CWIX Testing of M&S Standards In Federated Mission Networking

October 2023

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16 July 2023

Outline

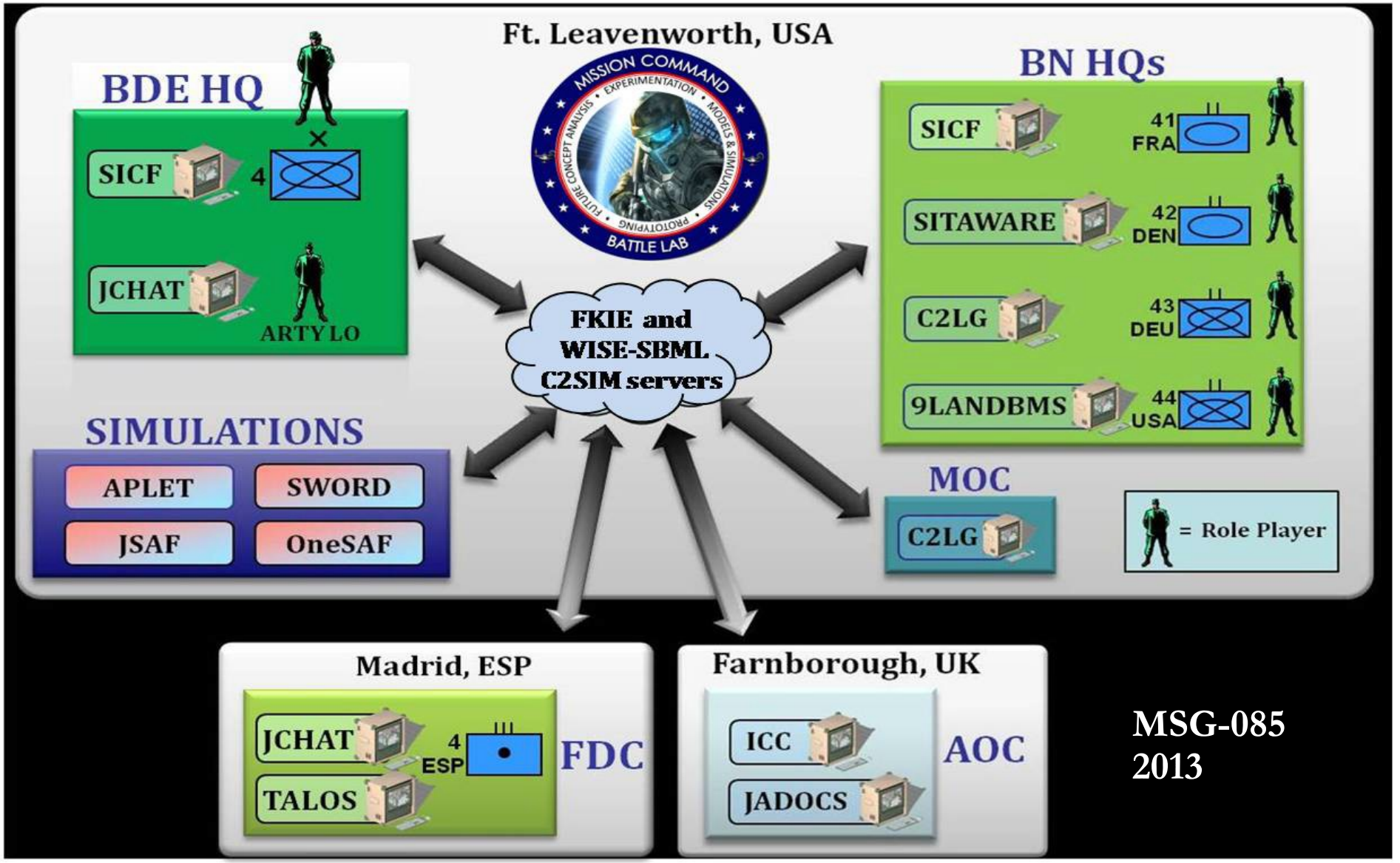
- Why & how validation
- Overview of validation events
- MSG-201 in CWIX 2022/2023
- NETN Testing
- C2SIM Testing
- Mission Rehearsal Testing

Role of Experimentation & Testing

- Testing:
  - Confirm the implementation works as specified
- Experimentation:
  - Confirm standard can work in operation
  - Confirm it is effective in intended role
- MSG-145 did testing in CWIX 2019 and experimentation in a Simulation-based Mission Rehearsal 2022 & 2023

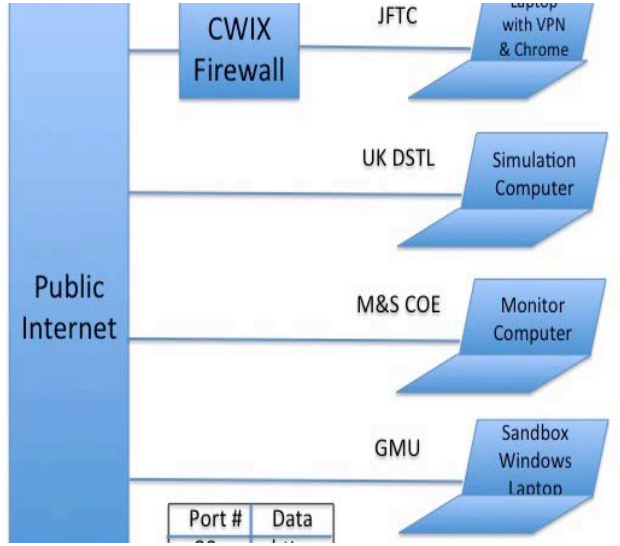
Previous Testing and Validation

- MSG-045 Experimentation
  - One week in Manassas, Virginia, USA
  - Concluded BML concept feasible
- MSG-085 Final Demonstration
  - One week at Fort Leavenworth, Kansas, USA
  - International audience very impressed
  - Concluded MSDL + C-BML had military value
  - But need to be unified & more extensible
- MSG-145 CWIX 2017 and 2018
  - Tested prototype C2SIM implementations

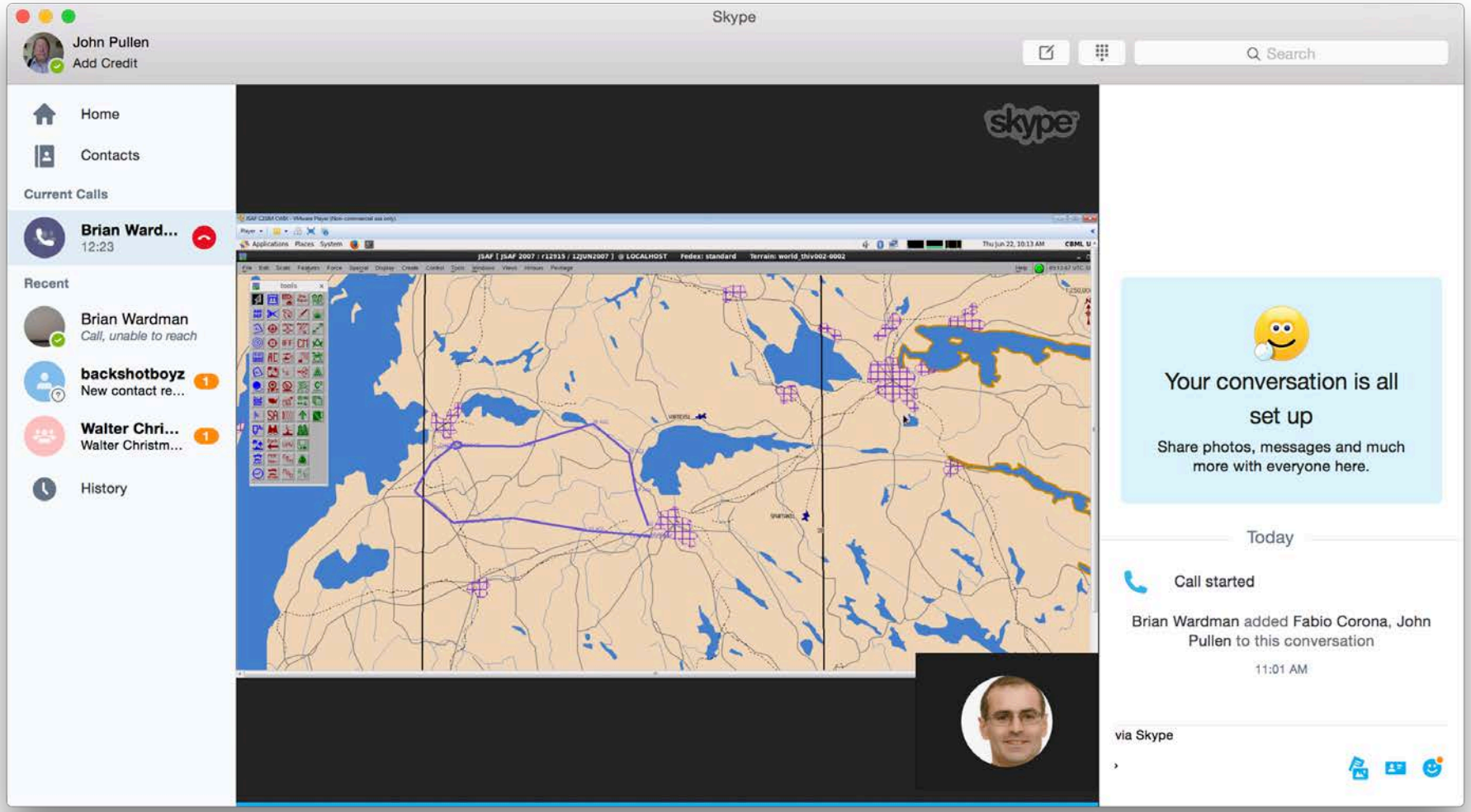

Ft. Leavenworth, USA
MISSION COMMAND
EXPERIMENTATION
MODELS & SIMULATIONS
PROTOTYPING
FUTURE CONCEPT ANALYSIS
BATTLE LAB
BDE HQ
SICF
4
JCHAT
ARTY LO
BN HQs
SICF
41 FRA
SITAWARE
42 DEN
C2LG
43 DEU
9LANDBMS
44 USA
FKIE and WISE-SBML C2SIM servers
SIMULATIONS
APLET
SWORD
JSAF
OneSAF
MOC
C2LG
= Role Player
Madrid, ESP
JCHAT
4 ESP
TALOS
FDC
Farnborough, UK
ICC
JADOCS
AOC
MSG-085
2013

MSG-145 CWIX 2017

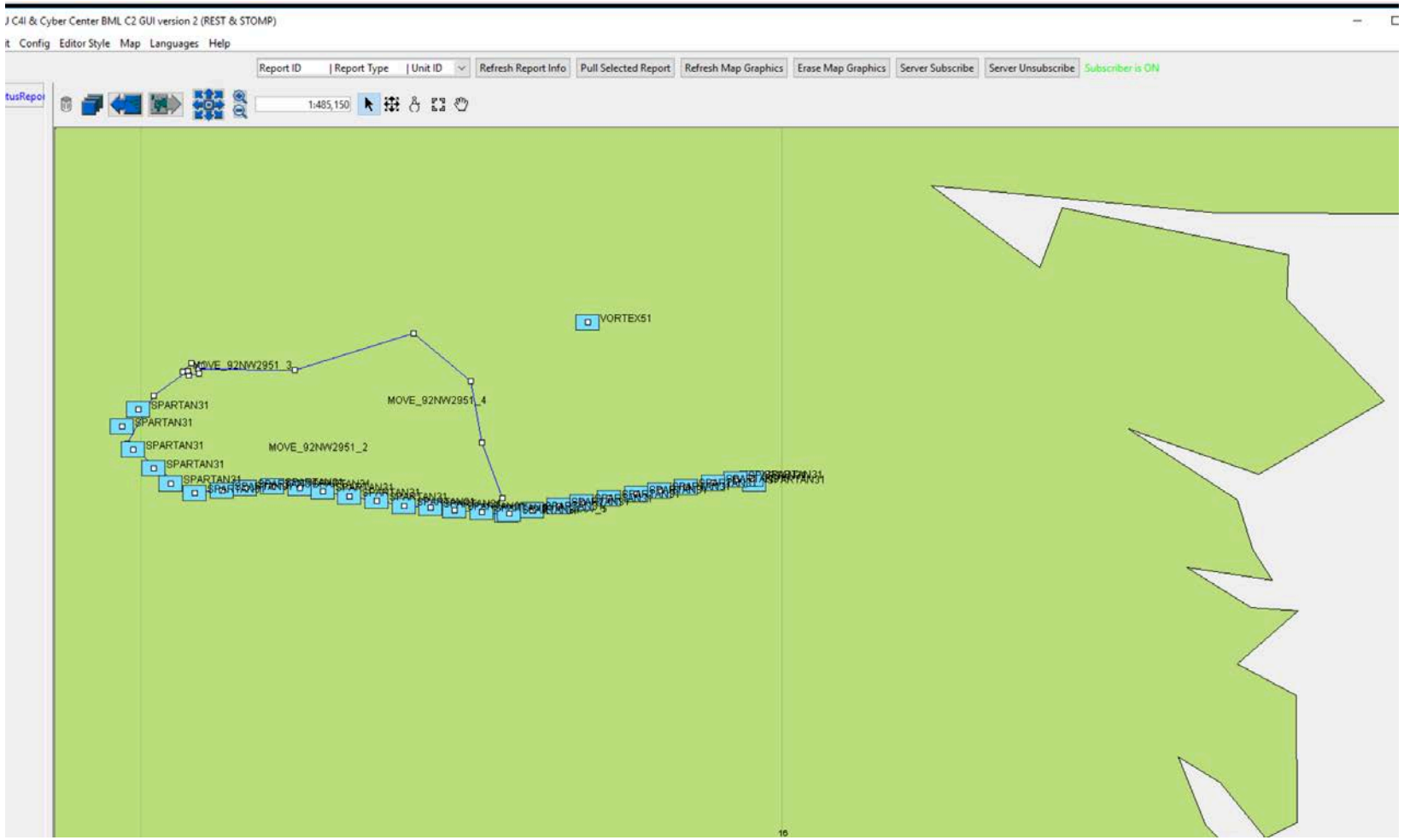
- Early version of C2SIM Sandbox at Joint Forces Training Center Poland
- Internet connection to JSAF in UK
- Monitor at MSCoE Rome
- Simple Cyber effects in server



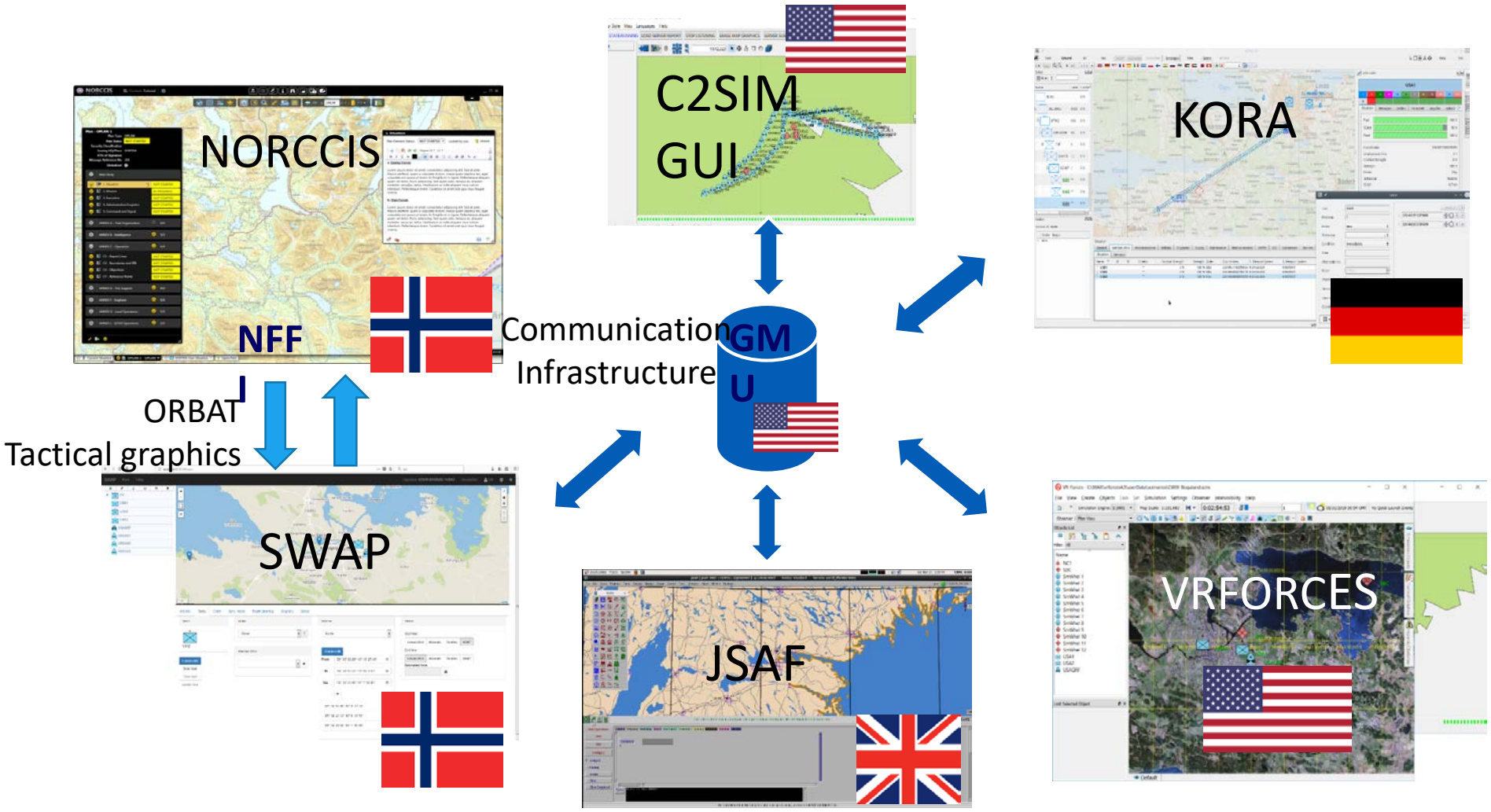
CWIX 2017 JSAF Screen in UK

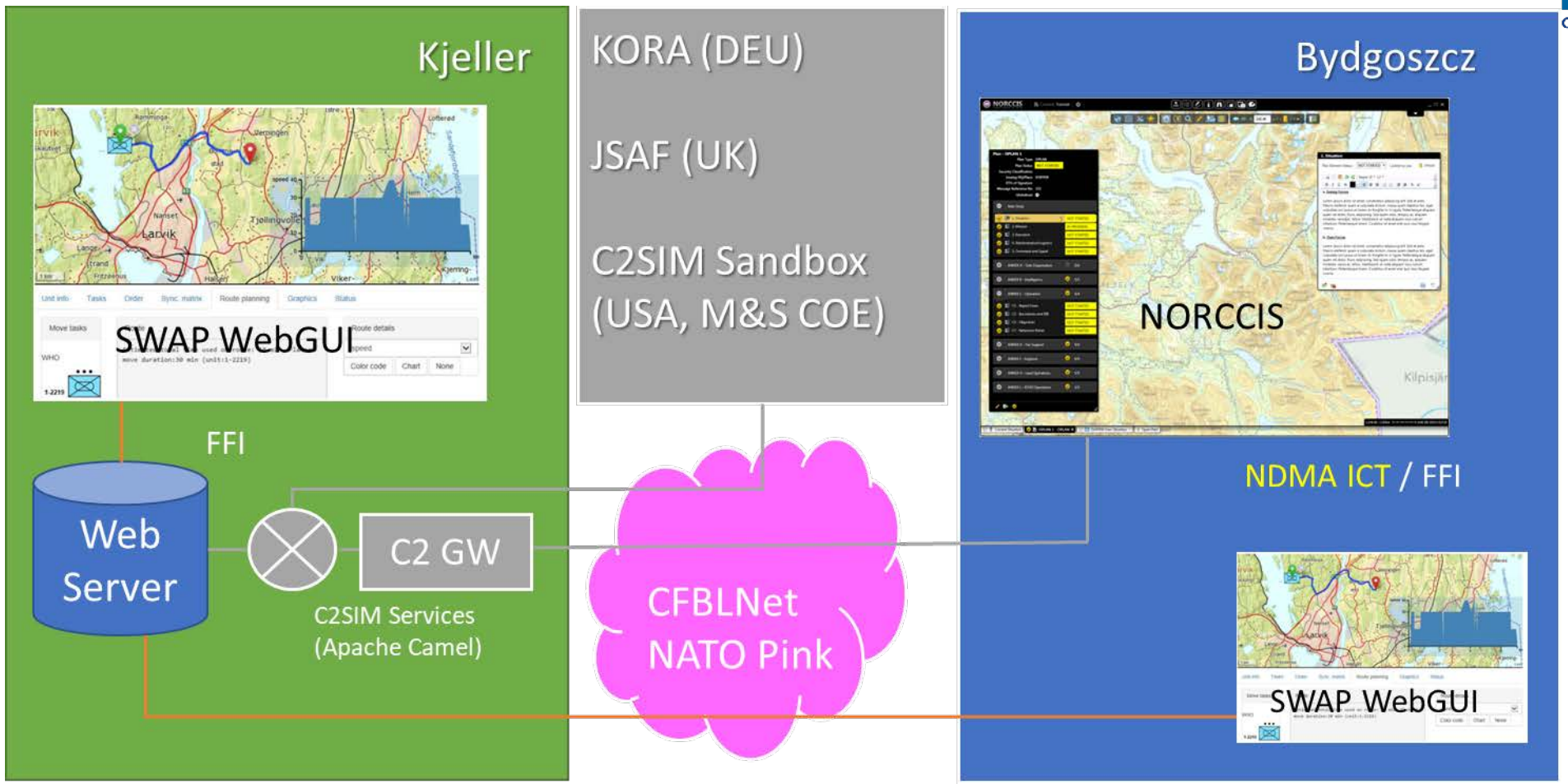


CWIX 2017 C2SIM GUI Screen at JFTC
(UAV order and reports)



MSG-145 C2SIM CWIX 2018





MSG-145 CWIX 2018

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

MSG-145 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

MSG-145 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

C2SIM Standard Overview (what we were testing)

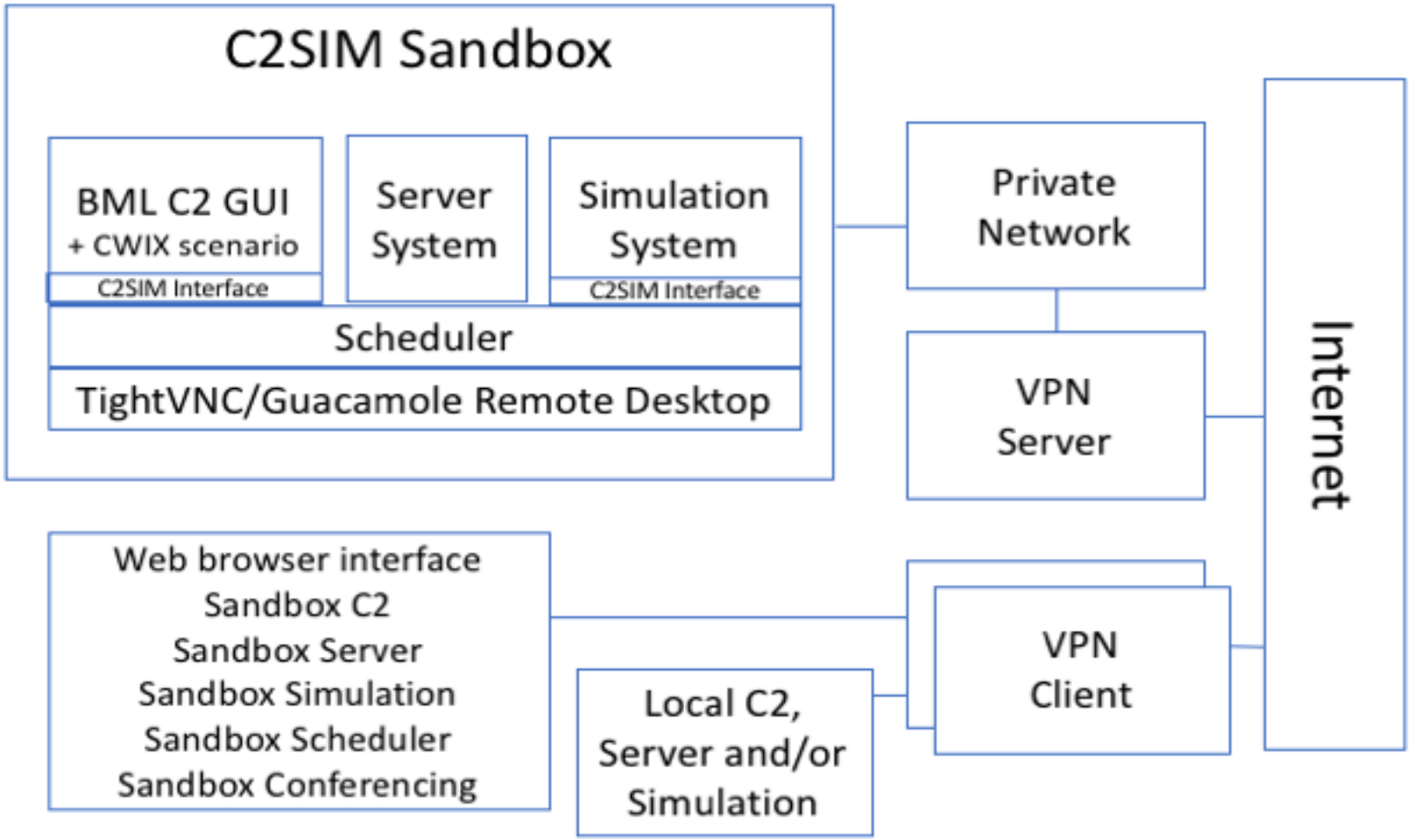
- SISO standards initial versions – backward compatibility
  - Military Scenario Definition Language (MSDL) supports initialization
  - Coalition BML (C-BML) provides for exchange of Tasking (orders and requests) and Reporting information
- Unified C2SIM standard
  - C2SIM Core and Standard Military Extension (SMX) Ontologies
  - Initialization & Synchronization messaging
  - Tasking & Reporting messaging
  - Extension Mechanism and Land Operations Extension
  - Guidance document

CWIX Testing Regimen

C2SIM Implementations for CWIX 2019

- France: MASA - Sword
- Germany: iABG – KORA
- Italy: NATO M&S Centre of Excellence
  - Autonomous Systems Extension (ASX)
  - VRForces plugin for autonomous aircraft
  - SWORD for autonomous ground vehicle
- New Zealand: Defence Tech Agency – VBS3
- United Kingdom: Legacy JSAF UAVs
- USA:
  - Army Test & Evaluation Command: OneSAF + SitaWare
  - Naval Postgraduate School: VRForces + SitaWare
  - George Mason University: Server and Editor
- Above all completed January to May 2019

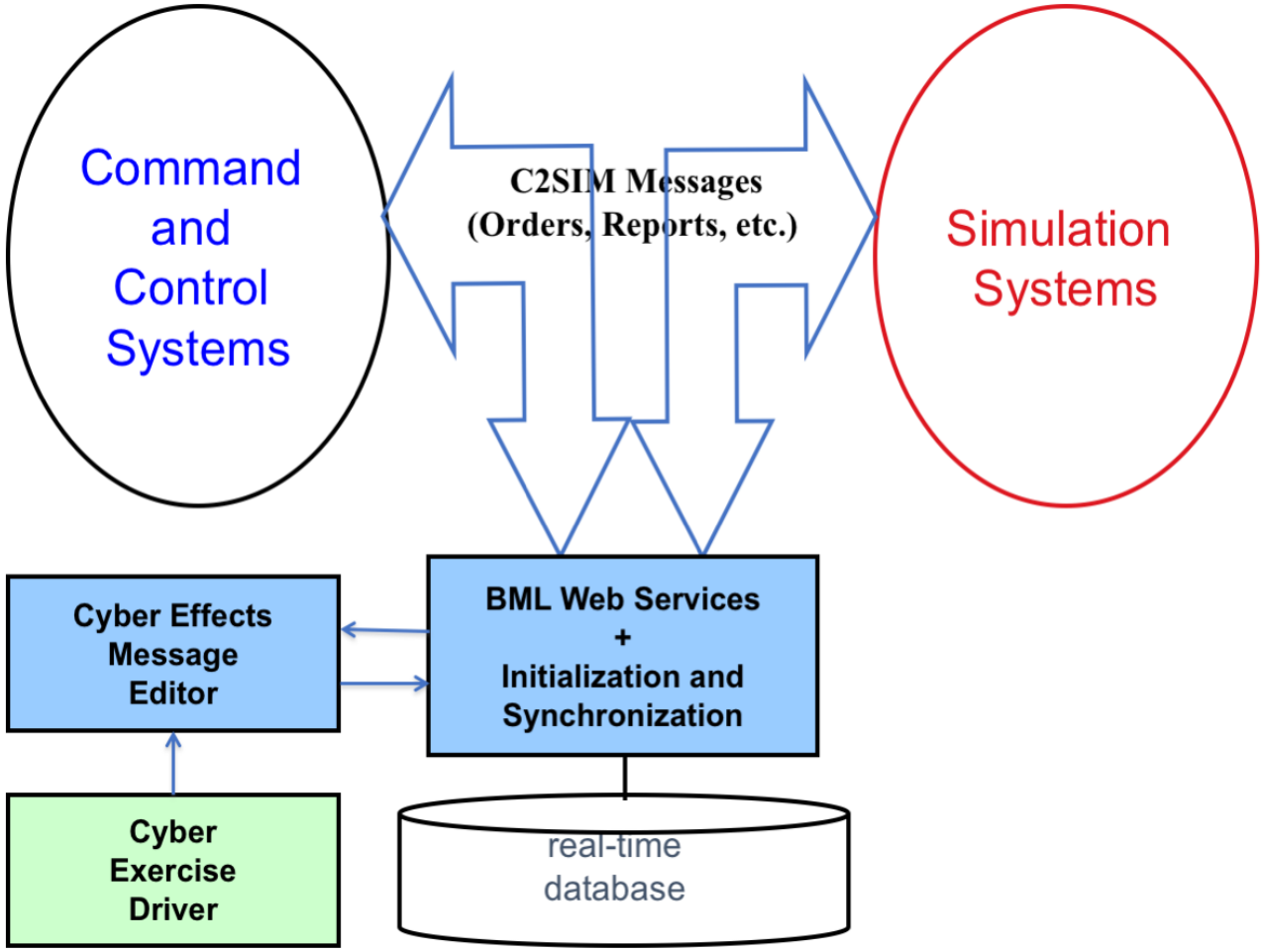
CWIX 2019 C2SIM Sandbox run by GMU and MSCoE



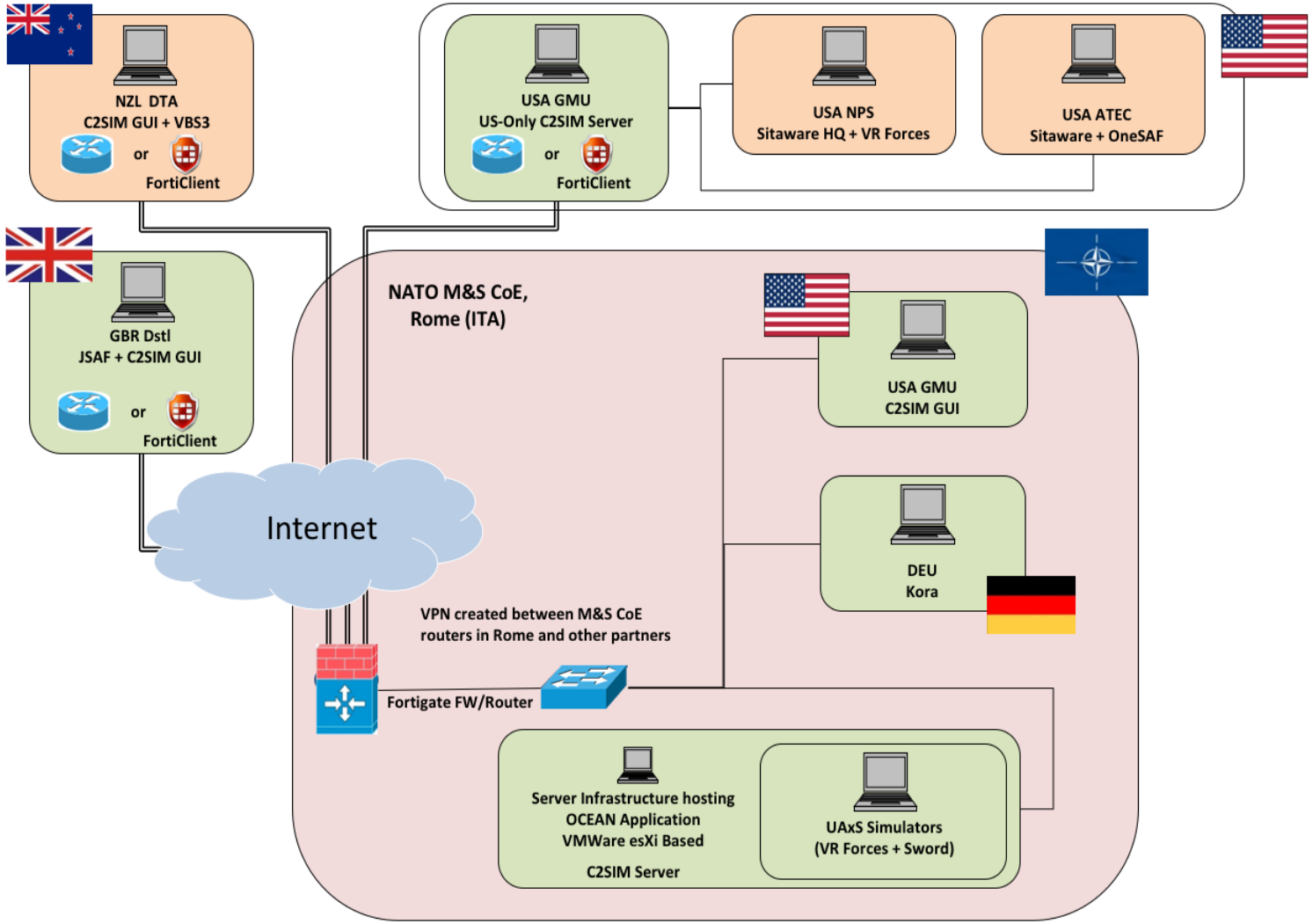
CWIX 2019

- 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
- Systems interoperated via Internet VPN; used GMU Editor
- Testing included imposing cyber effects on C2SIM messages passing through server
- Eleven of twelve test ”fully successful”
  - Twelfth was “limited success” – problem corrected quickly
  - Table 1 in our ICCRTS paper describes the tests

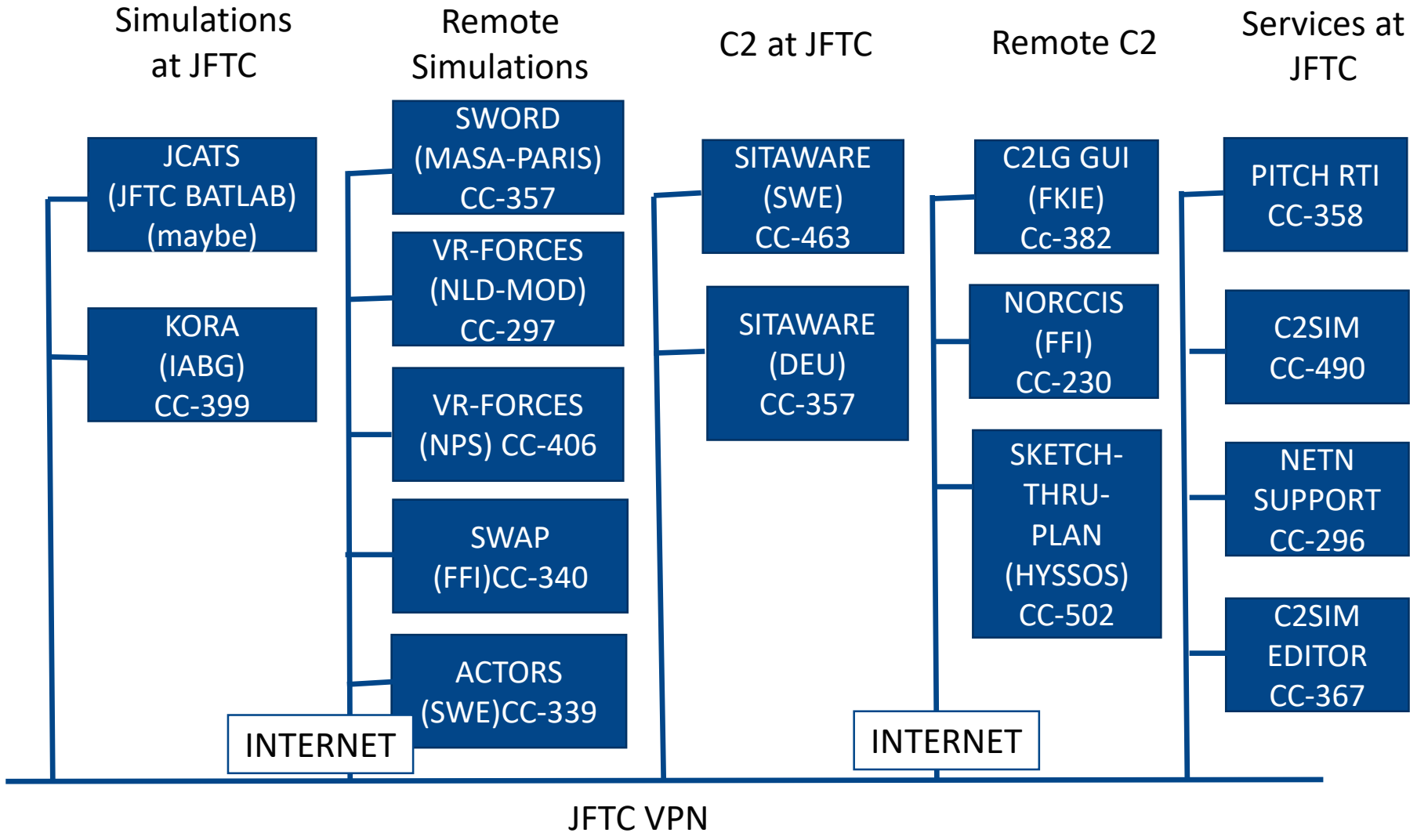
C2SIM with Cyber/EW Effects



CWIX 2019/MiniEx C2SIM Networks



CWIX 2023 Configuration



MSG-201 CWIX 2023 NETN Testing

- OBJ-142 eXplore FMN SP 6 M&S SI (HLA requirements)
  - This objective tested nine Capability Configurations (CCs) from NATO JFTC, Netherlands, Sweden, Norway, France and Germany
  - The purpose was to evaluate compliance with the HLA standard as configured under the NATO Education & Training Network (NETN) under AMSP-04 Edition B
  - Wiki shows 6 test case results; 3 limited or full success and 3 interoperability issue where one or more CCs did not comply, associated with lack of time synchronization (try again CWIX 2024)
- OBJ-143 eXplore FMN SP 6 M&S SI (MSaaS requirements)
  - Achieved by operating in cloud environment
  - Wiki test case results: 3 full success; 1 interoperability issue related to ability to start/stop/restart in in that environment

MSG-201 CWIX 2023 C2SIM Testing

- OBJ-144 eXplore C2 to Simulation Systems Interoperation
  - This objective tested ten Capability Configurations (CCs) from NATO JFTC, Netherlands, Sweden, Norway, France, Germany, and USA
  - The purpose was to evaluate compliance with C2SIM and HLA standards working together
  - Wiki shows 12 test cases, all full or limited result, and one not tested because the C2SIM System Message controls were not implemented
  - This is the fifth year of C2SIM testing in CWIX so the capabilities in general are mature (the one not implemented was new this year)

MSG-201 CWIX 2023 Mission Rehearsal

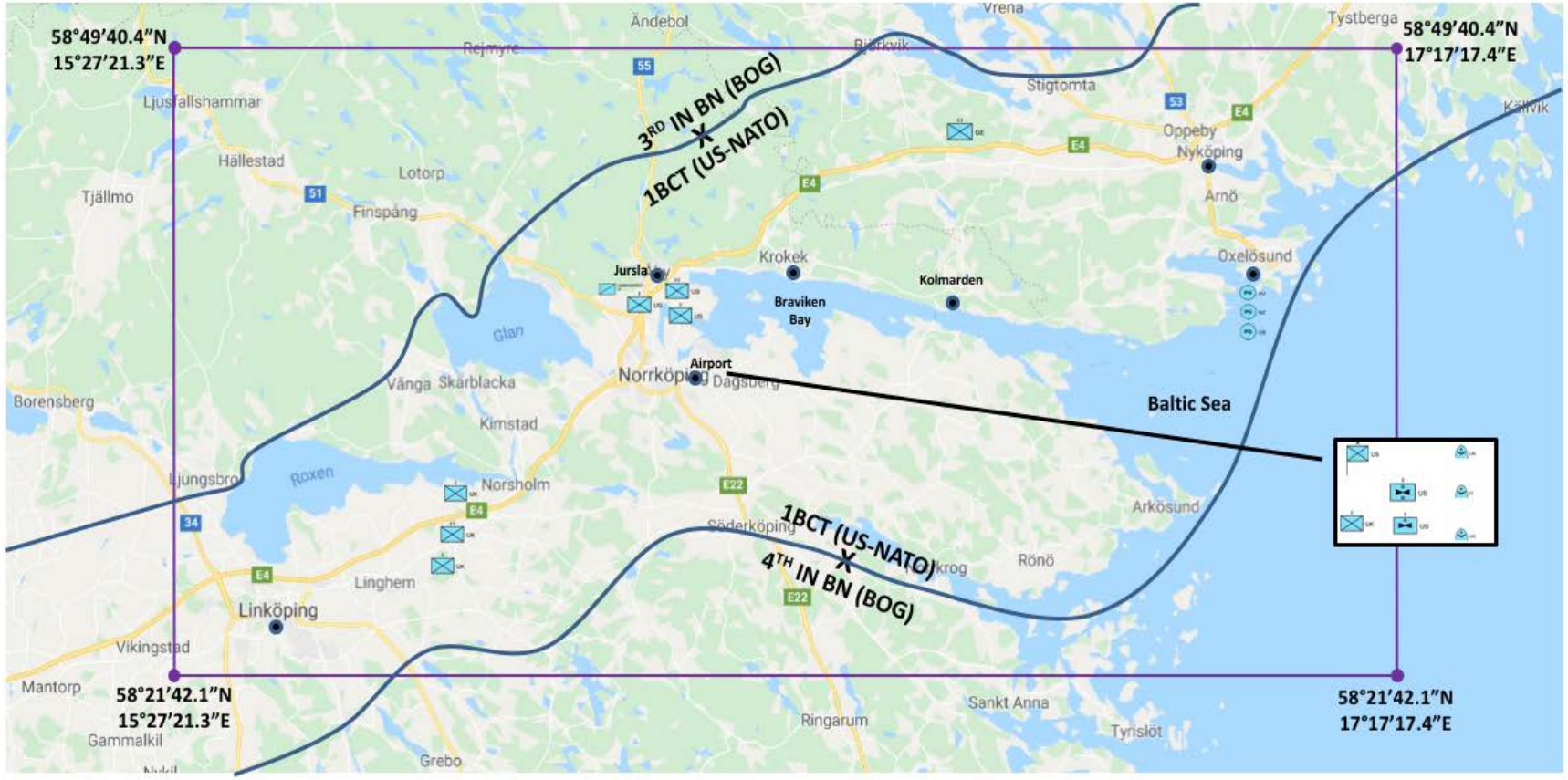
- OBJ-145 eXamine a representative Land Mission Rehearsal for FMN
- MR is the Initial FMN M&S application
- MR exercise preceded by individual simulation transaction testing
  - Successful CWIX testing showed systems can exchange data effectively using C2SIM & HLA
  - Exercise used six simulations interoperating with C2
  - C2 function filled by GMU Editor (+ SitaWare DEU/SWE)
- Running all simulations together for realism was challenging

MSG-201 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.

Friendly Forces

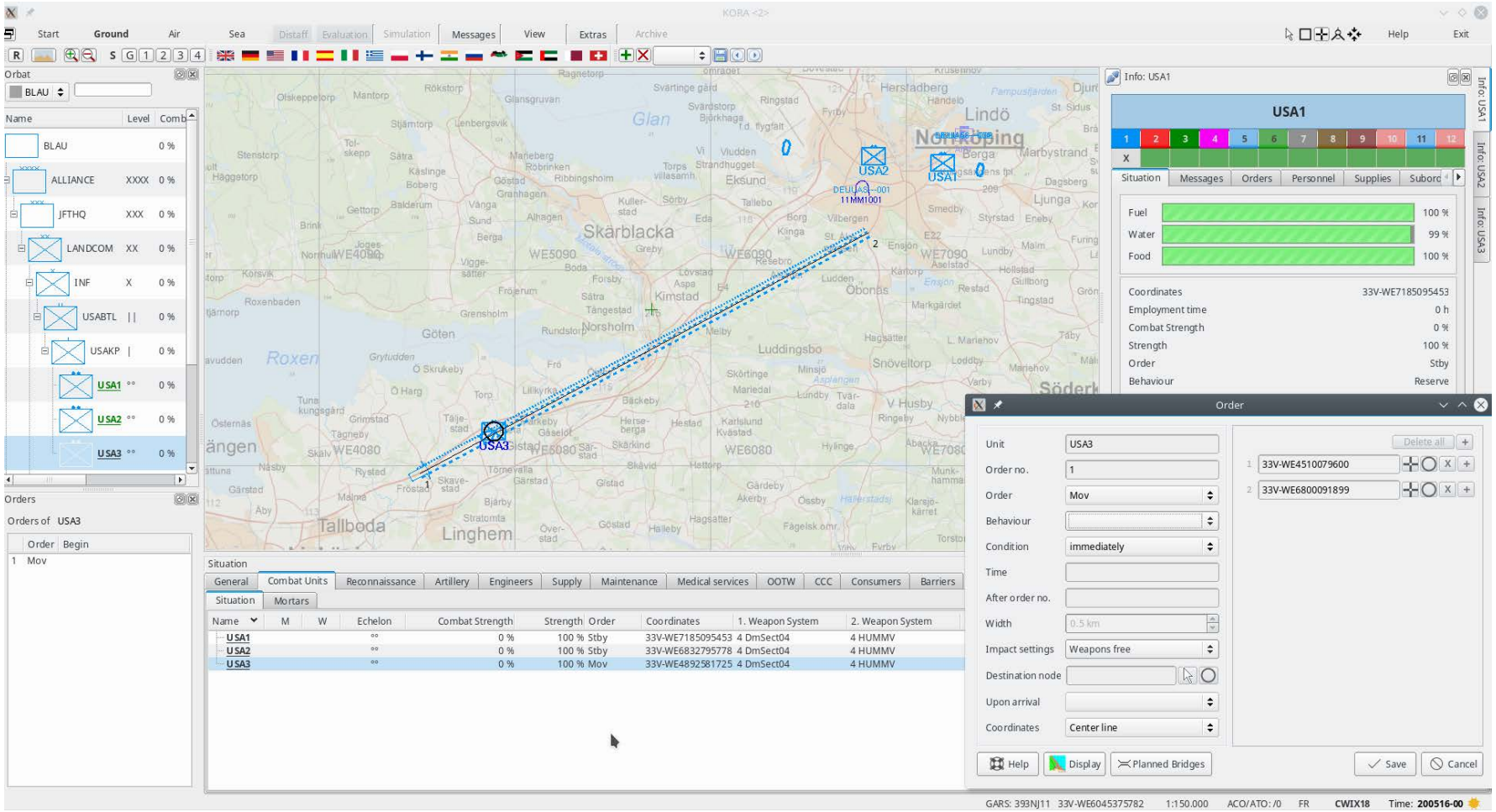
1BCT H Hour Initial Locations



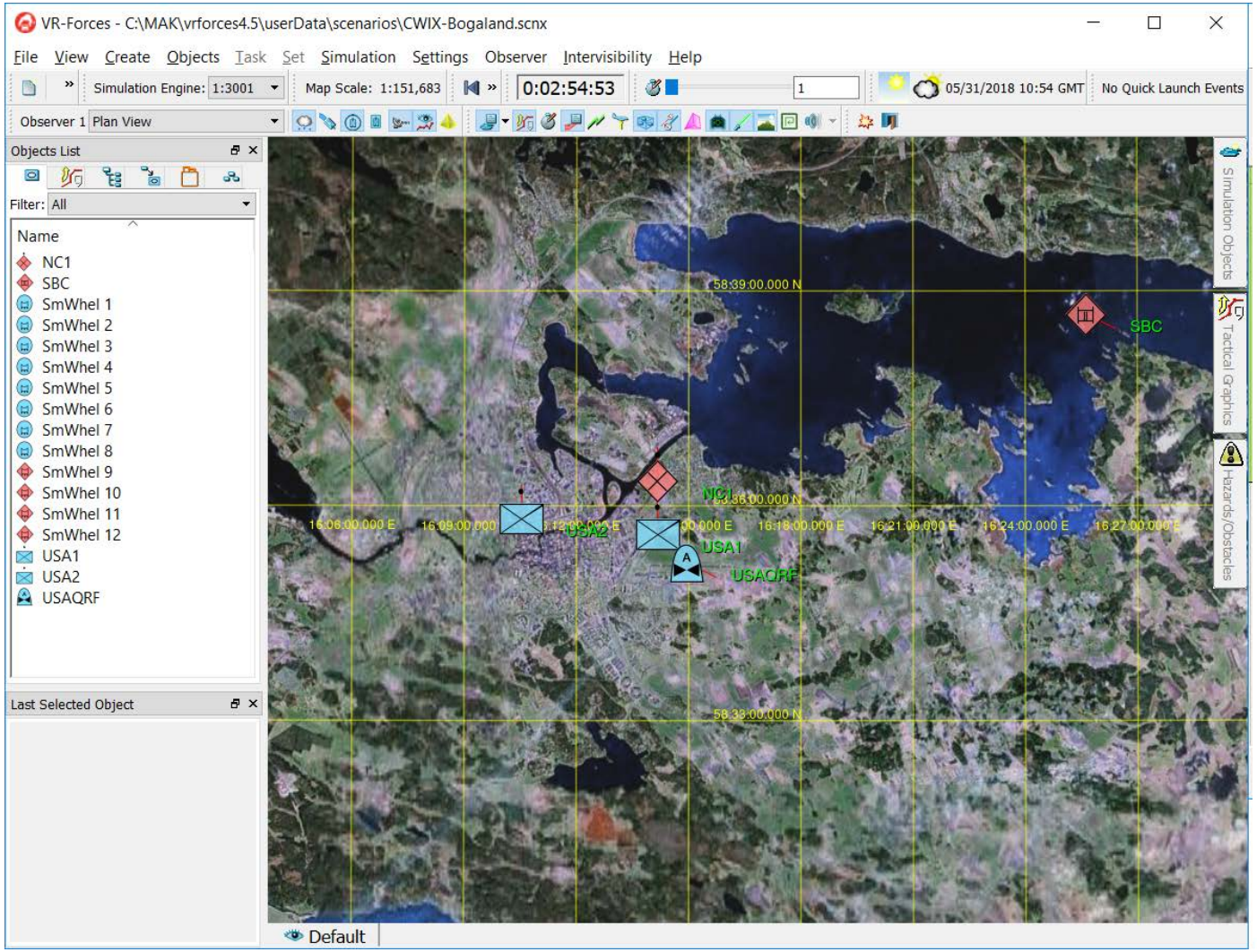
Opposing Forces

Enemy Situation at H Hour

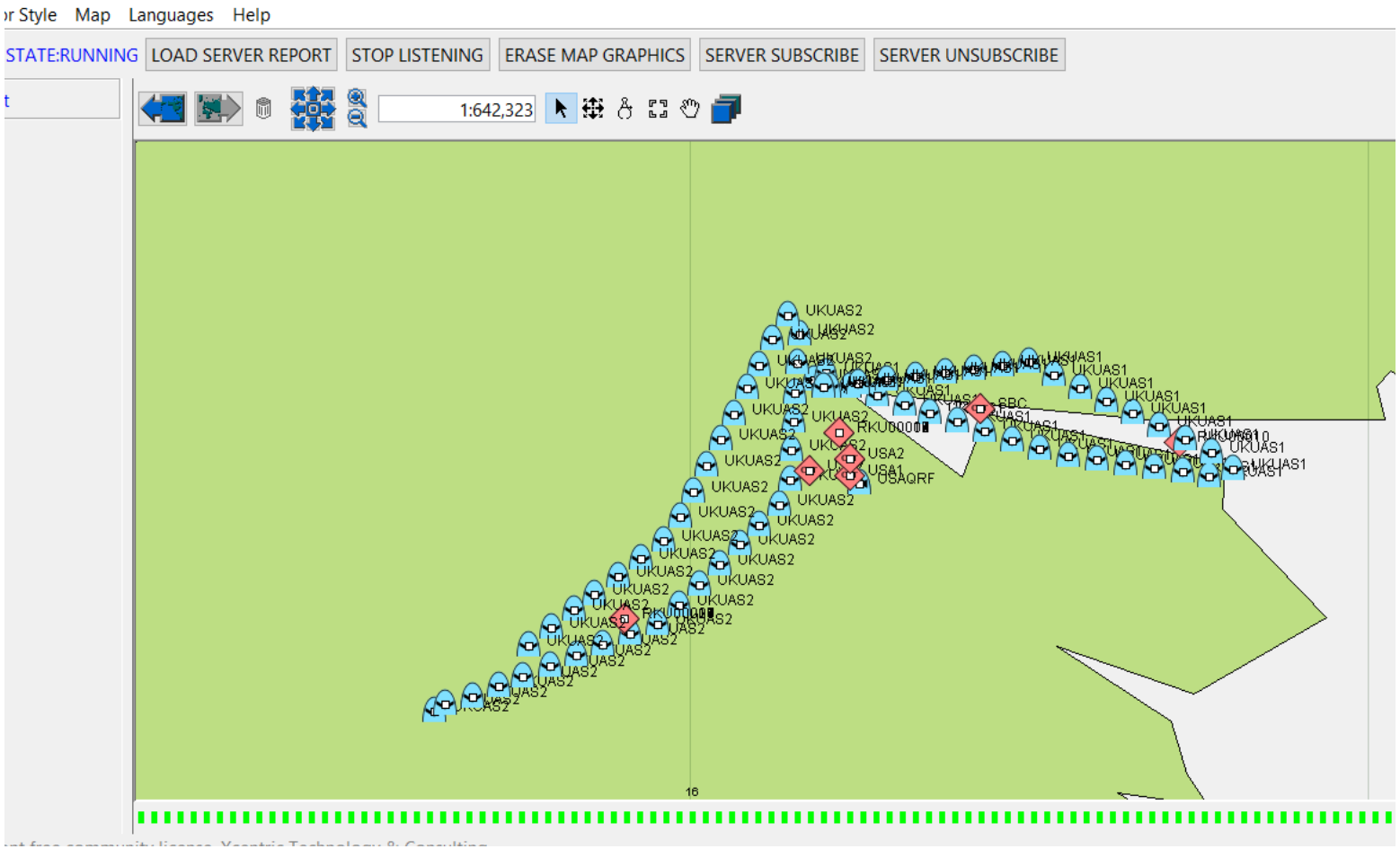
KORA German Simulation



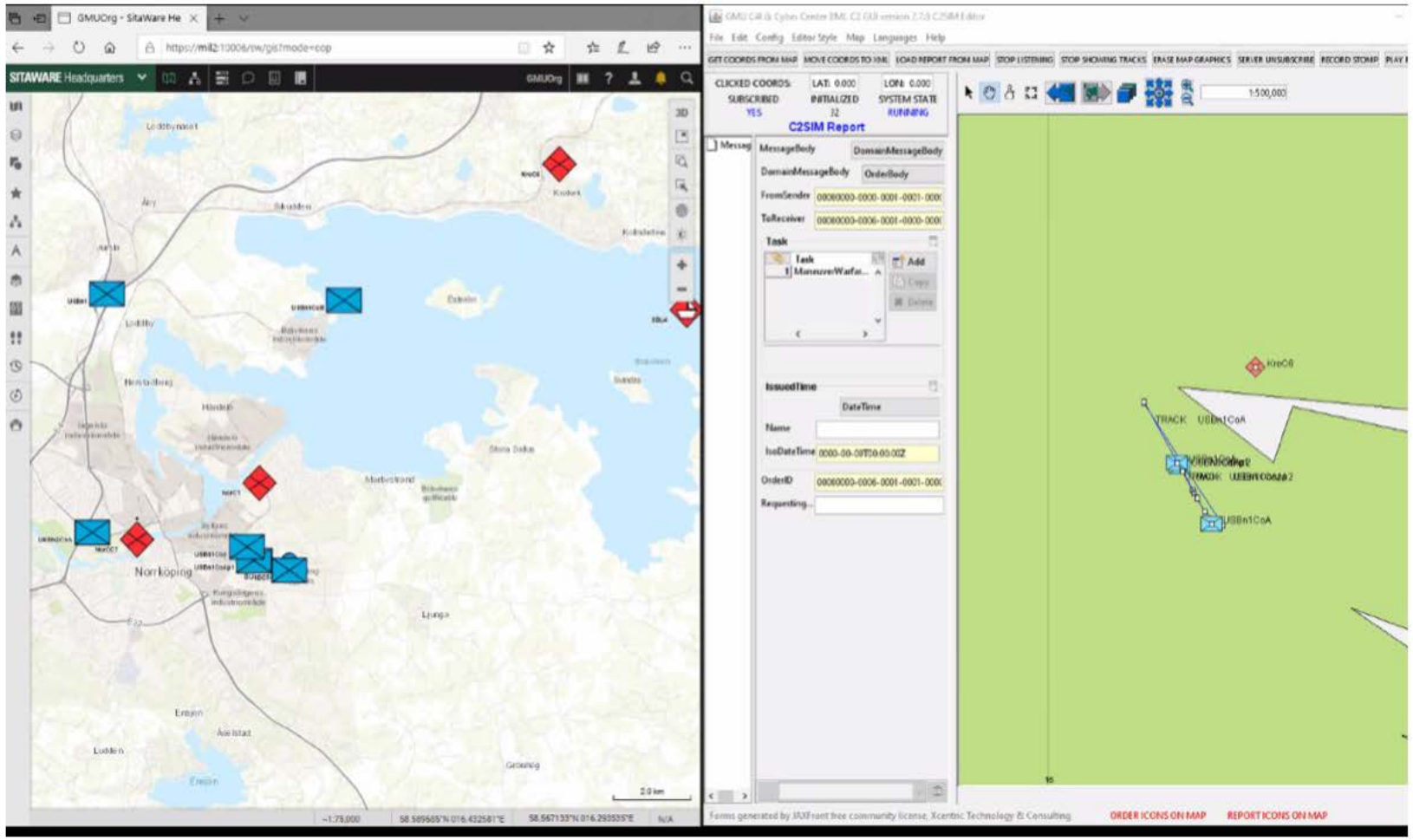
VR-Forces Commercial Military Simulation



GMU Open Source C2SIMGUI Editor
showing JSAF UAS recon reports



Execution as Seen in SitaWare and Editor



General Results CWIX 2023

- All interfaces identified in Federation Agreements were tested
- Had a stable network for testing
- Increased technical complexity over past CWIX
  - Also more national teams including FIN, NOR and SWE
- Some last-minute tweaking needed but systems mostly interoperated when delivered
- Relied heavily on Jitsi conferencing system
- Overall good results but we can do better in 2024
  - Must prepare to satisfy the FMN CIAV

Lessons Learned for Distributed Experiments & Exercises

- Great attention to detail is needed to prepare for distributed operation
  - Test, test, test all technology, particularly networks
  - If possible prepare alternatives for fallback
  - Provision alternate networks for operations (including voice), simulations, and exercise management
  - Pre-game the scenario with a “red team”
  - “Bullet-proof” all critical technologies
- We did most of this and still had rough spots
- However, all participants were convinced M&S will enable superior Mission Rehearsal in FMN

01/22/2024 | PAGE 32