Validating M&S Standards Interoperation in CWIX 2022

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Overview

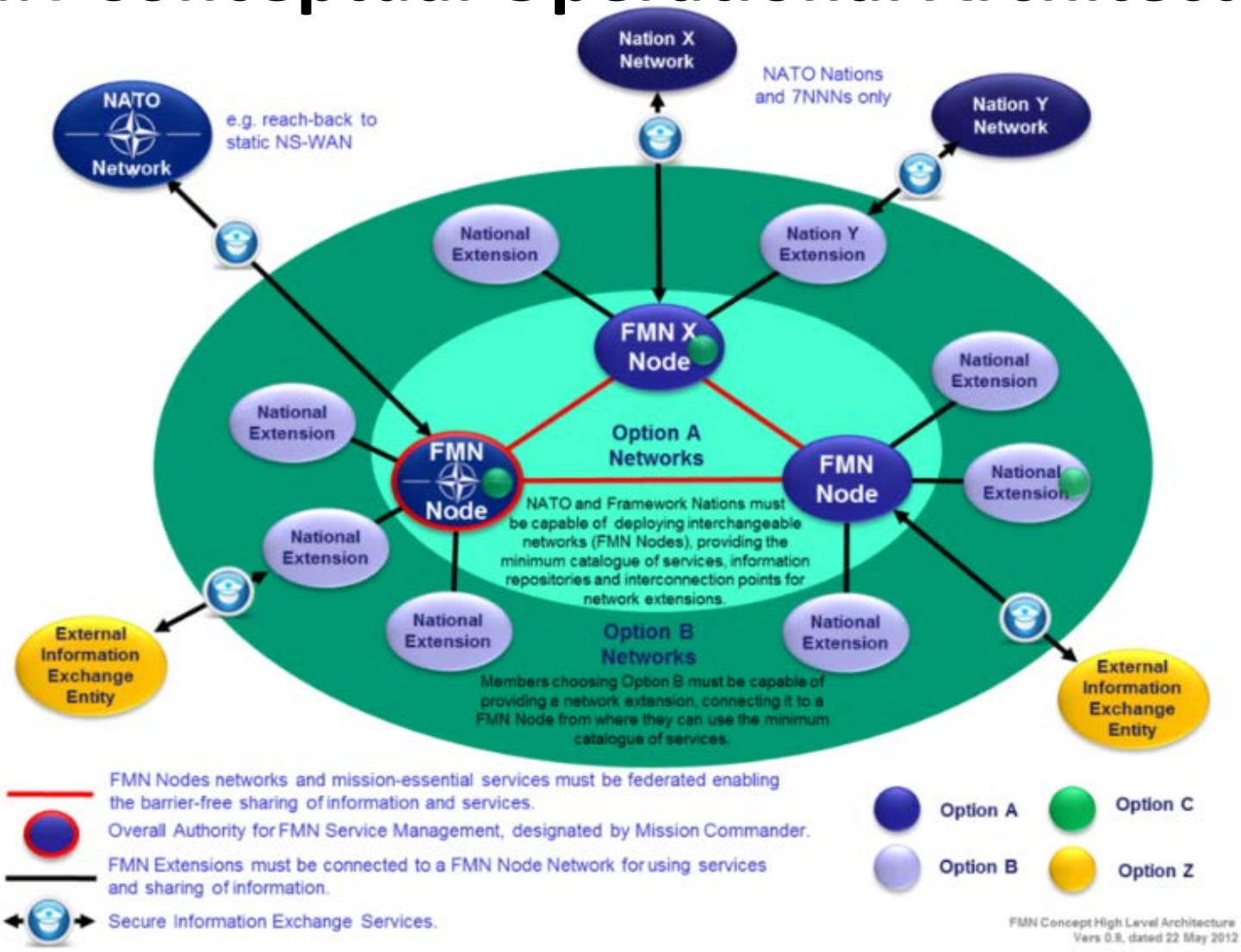
- Introduction: Why M&S in FMN
- FMN Spiral 5
- MSG-201 CWIX 2022 Testing
- Testing Experience
- Conclusions

Federated Mission Networking

- Multinational interoperability became essential with deployment of NATO International Security Assistance Force (ISAF) to Afghanistan
  - Took the form of Afghan Mission Network (AMN)
- Delays implementing AMN led to conclusion that NATO needs a "day zero" capability – usable with no delay
  - *Operate Together* and *Adapt Together*
- FMN is that capability
  - Standards and practices for nations to implement
    - Path to interoperability; not network infrastructure
  - Requirements defined in multiple "spirals"

Day Zero Interoperation

FMN Conceptual Operational Architecture



NMSG in FMN

- NATO M&S Group (NMSG) of NATO Science & Technology Organization (STO) has been developing technologies for networked military simulations, including interoperation with Command & Control (C2) for well over a decade
  - NMSG has responsibility for simulation standards in NATO
- Chartered Specialist Team MSG-193 to help
  - Participating in FMN specification
  - Designated M&S Syndicate by OCWG
  - Later promoted to Inter-WG (IWG) Syndicate by CPWG
  - Drafted Procedural Instructions (PI) for Mission Rehearsal
  - And Service Instructions (SI) for Modeling and Simulation
- NMSG considers its efforts successful
  - Has chartered MSG-201 through 2024 and Spiral 6 specification

MSG-201 CWIX Participation

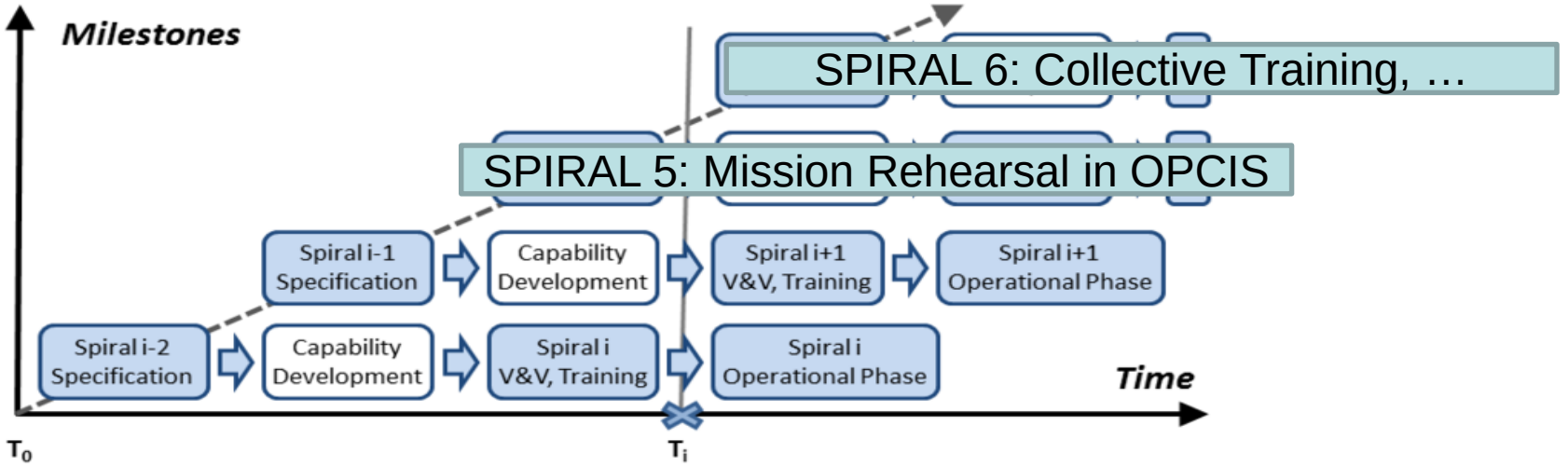
- FMN requires ready-to-run, validated standards/practices
  - Coalition Interoperability Assurance and Validation (CIAV) WG checks interoperability and federability
- Effective when linked to operational command and control (C2)
  - Which is the primary environment for FMN
- **C**oalition **W**arrior **I**nteroperability e**X**ploration, e**X**perimentation, e**X**amination e**X**ercise (CWIX) is the place we do this
  - Provides a detailed testing/validation environment
  - Some NMSG experience with CWIX already (e.g. MSG-145)
- For 2022 we tested running the Spiral 5 M&S SI elements
- System-of-systems distributed via Internet VPN – 4 nations
  - With 3 nations at main CWIX site JFTC Bydgoszcz Poland

FMN Syndicates

- "syndicates are informal working bodies - often already existing as collaborative undertakings for a specific subject, product or community of interest - focused at providing expert advice and tangible input for one or more FMN working groups."
  - Allied Command Transformation, *FMN Syndicates*
- Extension to bureaucratic structure of FMN management
- Allows for participation of
  - technical laboratory staff
  - industry experts
  - academics
- MSG-193 (now 201) designated as FMN M&S Syndicate
  - For Operational Coordination WG – later also Capability Planning WG

FMN Spirals and Roadmaps

- Like commercial development with repeated cyclic phases
  - Specification phase lasts 2 years working with 30+ nations
  - Overlapped with development/deployment of earlier spirals
  - Process based in standards and well-documented procedures
  - Annual Roadmap lays out goals and activities for next year
- Currently Spiral 5 specification phase (next year starts Spiral 6)



NMSG Contributing to FMN Specifications

- NMSG interest in FMN grew from C2 – Simulation (C2SIM)
  - Development fostered by multiple NMSG-activities since 2006
  - Partnered with Simulation Interoperability Standards Organization (SISO)
  - Realized C2SIM should be integral to FMN
- Spiral 5 has operational requirement for Mission Rehearsal
  - Major M&S application – good area to try out helping
  - After consideration we decided to limit contribution to ground Operational Communications/Information System (OPCIS)
  - Network like today's Internet, with multi-domain security
  - CPWG has described this as "M&SCIS"

M&S Focus for FMN Spiral 5: Mission Rehearsal (MR)

- Early operational requirement for FMN
- Conducted at all levels of military organization to familiarize coalition forces with plan prior to mission execution
- Defined mission in a specified operational context
  - Risk reduction, not training
- Follows the organization's stated policies and processes
- Most effective when closest to expected actual situation
- Supportable by collective training simulations with adjustment
  - Logging in simulation and in C2 reporting aids after action review
- Syndicate Spiral 5: MR in land Operational C2 Environment

Procedural Instructions (PI)

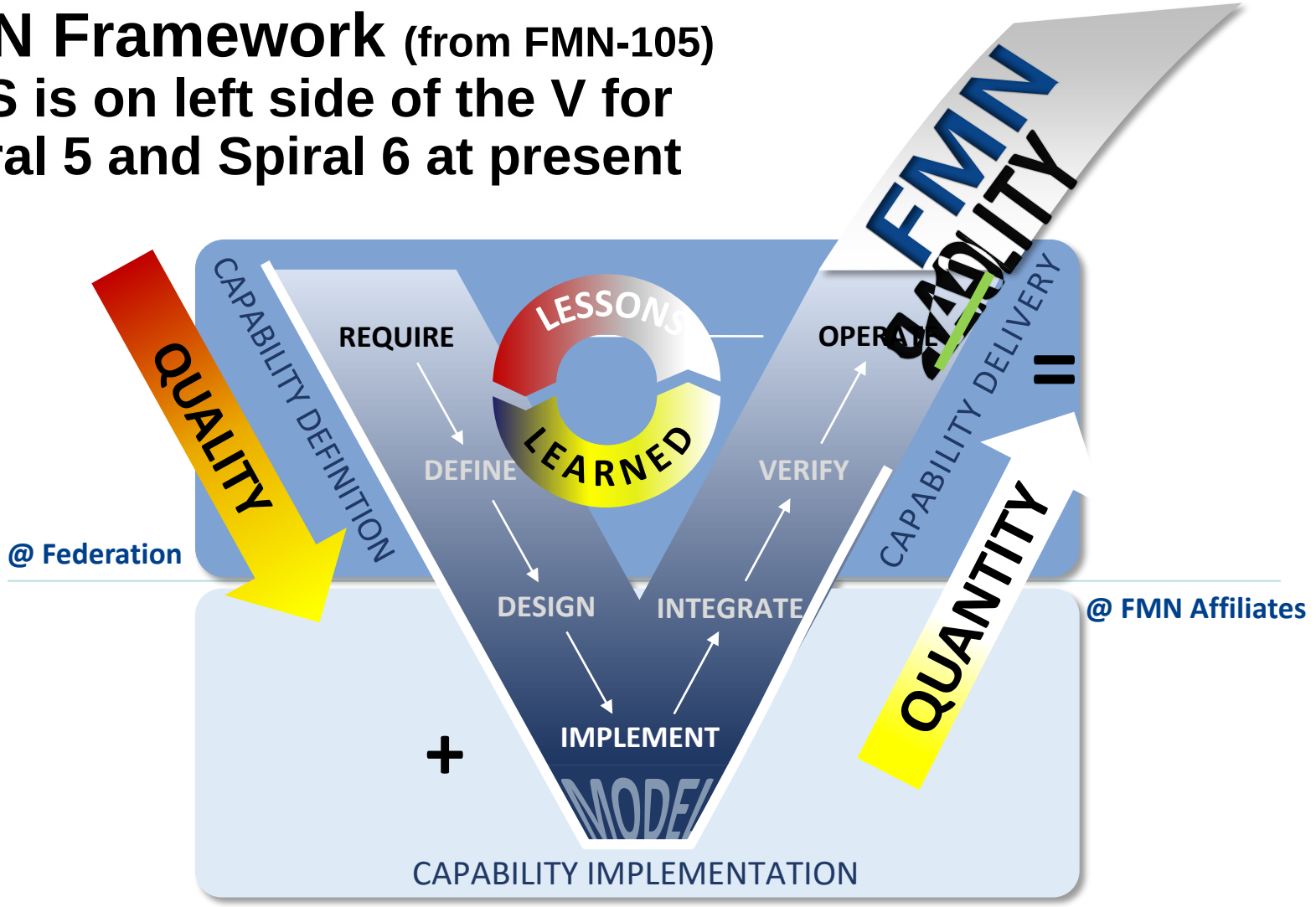
- Focused on operational needs
- We worked with Operational Coordination WG
- Good cooperation and we learned a lot
- Based on Mission Threads
  - Developed by M&S experts with operational experience
- PI intended to grow to other M&S applications
- Defines information products (IP) linked in Service Instructions (SI)
  - Supporting Information Exchange Requirements (IER)

SI: M&S Standards and Practices for MR

- FMN Service Instructions (SI) for M&S defines system interfaces based on standards:
  - Command and Control – Simulation Interoperation (C2SIM)
  - High Level Architecture (HLA) for Modeling and Simulation
  - NATO Education and Training Network (NETN) FOM
    - Based on AMSP-04 Edition B (draft)
    - New name: Distributed Synthetic Training
  - Modeling and Simulation as a Service (MSaaS)
- These also will form a good basis for FMN Spiral 6
  - "Train as you will operate" using actual C2 environment
- MSG-201 is validating interoperability in CWIX 2022 & 2023

FMN Framework (from FMN-105)

M&S is on left side of the V for Spiral 5 and Spiral 6 at present



SI Driven by Interfaces In Common With PI

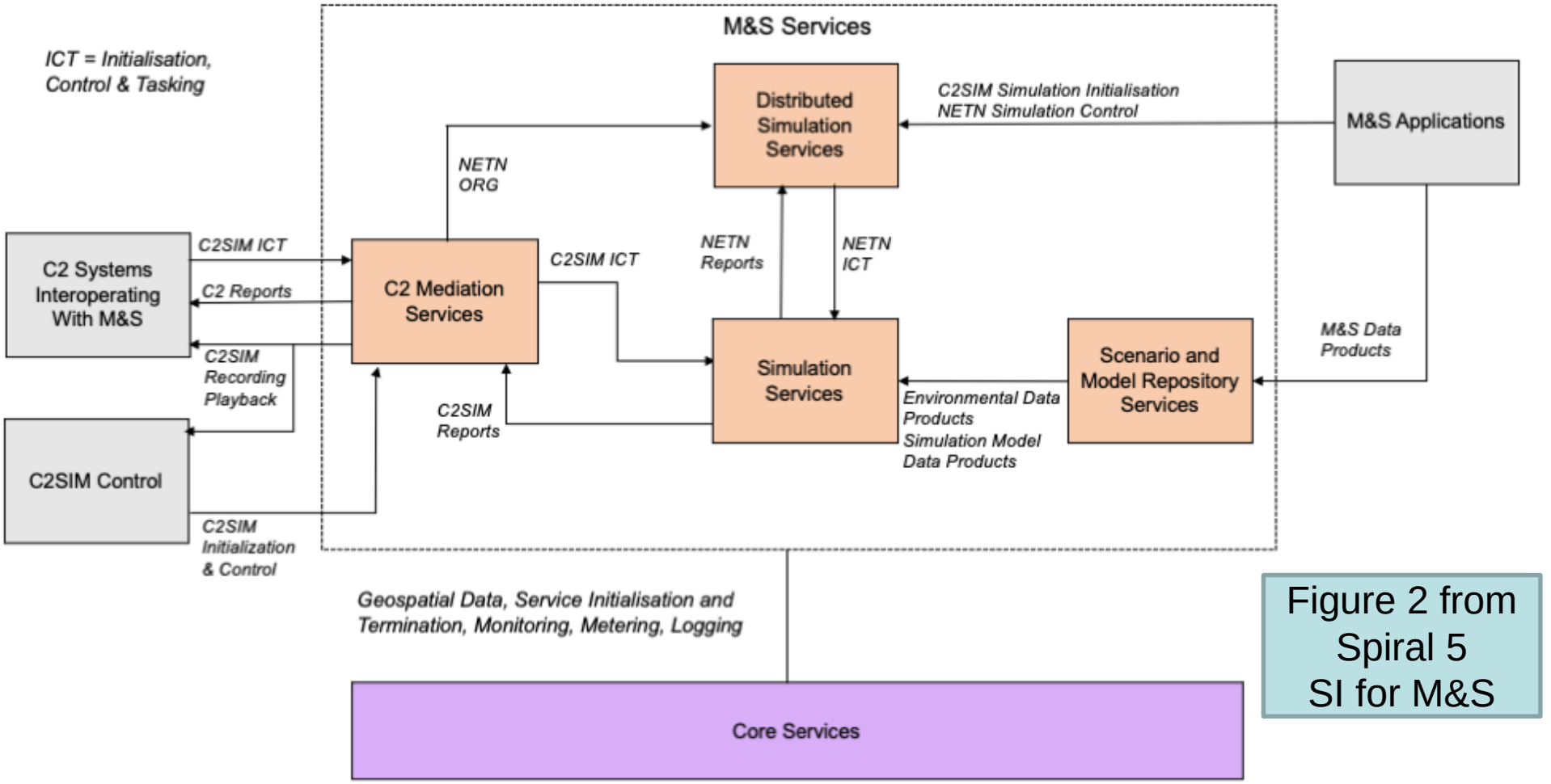
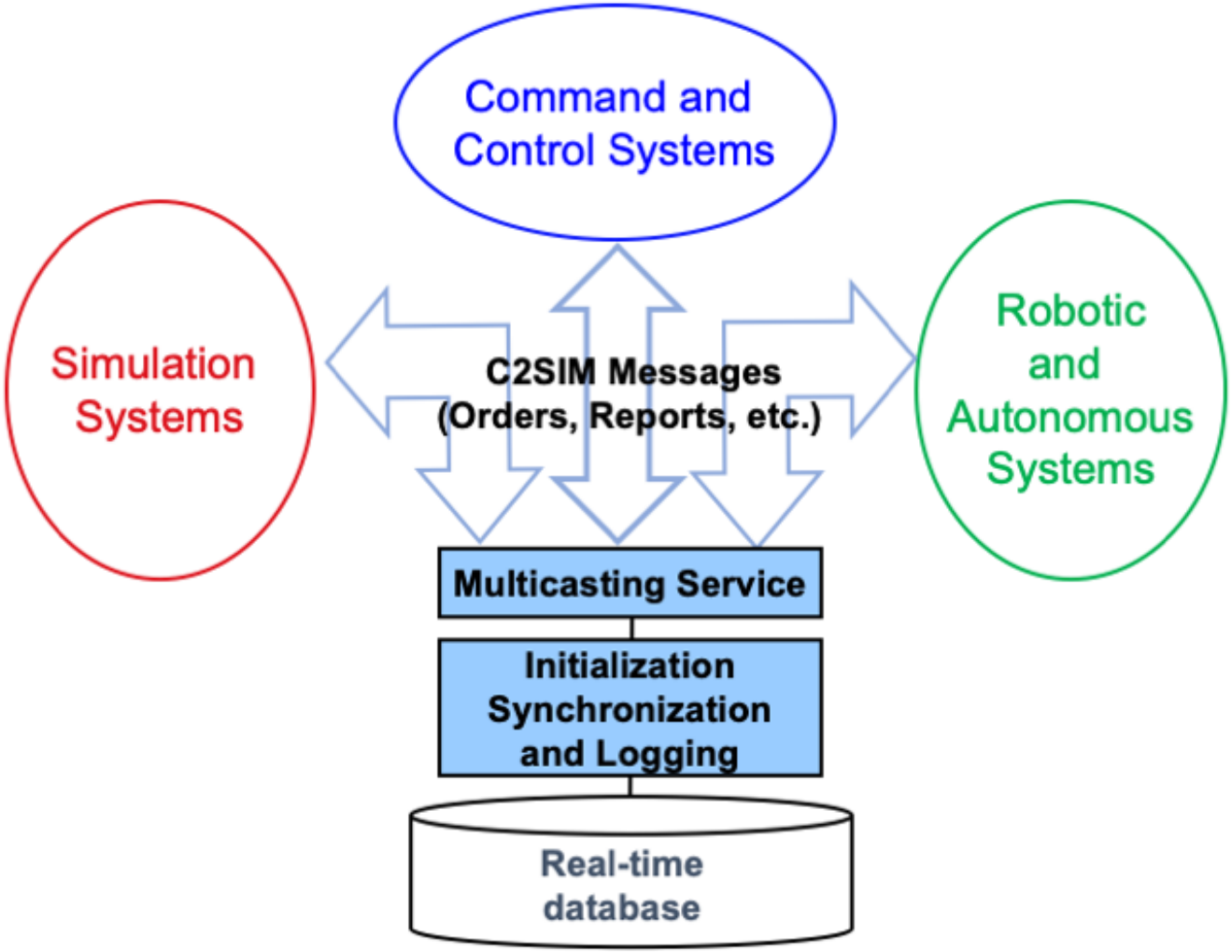


Figure 2 from Spiral 5 SI for M&S

MSG-201 in CWIX 2022

- Teams from five nations
  - DEU, FRA, NATO MSCoE, NLD, USA
  - Some at JFTC, others via Internet VPN
- Testing FMN M&S standards implementations operating together
  - C2-simulation interoperation (C2SIM)
  - Distributed simulation (HLA)
  - NATO Education & Training Net Federated Object Model (NETN-FOM)
  - Supported via networked cloud computing (MSaaS)
  - All of these must work together in networked environment
- Approach building on 2019 experience that validated C2SIM

C2SIM Basic Architecture

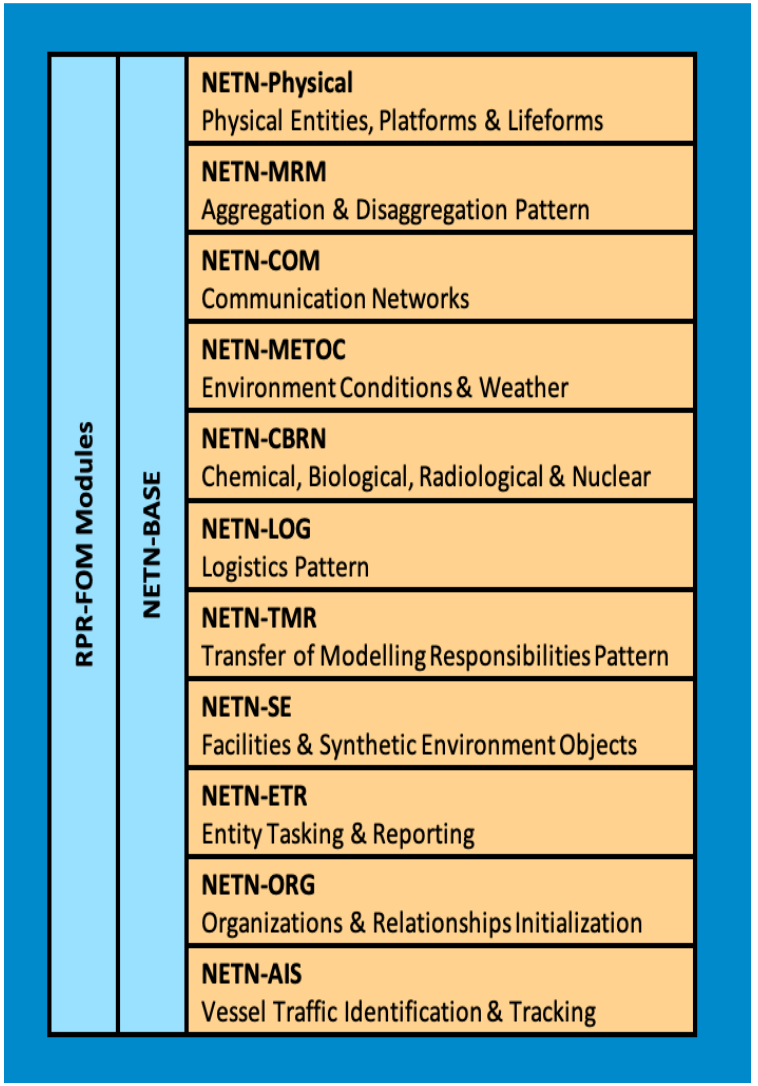


High Level Architecture (HLA) for M&S

- HLA is an IEEE simulation interoperability standard developed by SISO that has been adopted as NATO STANAG 5603
- Uses an object model approach to define the information that may be exchanged between simulations
- Supported by its own management services for things such as object management and time management
- Interfaces and underlying services are provided by supporting software known as the Run-time Infrastructure (RTI)
- Objects, interactions and associated ancillary information are defined in a Federation Object Model (FOM)
- NATO Education and Training Network (NETN) proceduralizes use of HLA for training with common NETN RPRFOM

NATO Education and Training Network (NETN) FOM

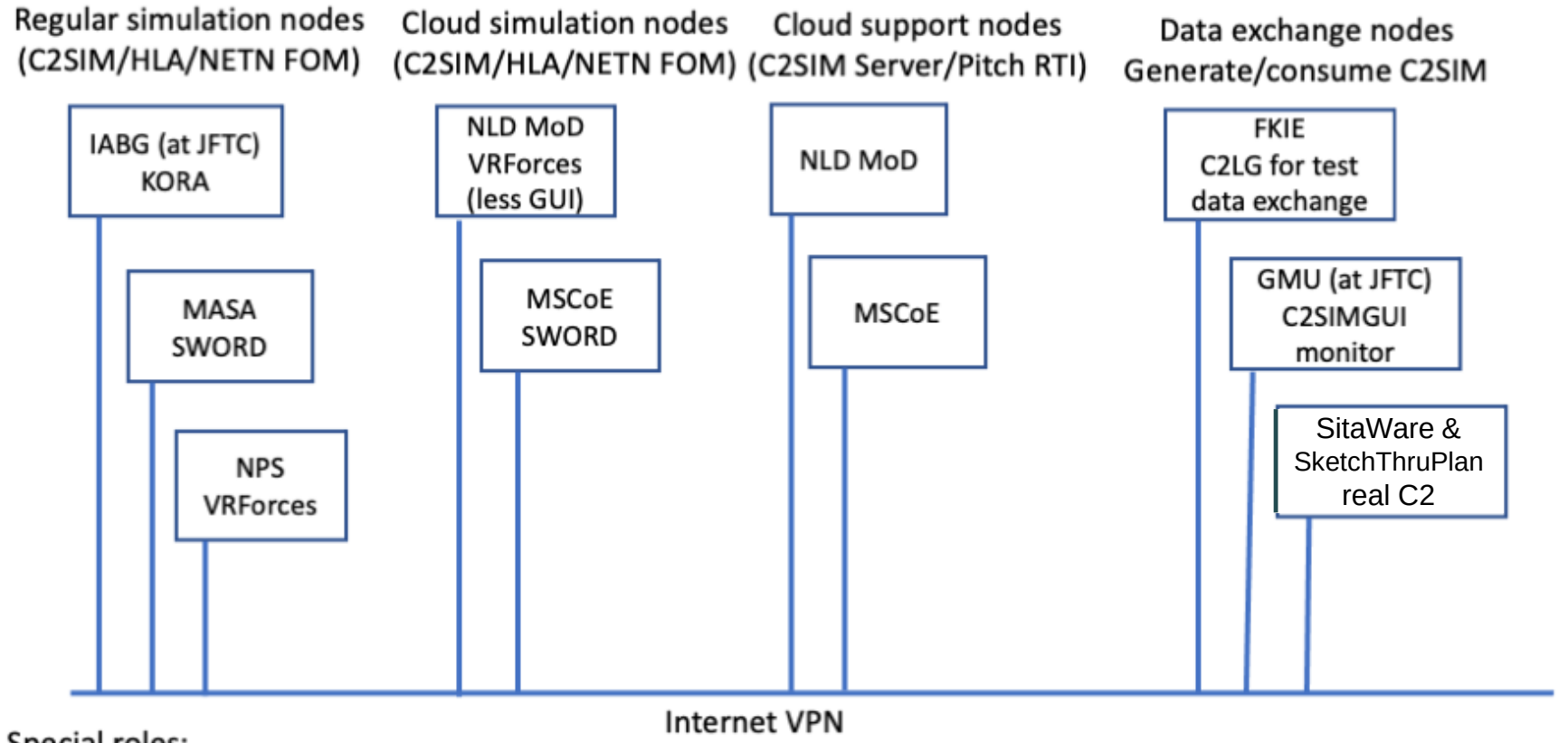
- To employ HLA must have a Federated Object Model (FOM)
- NETN modules address many aspects of simulated environment
- NETN is developed by a series of NMSG activities and proven in exercises
- Name change underway:
  NATO Federation Object Model for Distributed Synthetic Training



Modeling and Simulation as a Service (MSaaS)

- NATO approach to provide a means of delivering reusable, composable simulation to the user using a service-based architecture
  - M&S in the Cloud
- Maturing into three-stage process based on inustry standards
  - Discovery phase uses searchable simulation repositories to find simulations appropriate for the simulation task in hand
  - Composition builds and configures the simulation from discovered components; composability has the advantage that ‘best-of-breed’ or new models may be used
  - Deployment/execution is the final phase where the configured simulation is ready to be used.

MSG-201 CWIX 2022 Systems



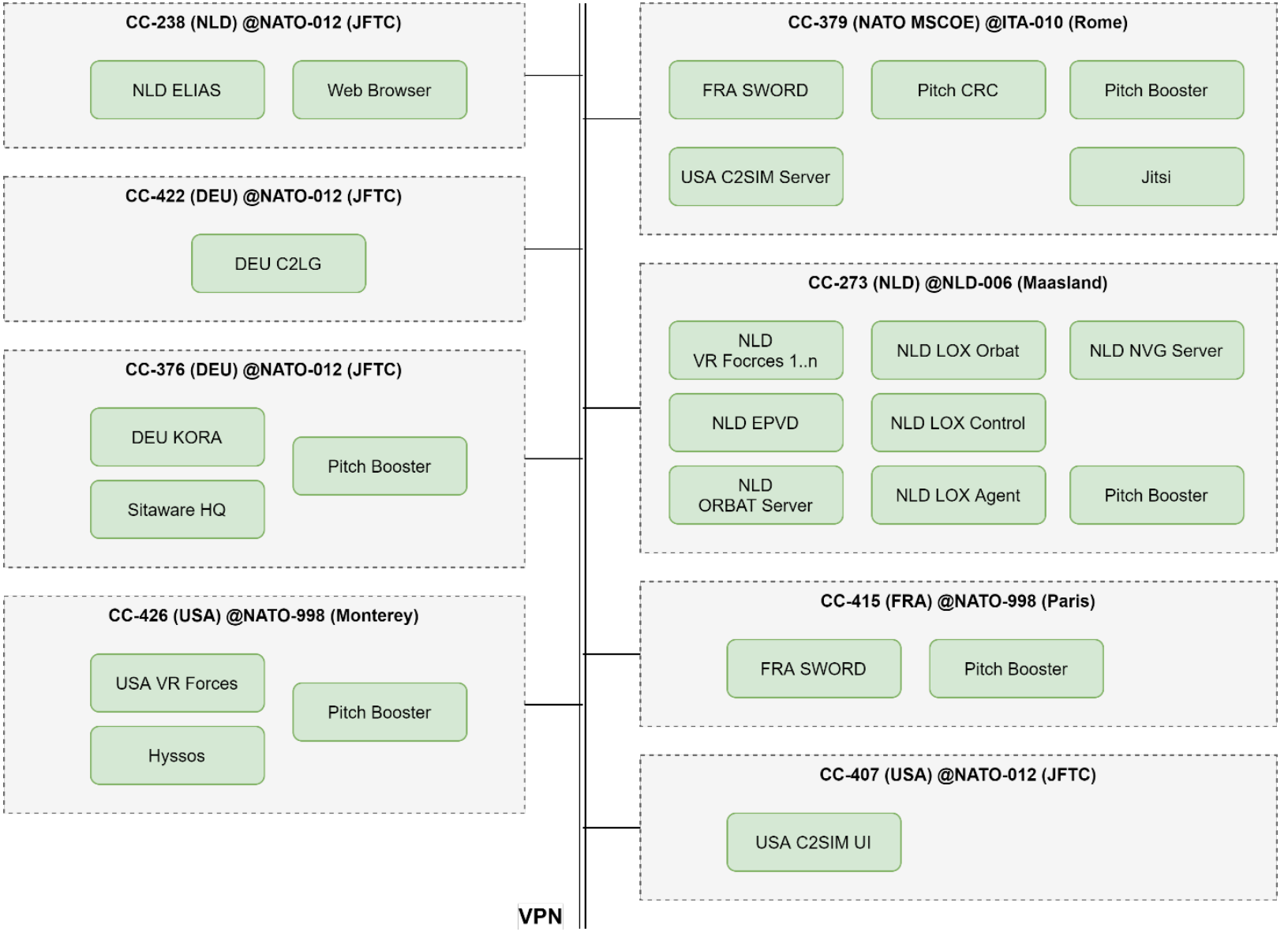
Special roles:
Trideum – scenario
TNO – HLA/NETN FOM assistance

Facilities for MSG-201 CWIX 2022

- Participating simulations and teams
  - SWORD from MASA (France)
  - VR-Forces from VT-MAK at NPS (USA)
  - KORA from IABG (Germany)
- Cloud-based simulations and services
  - SWORD at MSCOE (NATO/Italy)
  - VR-Forces at Netherlands MoD
  - Graphic and ORBAT services at Netherlands MoD
  - C2SIM server and Pitch RTI at MSCOE
  - FKIE C2LG GUI; GMU C2SIM GUI editors as C2 surrogate
- C2 Systems
  - Sketch-Thru-Plan (create/send C2SIM orders)
  - SitaWare (display C2SIM reports)

distributed simulations and support

MSG-201 CWIX 2022



Transaction Interoperability Testing

- C2SIM Server connection from simulation
- C2SIM control and initialization to simulation
- C2SIM Order to simulation via server
- C2SIM Report simulation to server
- C2SIM Move Order to simulation via server, with resulting reports
- C2SIM Attack Order to simulation via server, with resulting reports
- HLA RTI connection from simulation
- HLA information sharing among simulations, via RTI
- HLA information sharing reflected in C2SIM Reports
- Cloud-based deployment via Service Management and Control capabilities
- Overall our Test Cases were ¾ fully successful, ¼ limited success
  - Only 3 out of 162 Test Cases had “Interoperability Issue” (failed)

Mission Rehearsal Description

- Practice key aspects of the concept of operations to help leaders/Soldiers orient to the environment and other units
- Prior to execution of the operation
- Commander's tool to ensure staffs and subordinates understand the commander's intent
- Identifies shortcomings in the plan not previously recognized
- Contributes to external and internal coordination

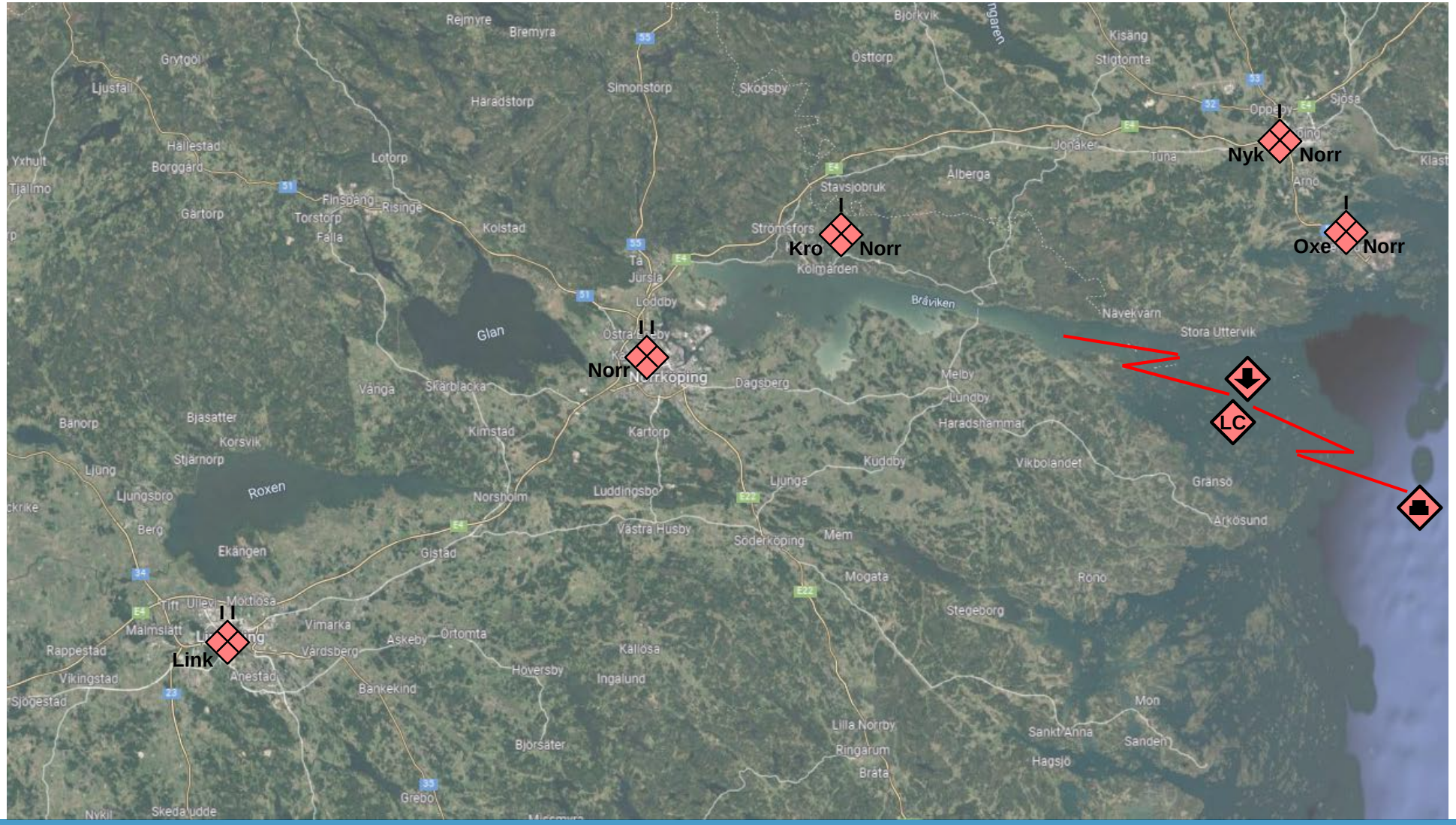
Mini-Mission Rehearsal

- Purposes:
  - Validate that the collected C2 & simulation function of the Spiral 5 SI for M&S will support mission rehearsal effectively
  - Familiarize the MSG-201 CWIX team with MR
  - Including need to pause/restart and revert to a control point
- Approach:
  - Revise/expand the MSG-145 scenario to create an MR simulation
  - Partition the MR execution to various scenarios/simulations
- Results:
  - All systems would have needed to be fully functional for complete success
  - The Mini-MR was considered “limited success” because some of the needed steps could not be executed

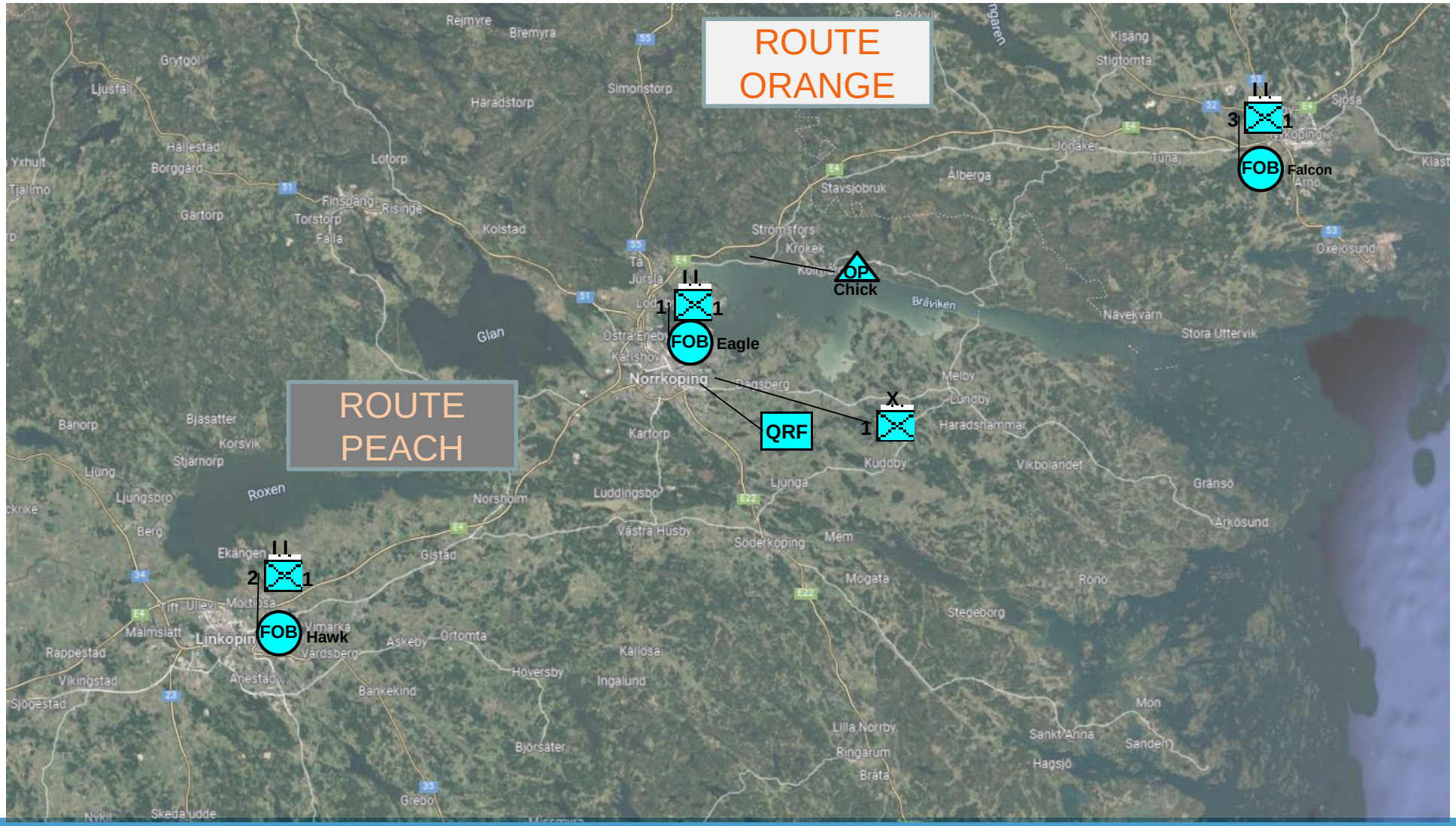
Brigade Area of Responsibility

Bogaland

Overview of Threat Force Locations



MINI-MR Routes from APOD to Initial Positions (Phase II and III)



Impediments

- Could not pre-test distributed operation with JFTC (CWIX) VPN
  - Used a surrogate VPN but there were different issues in execution
- Did not have adequate intra-group communications
  - CWIX rules did not allow use of Internet-based conferencing
  - After delay, ran our own Jitsi server but with only one audio channel which limited number of concurrent tests
- Ended up taking two of our five testing days to get VPN and conferencing set up
- Had to reconfigure daily because JFTC VPN reassigned IP addresses

Lessons Learned

- Need a stable testing environment, starting with pre-testing
  - JFTC BATLAB has offered to host MSG-201 CWIX 2023 so we can have stable testing environment early in the year
- Wherever practical, locate services at JFTC
  - Can't do this for some simulations whose operators can't afford time/cost of travel to JFTC
- Schedule overlapped time periods for best collaboration
- Embrace more rigorous distributed engineering (SISO DSEEP)
  - Track activities in writing daily
  - Ensure test operators are experienced with systems tested
- Complete pre-testing using available GMU (or JFTC) "sandbox"
- Assemble a "dashboard" of essential operating information

CWIX 2023 & 2024

- CWIX 2022 tested FMN Spiral 5 Service Instructions for M&S
  - Built credibility that proposed standards and practices will work well for Mission Rehearsal in FMN
  - In 2023 the goal is a very robust and more manageable configuration
  - Prepare for full CIAV validation CWIX 2024
- CWIX 2024 must test mature collection of M&S standards and practices in FMN context
  - Formalized testing with FMN Coalition Interoperability Assurance & Validation WG
  - Work with other Focus Areas – Future Core Services? MIP? OpCmd?

Conclusions

- M&S is an important capability for FMN to support NATO multinational deployments
  - Mission Rehearsal in the "M&SCIS"
  - Collective training "train as you fight"
  - Validate proposed capabilities in CWIX
- NMSG is participating in the FMN Spiral process to help achieve this, in order that NATO will have capabilities necessary to continuing its role of sustaining international peace
  - Providing M&S Syndicate of experts to support specification
  - CWIX 2022 was a good start, testing FMN Spiral 5 SI for M&S
  - Mostly fully successful; about ¼ limited success; included "Mini-MR"
  - Planning to participate through Spiral 6 in CWIX 2023 and 2024

Questions