Advancing Modelling and Simulation in NATO Federated Mission Networking

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Overview

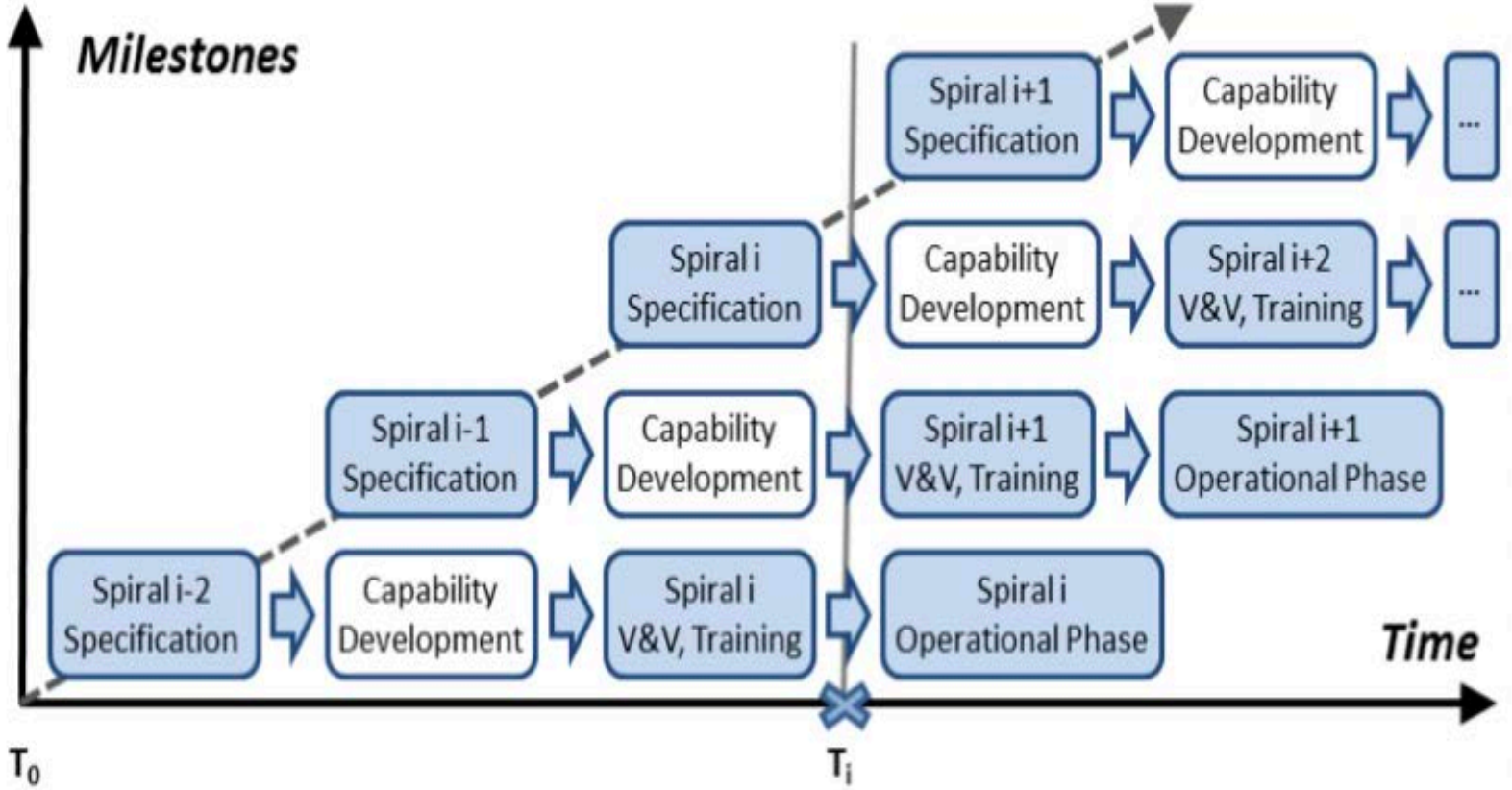
- Introduction: FMN and CWIX
- M&S Standards Proposed for FMN
- MDO Support in FMN Using M&S
- CWIX 2023 Testing
- Conclusions

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 Spiral Development



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 MSG-193 followed by MSG-201 to help
  - Participating in FMN specification
  - Designated M&S Syndicate by Operational Coordination Working Group (OCWG)
  - Later promoted to Inter-WG (IWG) Syndicate by Capability Planning WG (CPWG)
  - Drafted Procedural Instructions (PI) for Mission Rehearsal
  - And Service Instructions (SI) for Modeling and Simulation
- Initially Spiral 5; now 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 helping role
  - 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"

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 & 2023 we tested running the Spiral 6 M&S SI elements
- System-of-systems distributed via Internet VPN and at JFTC
  - DEU, FRA, NLD, NOR, SWE, USA

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
- Spiral 5/6: MR in land Operational C2 Environment

Procedural Instructions (PI)

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

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)
    - Focus on networked cloud computing
- 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

SI Driven by Interfaces In Common With PI
ultimately we must convince the CIAV this meets FMN needs

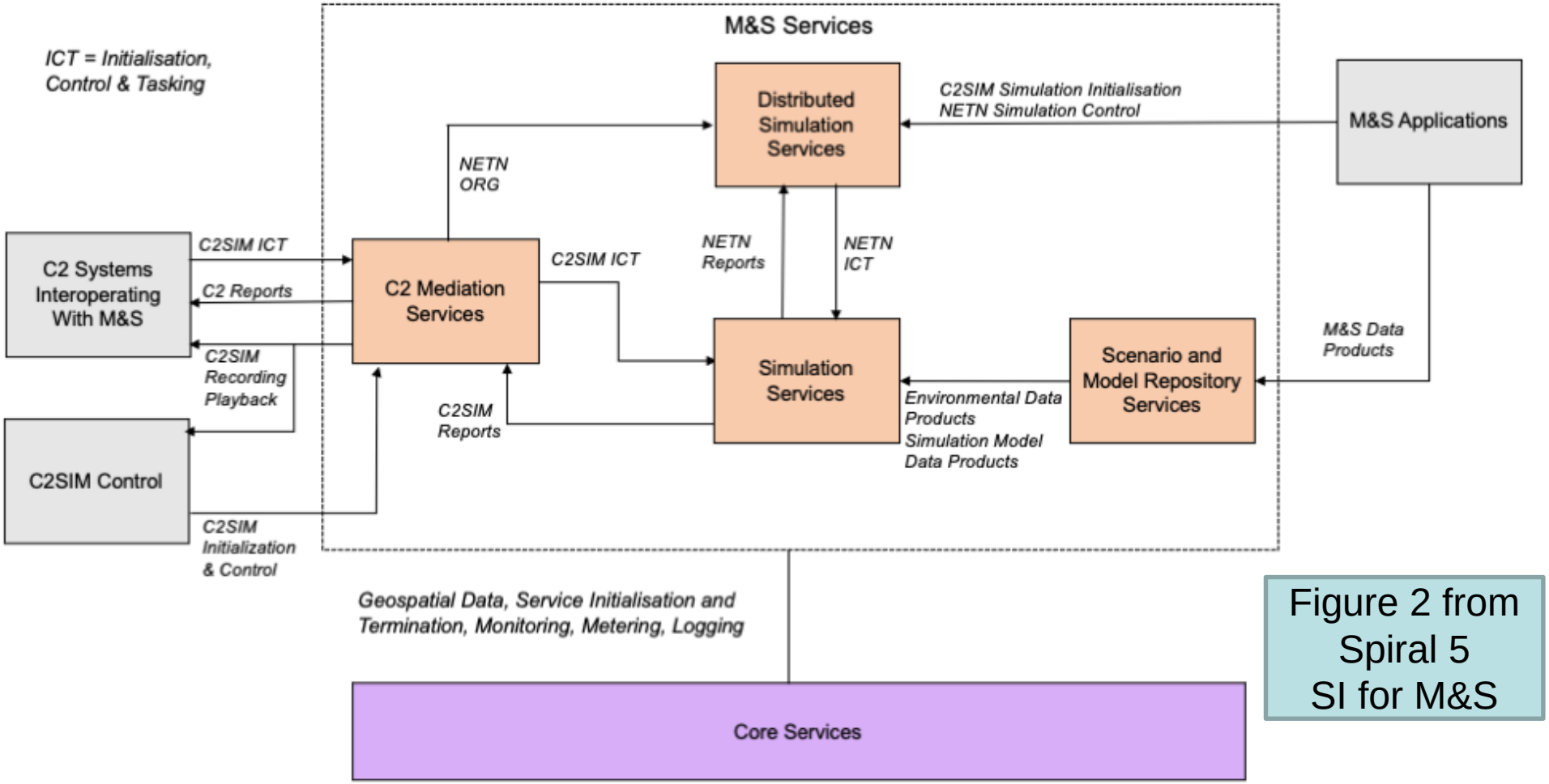
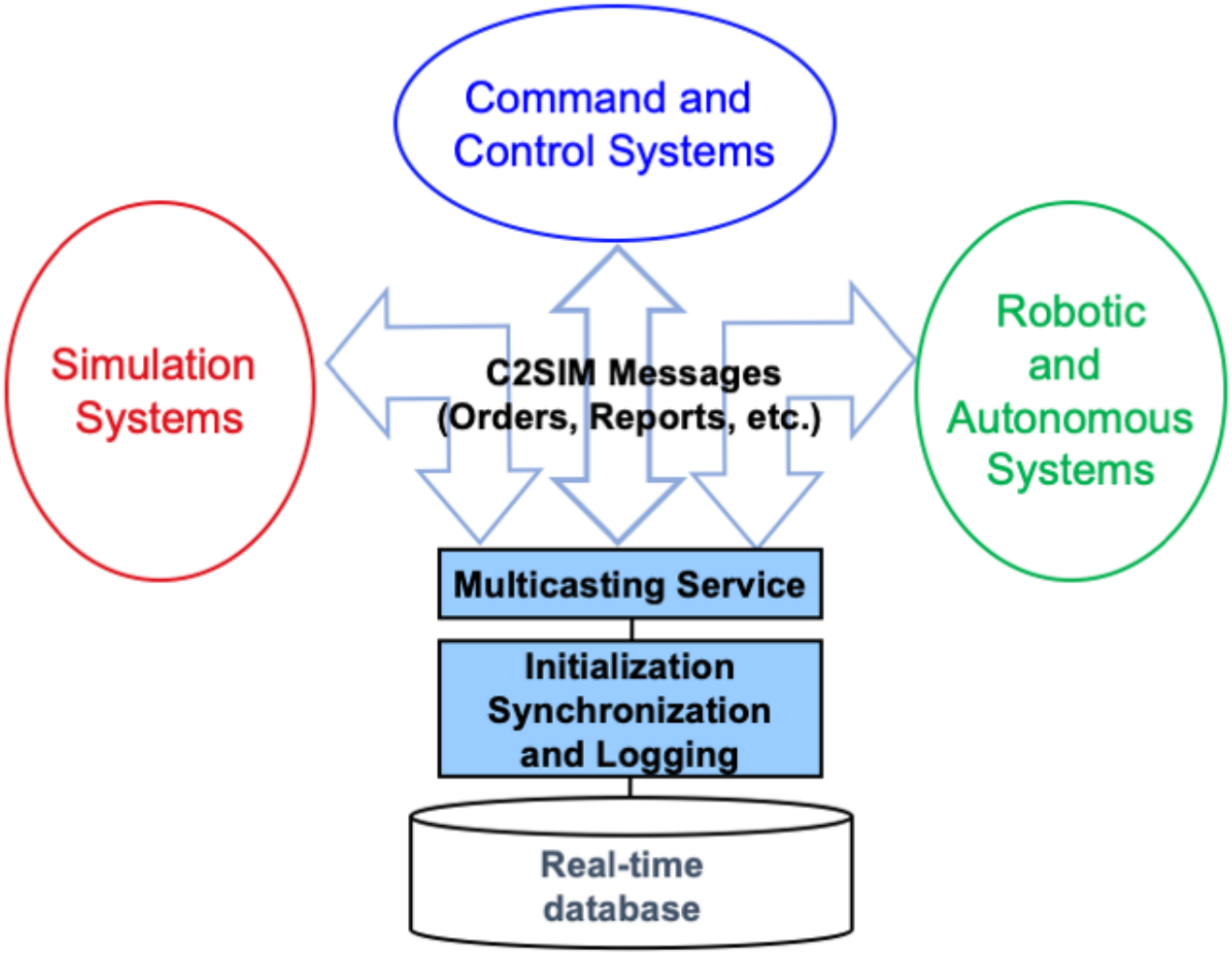


Figure 2 from Spiral 5 SI for M&S

M&S Standards Proposed for FMN

- CWIX tests standard implementations interoperating
  - C2-simulation interoperation (C2SIM)
  - Distributed simulation via HLA
  - NATO Education & Training Network (NETN)
    - Takes form of HLA Federated Object Model (FOM)
    - Name change pending: Distributed Synthetic Training
  - Supported via networked cloud computing (MSaaS)
  - All of these must work together in FMN environment

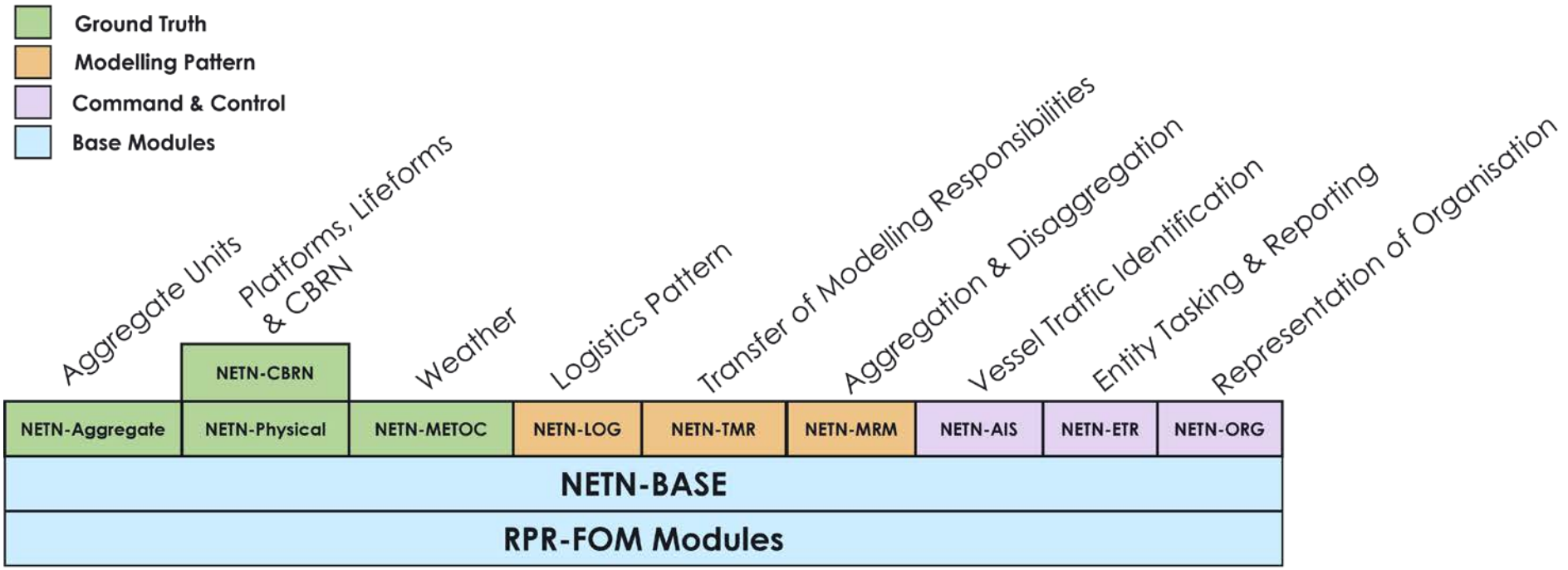
C2SIM Basic Architecture



High Level Architecture (HLA) for M&S

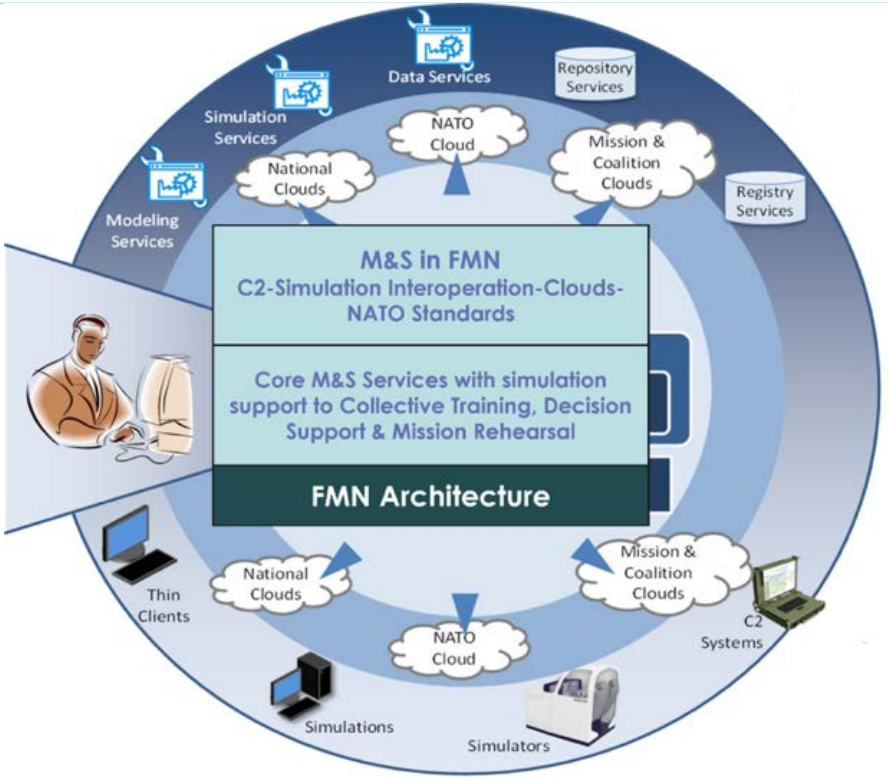
- HLA is an IEEE simulation interoperability standard developed by SISO that has been adopted as NATO STANAG 5603
- Uses an object model approach to define the information that may be exchanged between simulations
- Supported by its own management services for things such as object management and time 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 version of RPRFOM

NETN FOM Principal Components

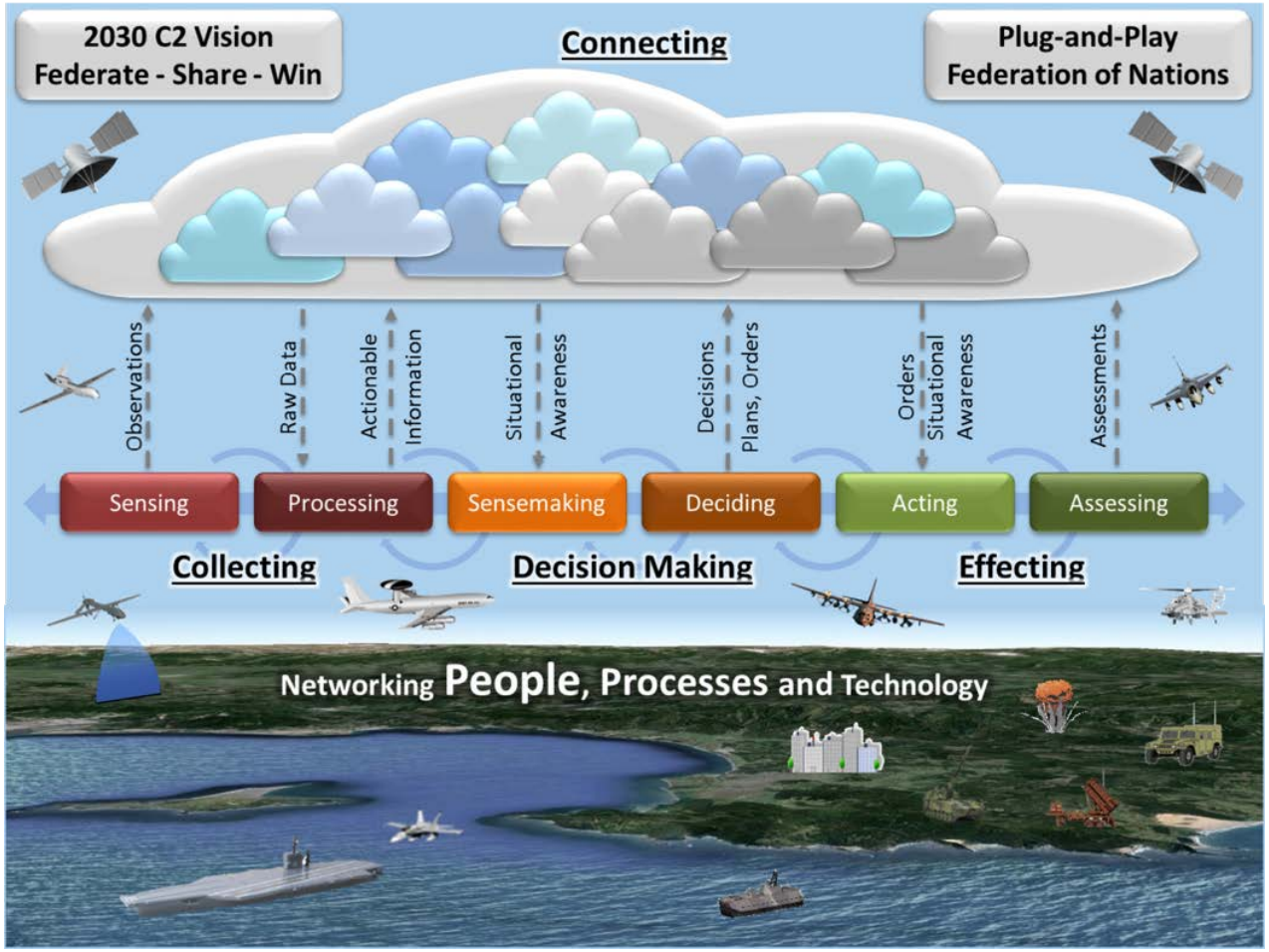


Modeling and Simulation as a Service (MSaaS)

- NATO approach to provide a means of delivering reusable, composable simulation to the user using a service-based architecture: M&S in the Cloud

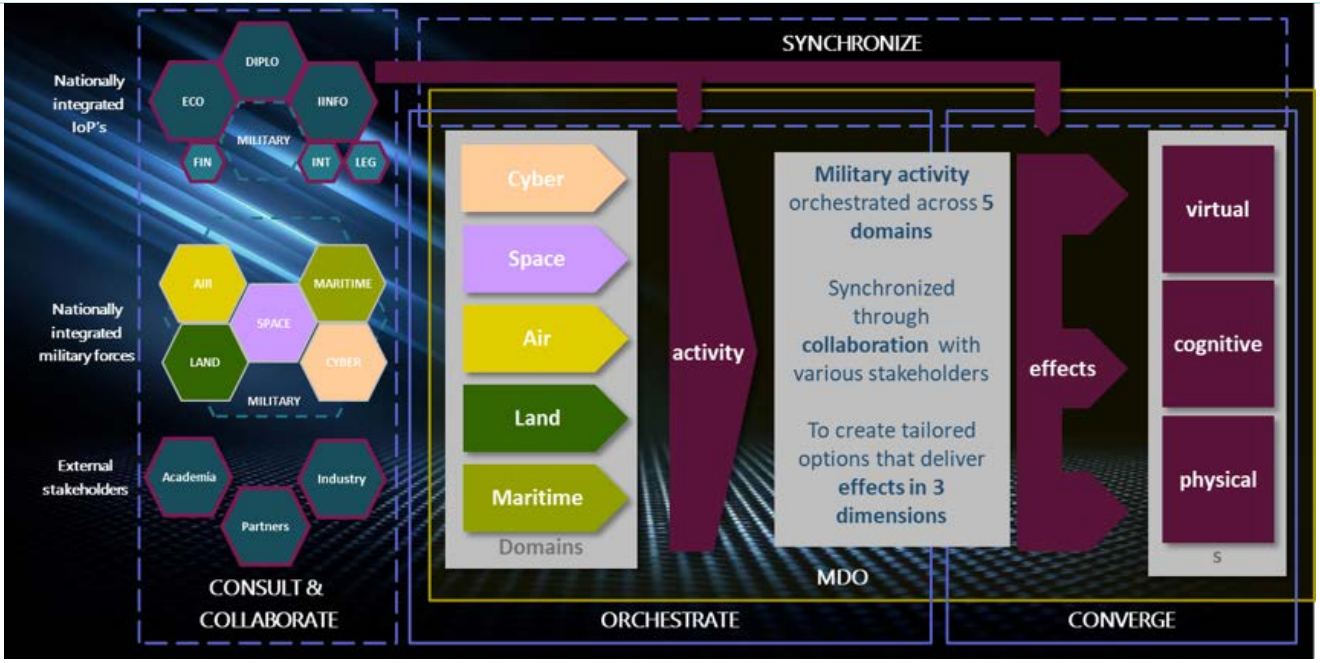


NATO C2 Vision
Supports Multi-Domain Operations (MDO)

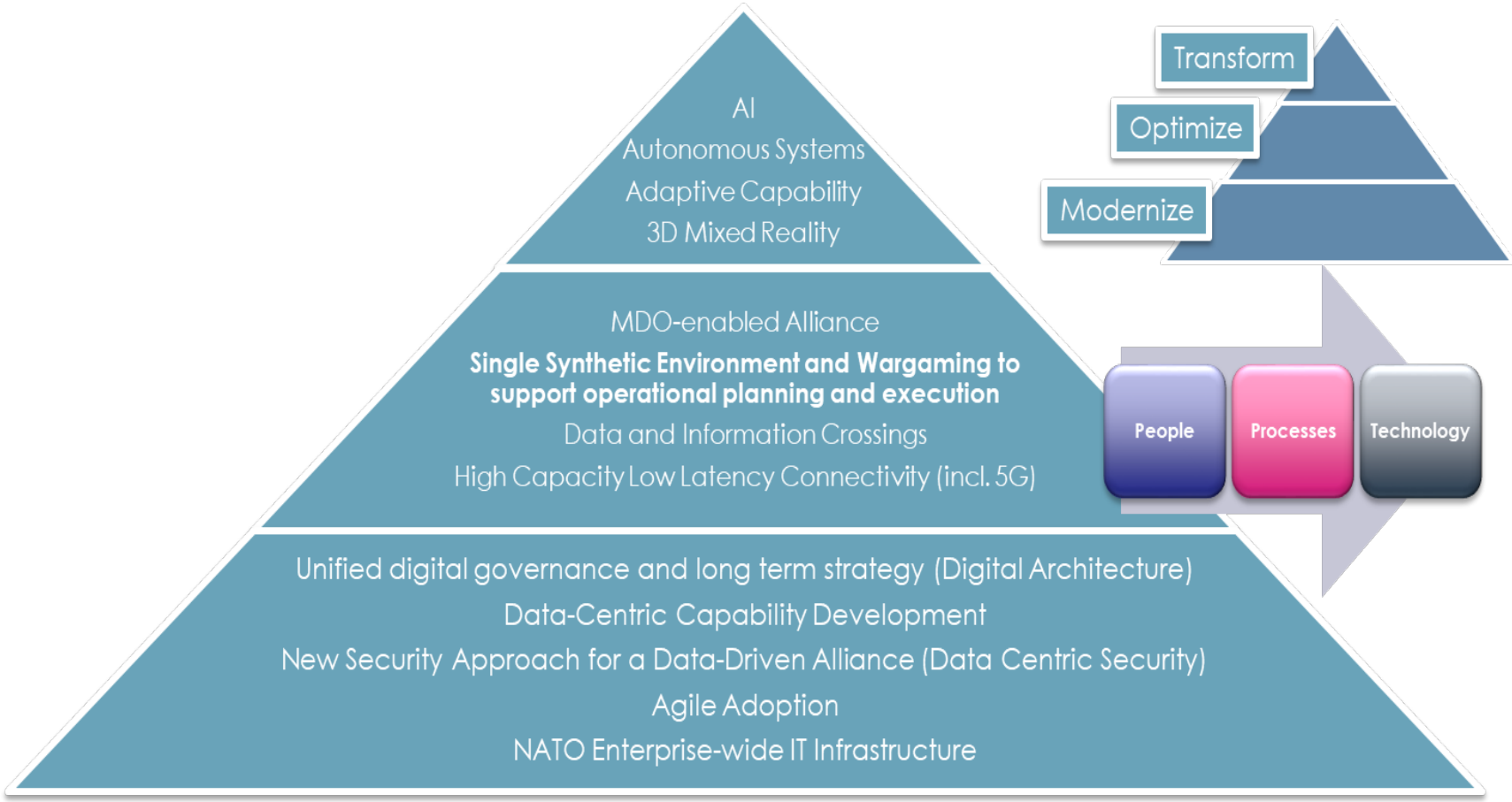


Scope of MDO Support in FMN Using M&S

- MDO is "Joint C2" for all operational domains
  - Land, Air, Maritime, Cyber, Space, …
  - Synchronized with non-military activities
- NATO is committed to implement MDO by 2030
  - underpinned by Digital Transformation and FMN



Digital Transformation in Support of MDO



M&S in MDO

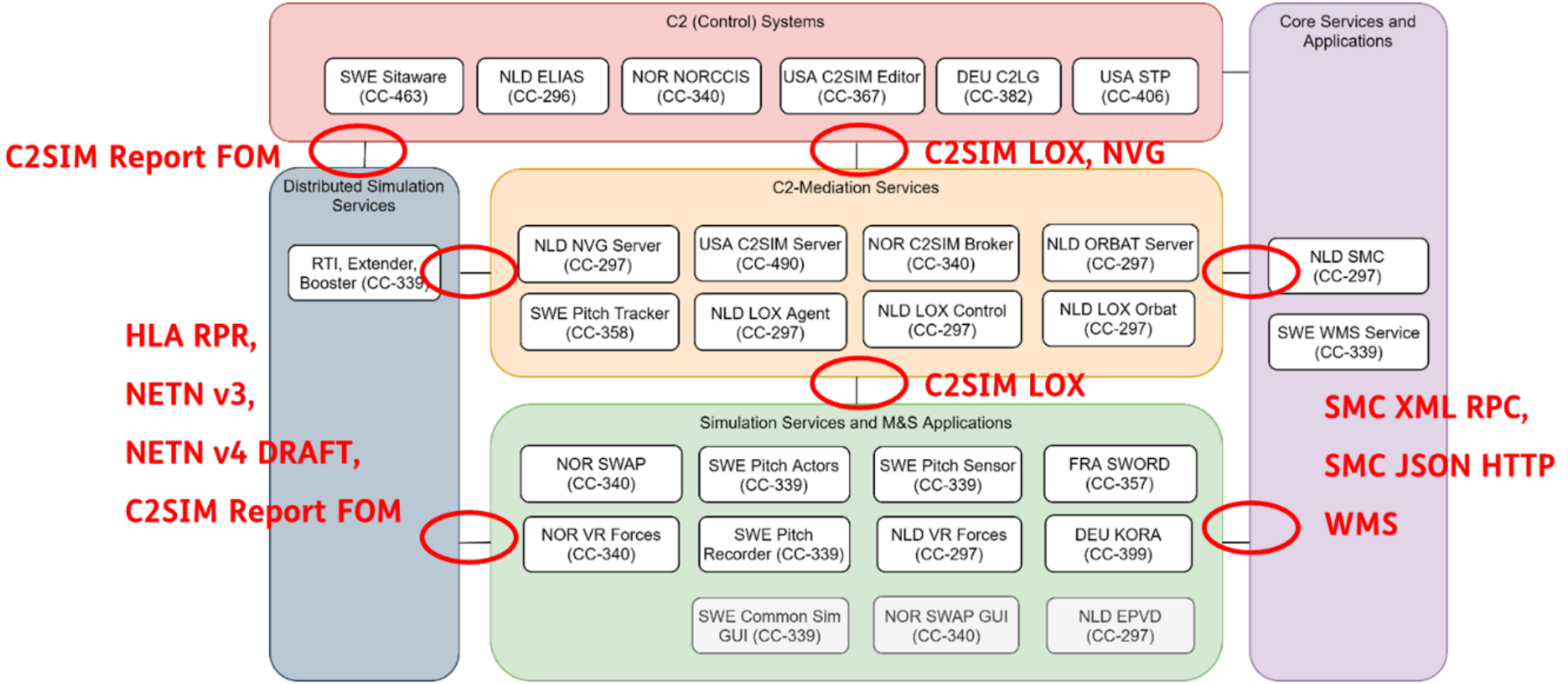
- Single Synthetic Environment and Wargaming to support operational planning and execution is required
  - M&S must operate in this context
  - Requires FMN capabilities plus integration of simulations
- To be used for
  - Course of action analysis
  - Wargaming
  - Mission rehearsal
  - Collective training
- Necessary in the battlefield of the future

CWIX

MSG-201 CWIX Approach

- Based on Spiral 5 SI and PI
- Objectives laid out in CWIX methodology
  - Explore HLA requirements
  - Explore MSaaS requirements
  - Explore C2SIM requirements
  - Examine their combination in Mission Rehearsal Exercise
- Assembled Test Cases using 4 C2 and 5 Simulation systems
  - Combined efforts of DEU, FRA, NLD, NOR, SWE and USA teams
  - Tested 36 cases: interoperability of simulations, C2 systems, service management and control
  - Culminated in limited Mission Rehearsal exercise

Tested Technical Interfaces



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

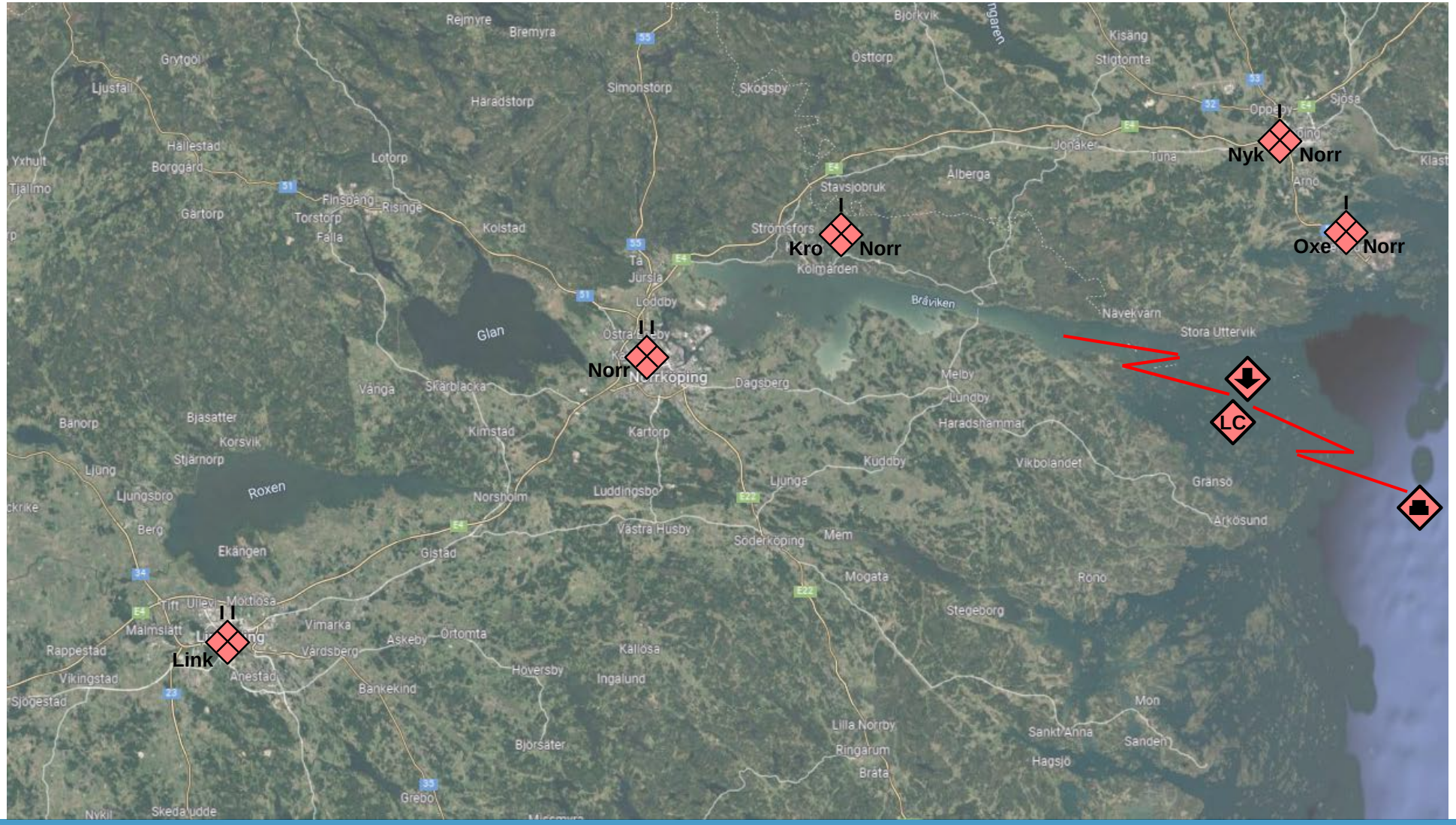
Mini-Mission Rehearsal

- 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 CWIX 2022 MR scenario
  - Partition the MR OPORD to various tasks/simulations
- Results:
  - All systems were able to interoperate and participate using C2SIM and HLA with NETN FOM
  - More realistic MR for 2024 would have participating teams creating their own subordinate C2SIM orders

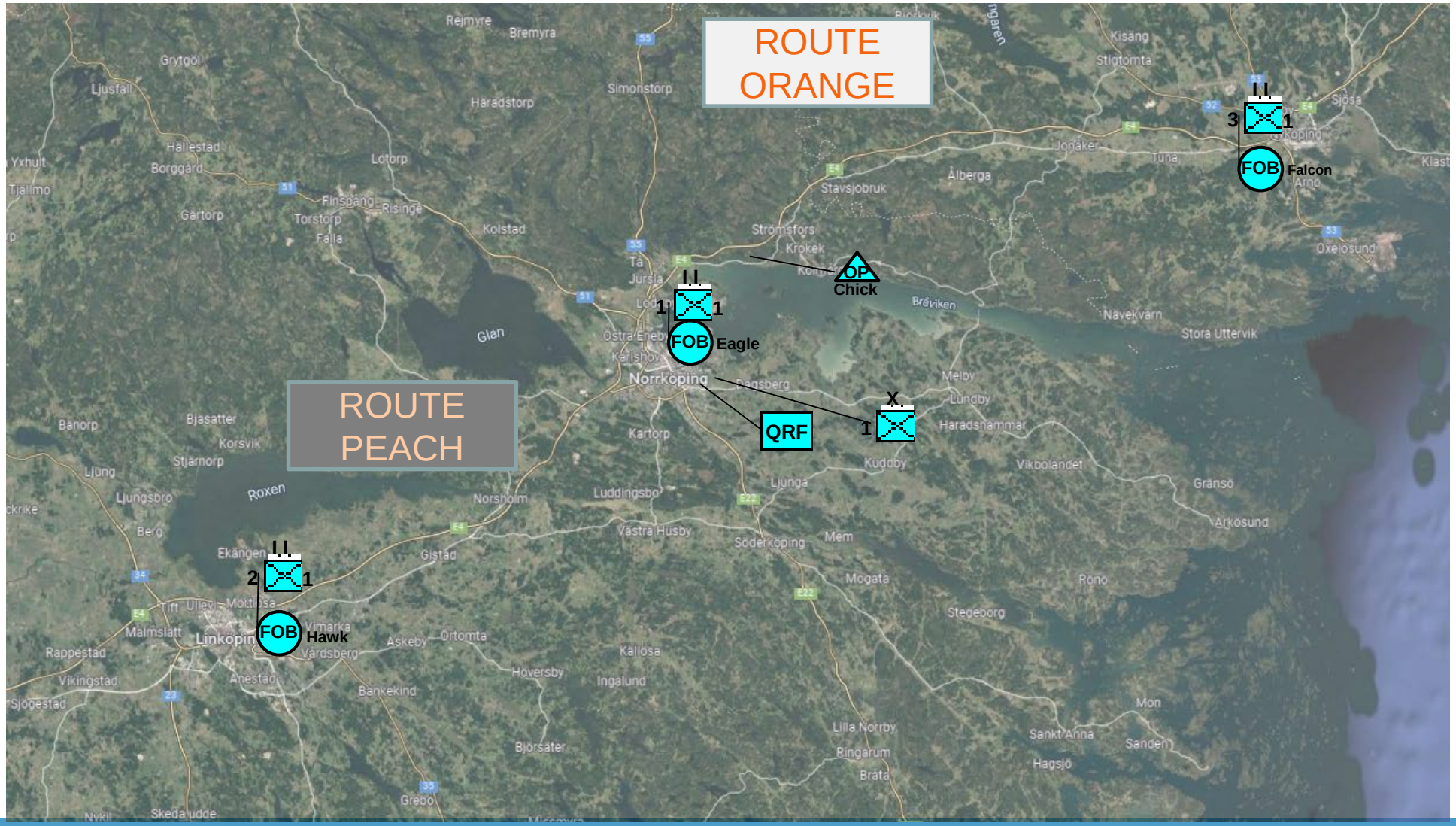
Brigade Area of Responsibility

Bogaland

Overview of Threat Force Locations



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



Lessons Learned

- Need a stable testing environment, starting with pre-testing
  - JFTC BATLAB provided VPN to enable this
- 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 multiple overlapped tests to enable more testing
- Distributed engineering (SISO DSEEP) enables better testing
  - Track activities in writing daily
  - Ensure test operators are experienced with systems tested
- Coordinate with CIAV to ensure FMN requirements are met

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 continue its role of sustaining international peace
  - Providing M&S Syndicate of experts to support specification
  - CWIX 2022/2023 was a good start, testing FMN Spiral 5 SI for M&S
  - Planning to participate through Spiral 6 in CWIX 2024 and begin to include Collective Training

Questions