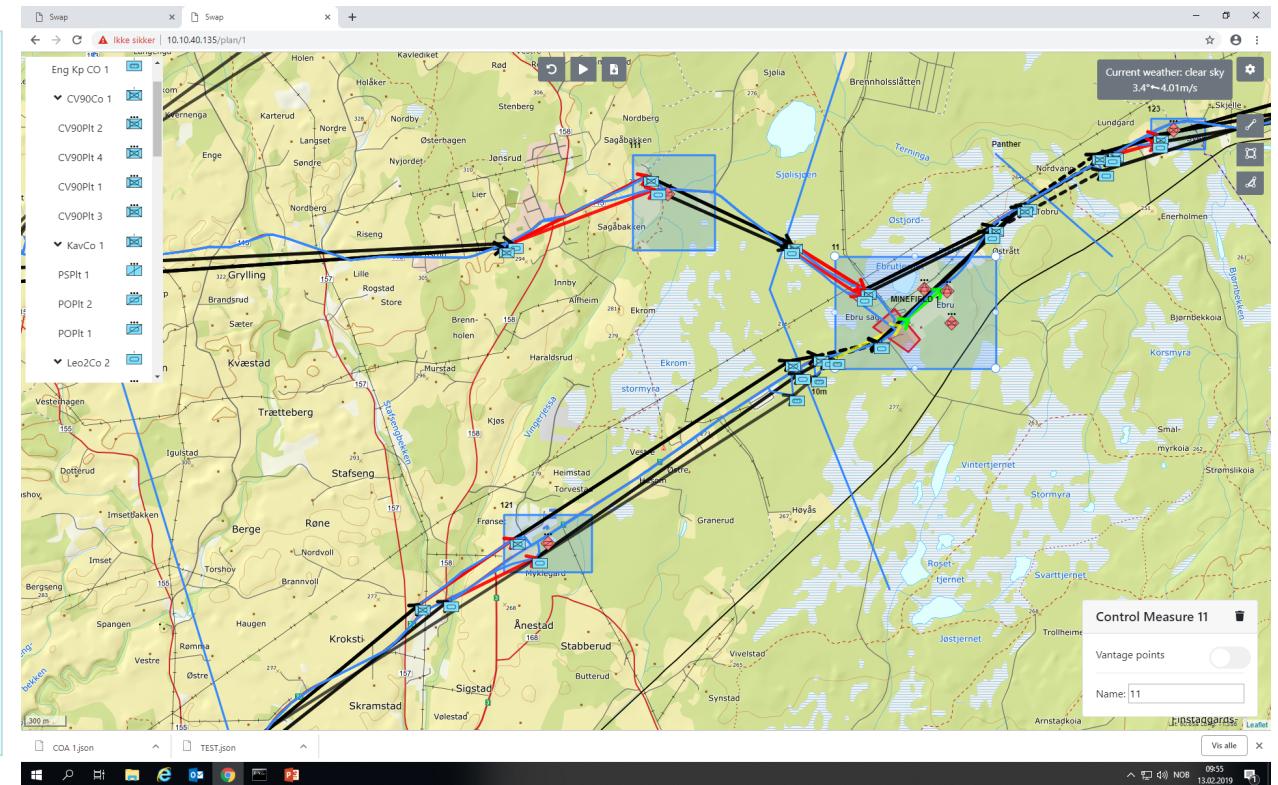
# SWAP supports the preparation of an Army operation by visualizing possible courses-of-action

## Wargaming for COA analysis

- Terrain analysis
- Simulation

Show consequences

Identify possible weakness in plan



# The purpose of SWAP

## Assessment of

- benefit of planning support tools
- potential of C2SIM and MSaaS

## Characteristics

- Enabled by C2SIM
- Developed according to MSaaS
- Based on standards

## Functionality

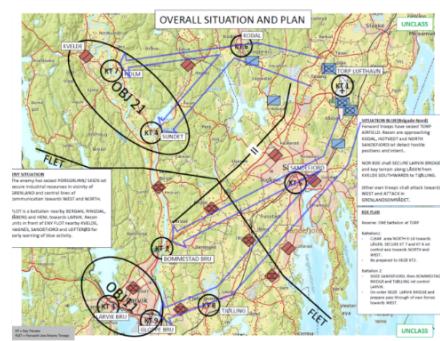
- Digital COA development
- Course-of-action (COA) simulation
- Terrain analysis



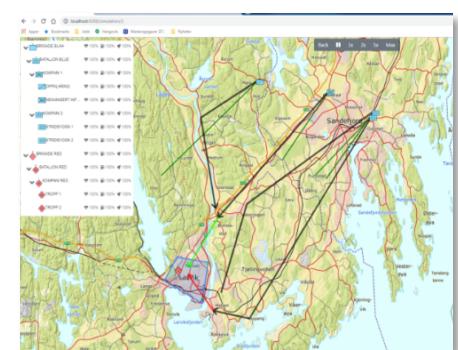
vs.



Experiment with 52 cadets from the Norwegian Military Academy in 2019



vs.



PowerPoint

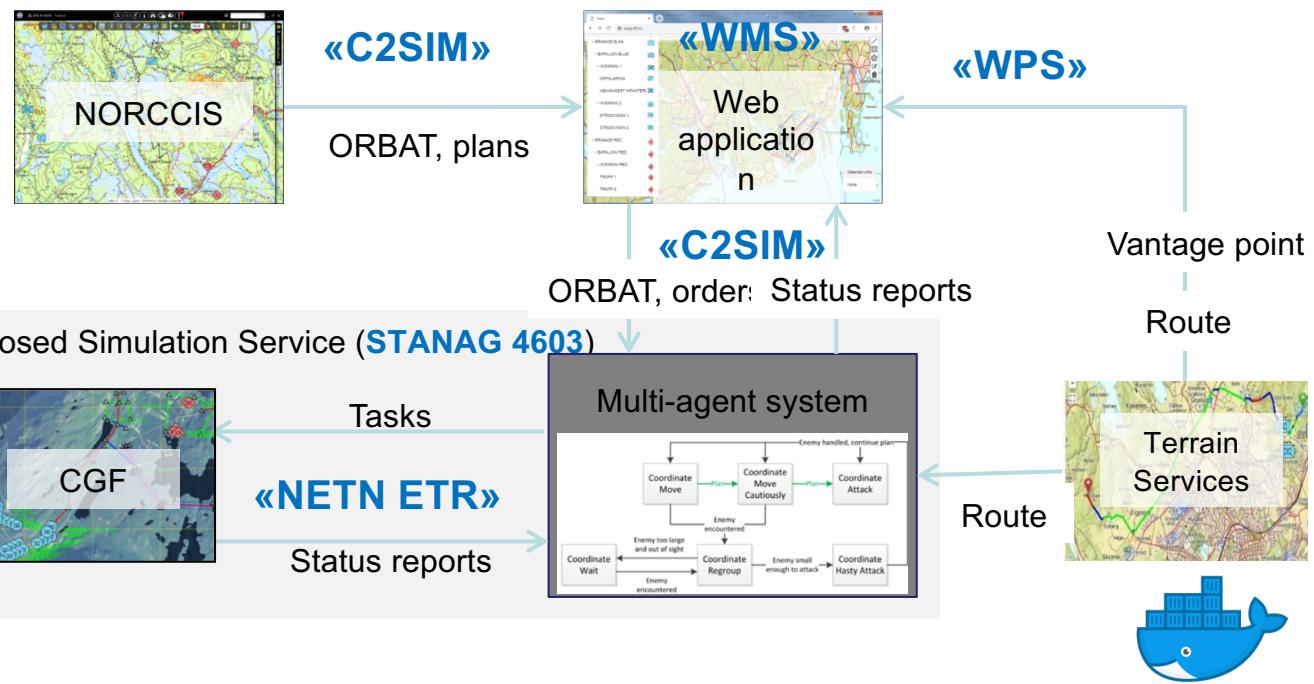
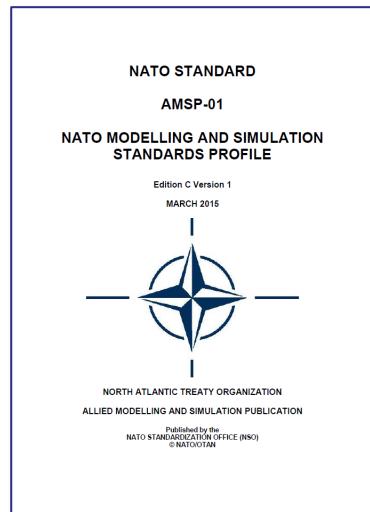
Digital, executable COA

# SWAP as an MSaaS demonstrator

Composed of services

Runs in the cloud

Uses NATO standards



**NETN** NATO Education and Training Network FOM (AMSP-04)

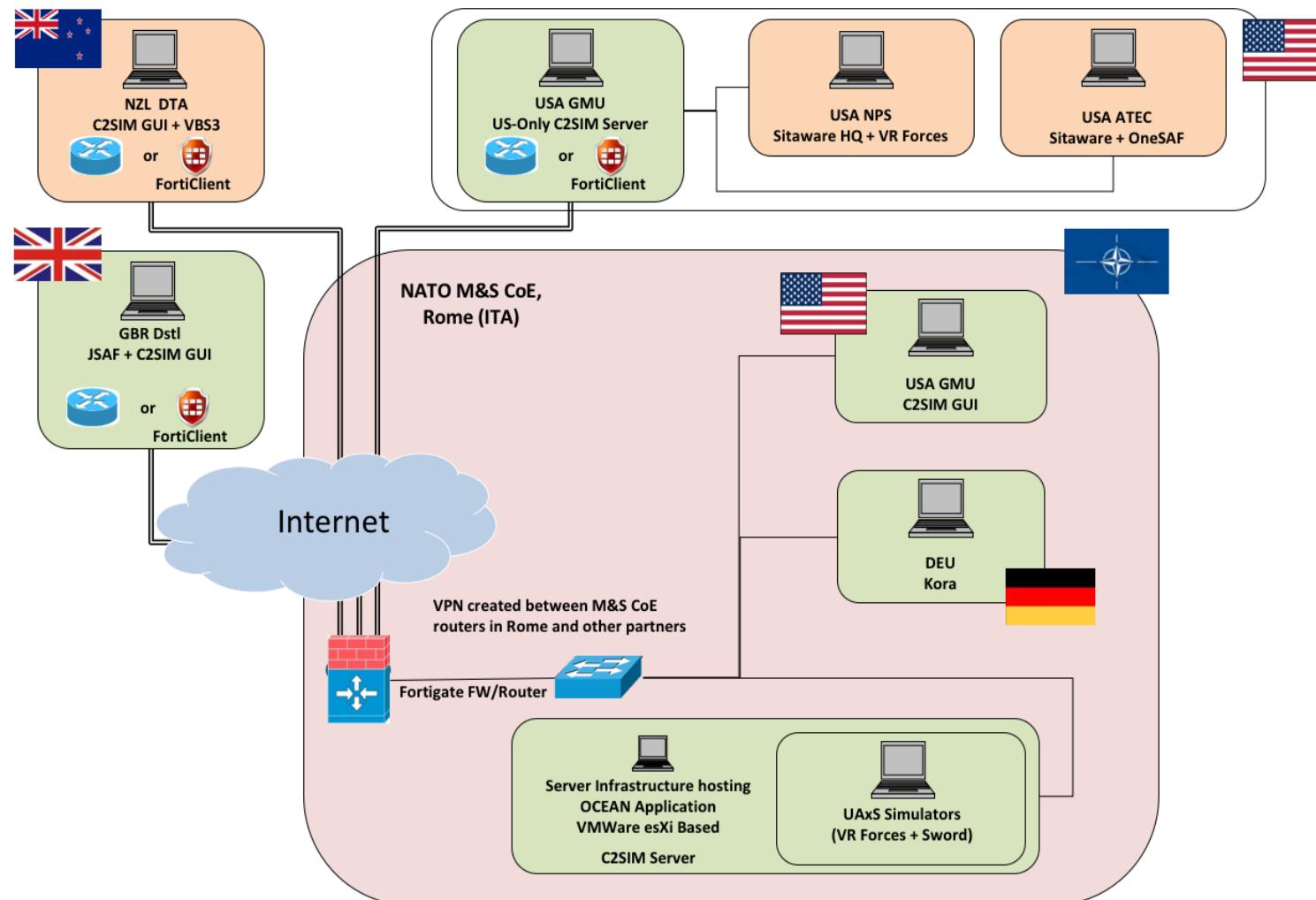
**ETR** Entity Tasking and Reporting

**C2SIM** SISO Command and Control Systems – Simulations Systems Interoperation

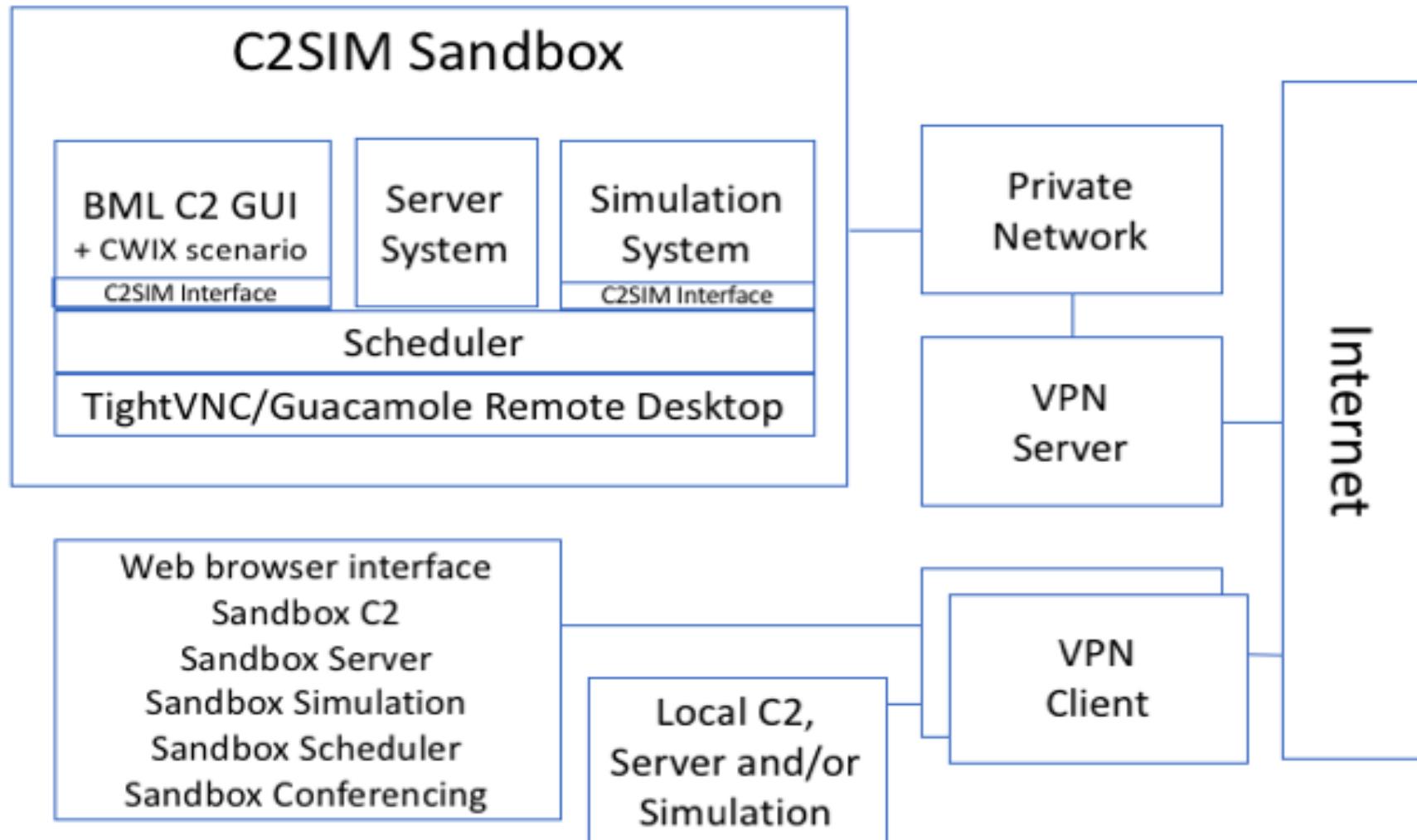
# CWIX 2019

- **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



## 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.

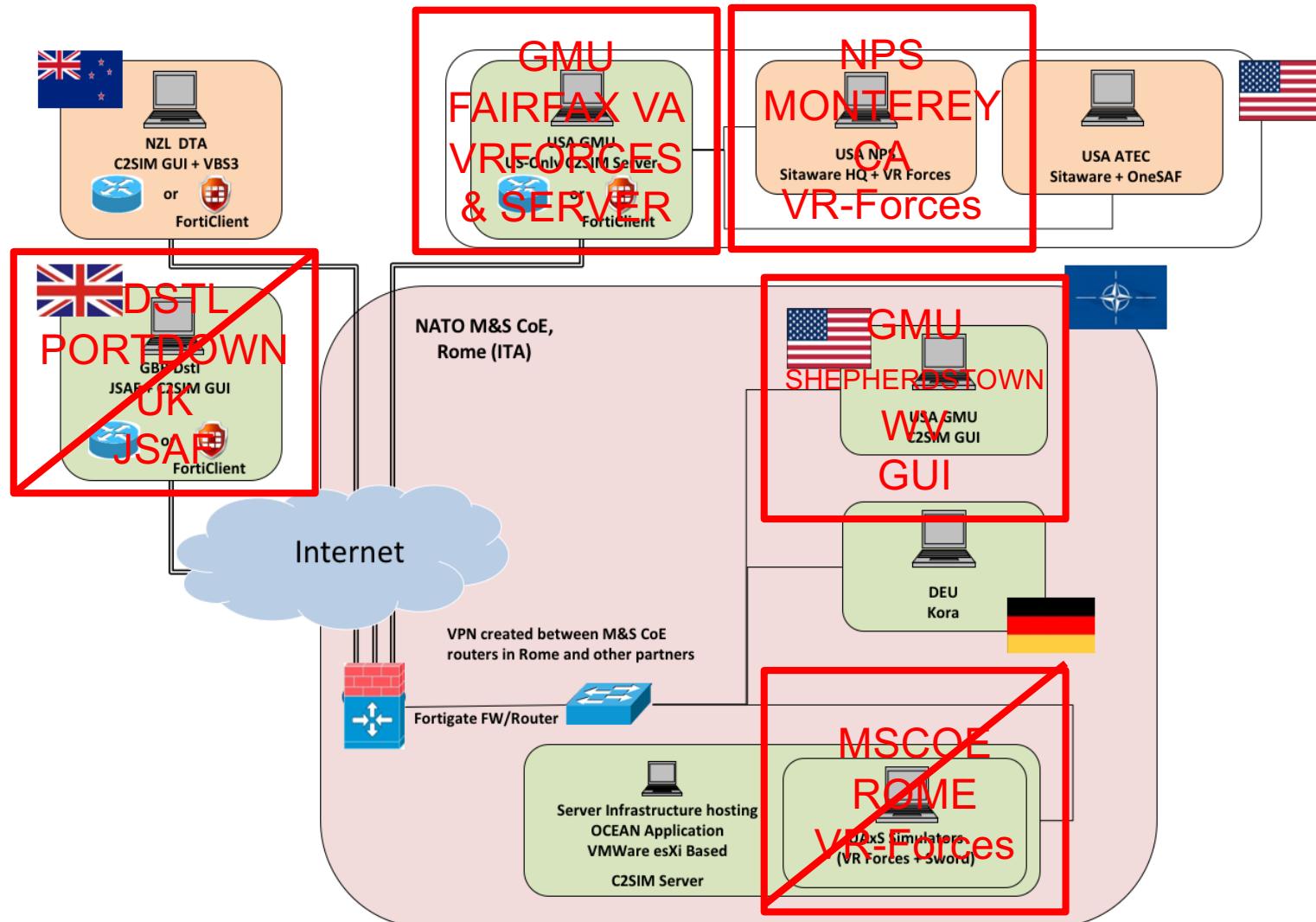
# Execution as Seen in SitaWare and Editor

The screenshot displays two windows side-by-side. The left window, titled 'GMUOrg - Sitaware He', shows a map of southern Sweden with various military units represented by blue icons with crossed swords. Key locations labeled include Lötby, Skudden, Krook, Ulricehamn, Laddby, Härnösand, Härnösandsfjärden, Bäckefjärden, Bråviken, Svarteborg, Norrköping, Östra Torsås, Kungsåra, Östra Västergötland, Älvängen, Åseda, and Gränna. A red diamond icon is located near Krook. The right window, titled 'GMU C4I & Cyber Center EML C2 GUI version 2.7.0 C2SIM Editor', contains a 'C2SIM Report' panel with tabs for 'MessageBody', 'DomainMessageBody', 'Orderbody', 'FromSender', 'ToReceiver', and 'Task'. It also includes sections for 'IssuedTime' (with fields for 'Name', 'IsoDateTime', 'OrderID', and 'Requesting...'), a 'Task' list (containing '1| ManeuverWafar...'), and a 'ReportIconsOnMap' section.

# C2SIM Demonstration

- Drawn from the scenario of CWIX/MiniEx 2019
  - Shown in previous slides
- Participants:
  - GMU C4I & Cyber Center Fairfax, VA, USA
    - Simulate Red Forces
  - NPS Modeling Virtual Environments and Simulation, Monterey, CA USA
    - Simulate Blue Forces
  - ~~NATO M&S Center of Excellence, Rome, Italy~~
    - ~~Simulate Autonomous Systems~~
  - ~~Defence Science and Technology Laboratory, Portsmouth, UK~~
    - ~~Simulate UAS Reconnaissance~~
- Systems:
  - Orders & reports editor: C2SIM GUI (including logfile playback)
  - Server: C2SIM Reference Implementation
  - Simulations: MAK VR-Forces and JSAF

# FMN DEMO C2SIM Replays CWIX 2019



# DEMONSTRATION

## C2SIM and MIP

- **C2SIM ontology data classes reference JC3IEDM definitions wherever possible**
  - Therefore interface with MIP is straightforward
  - Main difference is C2SIM packaged as XML
    - Messages have tree structure
- **GMU working on C2SIM to MIP interface**
  - Open source Java code - C2SIM access for MIP applications
  - Planned for use with SitaWare by GMU and Sweden
- **Should be straightforward to use C2SIM-capable simulations for MIP testing**

# 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, STANAG
- **C2SIM standard is an excellent candidate for FMN**
- **Video:** [https://www.youtube.com/watch?v=3L\\_Hhxuh6Zc](https://www.youtube.com/watch?v=3L_Hhxuh6Zc)

# QUESTIONS ???

**MSG-145 C2-Simulation participants expected to connect:**

- Dr. Curt Blais, NPS, USA
- Adam Brook, DTSL, UK
- Dr. Donald Brutzman, NPS, USA
- Douglas Corner, GMU, USA
- Major Fabio Corona, MSCOE, Italy
- Magdalena Dechand, FKIE, Germany
- Michael Dembach, FKIE, Germany
- Dr. Rachid Khayari, IABG, Germany
- Morgan Lindberg, Swedish Armed Forces
- Kevin Galvin, Thales, UK
- LtCol Robert Nordlander, Swedish Armed Forces

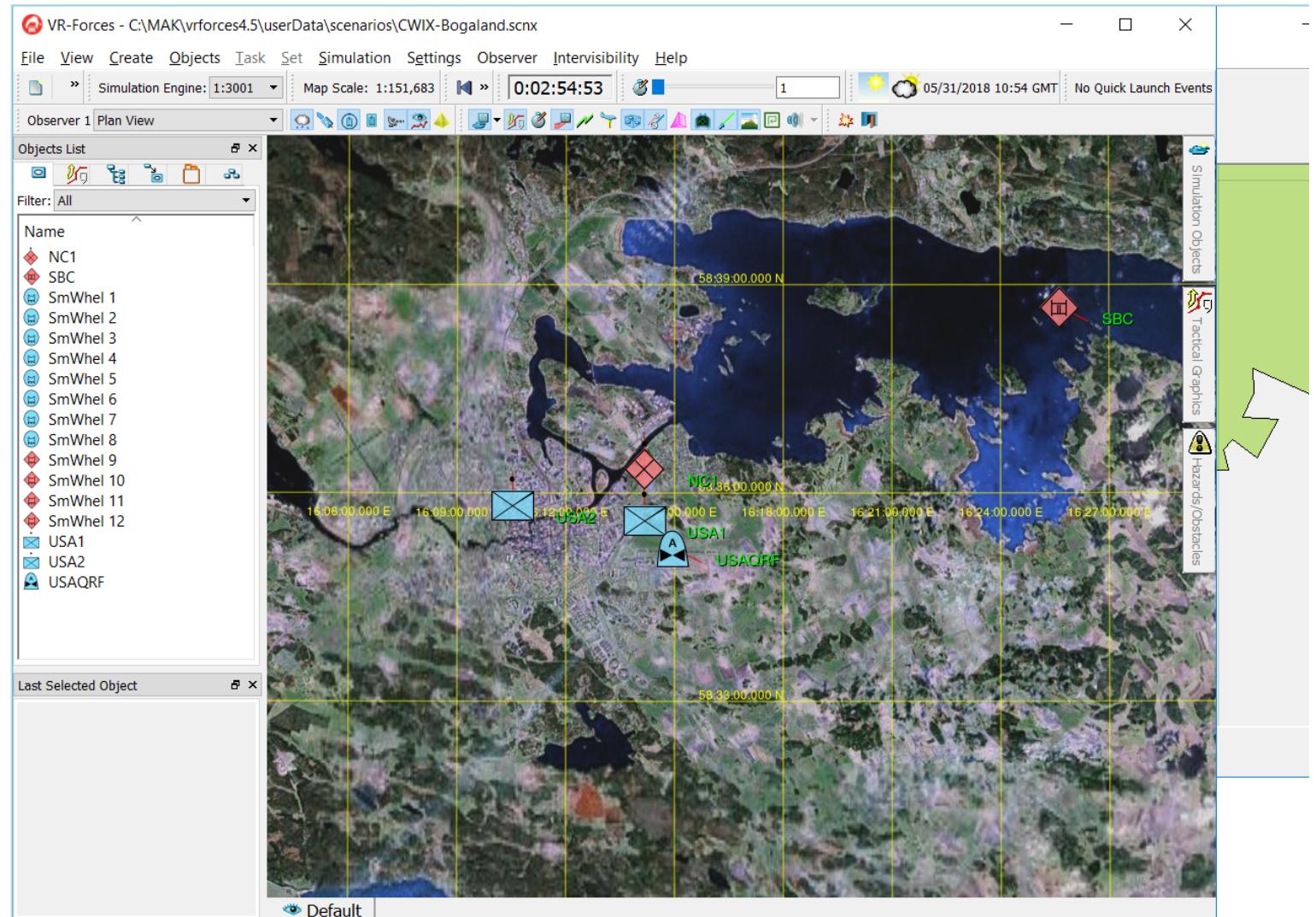
# BACKUP

# KORA German Simulation

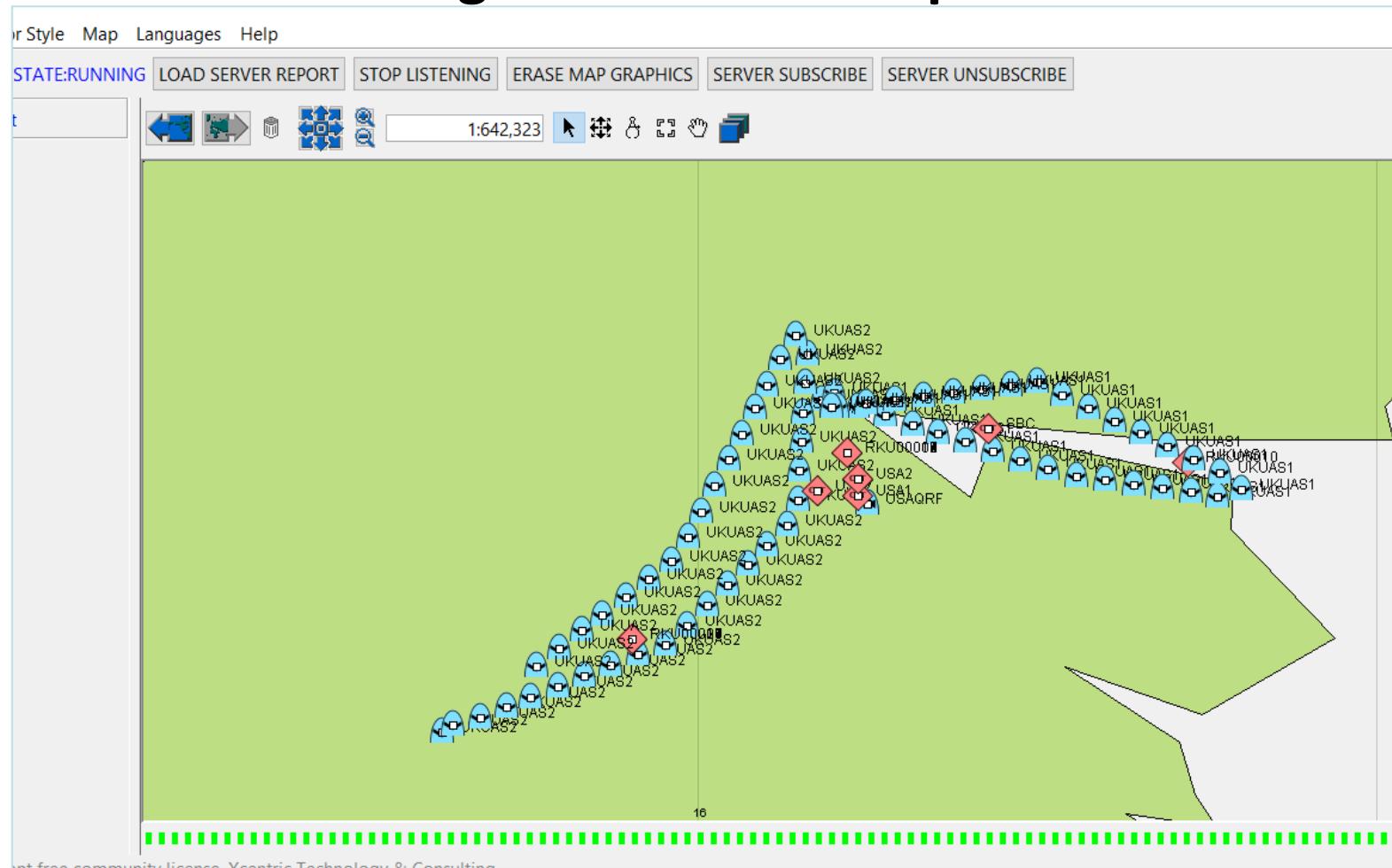
**KORA <2>**

The screenshot shows the KORA German Simulation interface. The main window displays a map of Sweden and surrounding regions, with several military units plotted. A blue dashed line with arrows indicates movement paths for units like USA1, USA2, and USA3. The left sidebar shows the Orbat (Order of Battle) for the BLAU alliance, listing units such as JFTHQ, LANDCOM, INF, USABTL, USAKP, USA1, USA2, and USA3. The right side features several panels: 'Info: USA1' showing resource status (Fuel 100%, Water 99%, Food 100%) and coordinates (33V-WE7185095453); 'Info: USA2' and 'Info: USA3'; a 'Situation' panel for USA1; and an 'Order' panel where a movement order for USA3 is being configured. The order details include Unit: USA3, Order no.: 1, Order: Mov, Behaviour: immediate, Condition: immediately, Time: (empty), After order no.: (empty), Width: 0.5 km, Impact settings: Weapons free, Destination node: (empty), Upon arrival: (empty), and Coordinates: Center line. The bottom status bar shows 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 JSAF 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