



M&S Standards for FMN Workshop Hands-on Details for C2SIM & HLA

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Outline

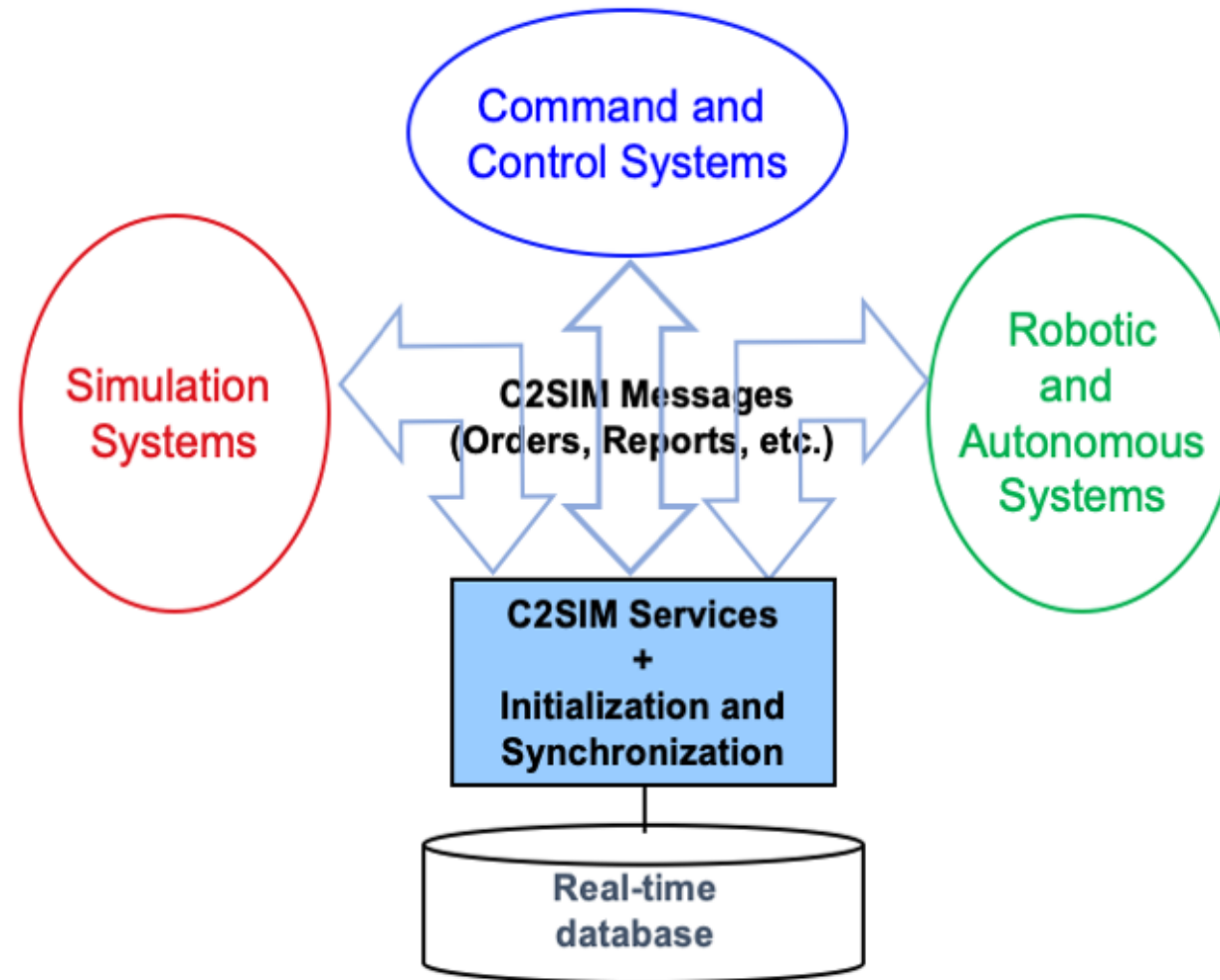
- Server & ClientLib
- C2SIM Server configuration and coalition states
- C2SIMGUI Editor & C2SIMcontrol
- XML document flow: Initialization, Orders, Reports using C2SIMGUI
- Hands-on walkthrough of C2SIMGUI & VRForces simulation
- Operation of HLA RTI
- Configuring & running Pitch pRTI

Workshop Agenda

subject to revision

1. Welcome and setup (.5 hour)
2. Refresher summary of MSG-194 RTC (1 hour)
3. C2SIM & NETN HLA standard hands-on internal details (1.5 hour)
Ontologies, Messages, information flow
4. Assembling C2SIM Initialization, Orders and Reports (1 hour)
5. Individuals create tasking orders and run independently (1 hour)
6. Group runs a collective exercise and group discussion (1 hour)

C2SIM Basic Architecture



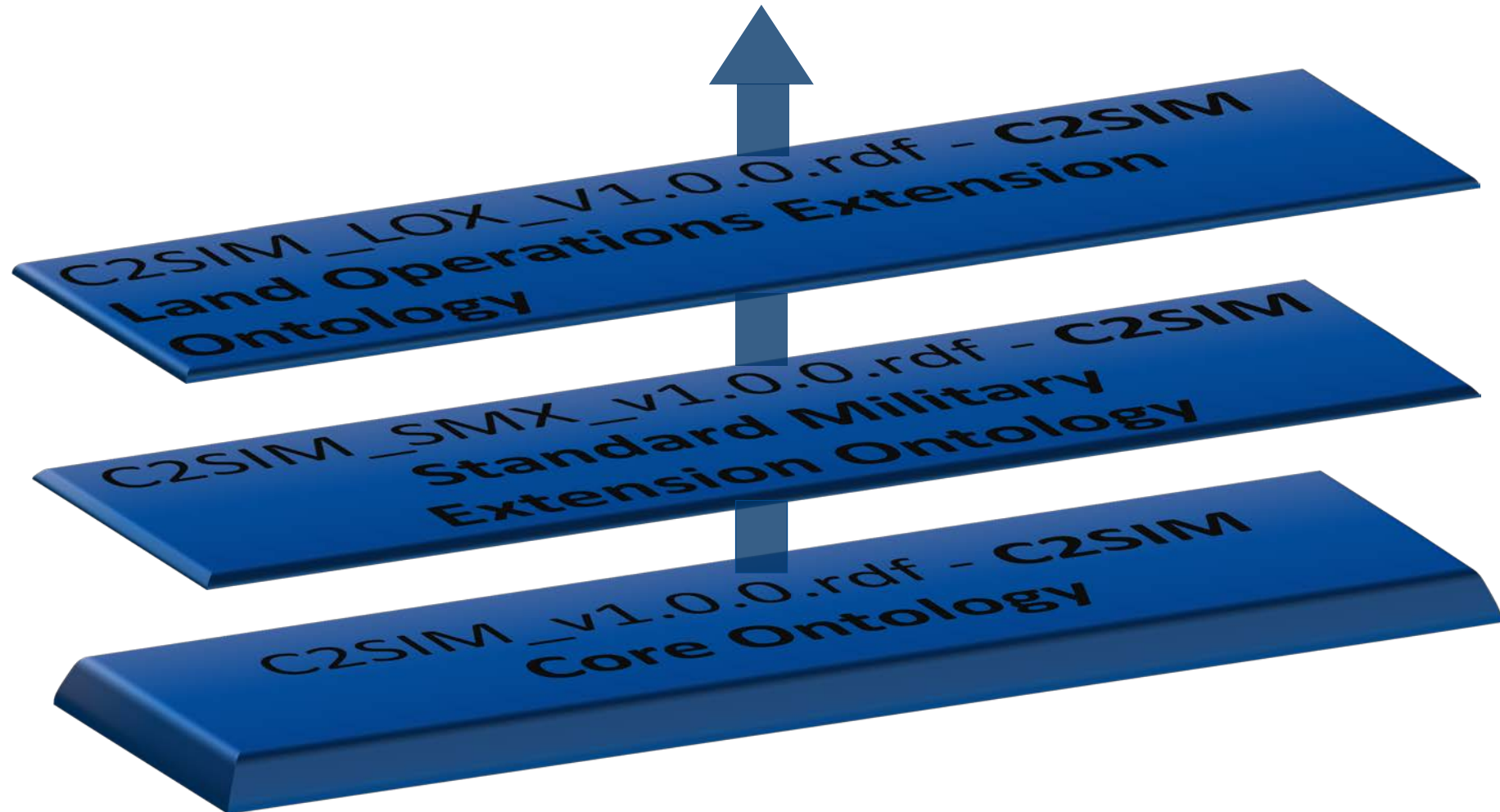
C2SIM Standard

- 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 and Tasking & Reporting messaging
 - Extension Mechanism and Land Operations Extension
 - Guidance document

C2SIM Ontologies

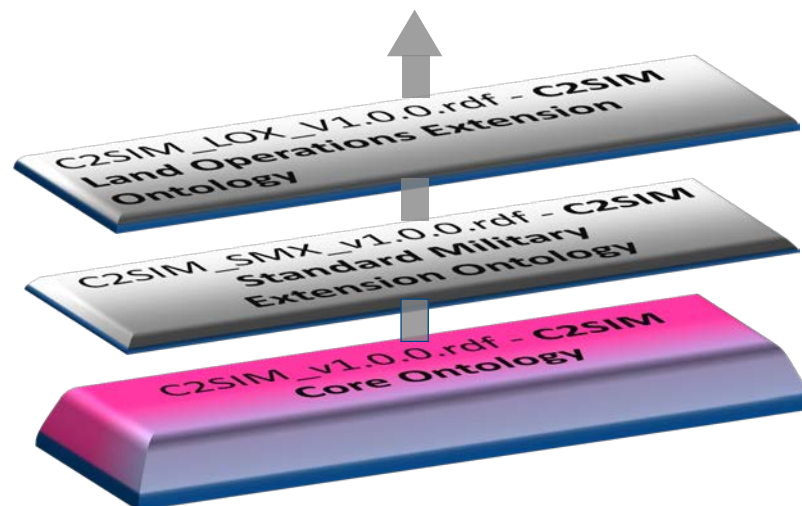
- Definition: Set of concepts and categories in a subject area or domain that shows their properties and the relations between them
- Core: data classes and properties that are needed by all C2 and simulation systems to interoperate (Who, what, when, where)
- Standard military extension (SMX): classes 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

Overview of C2SIM Ontologies



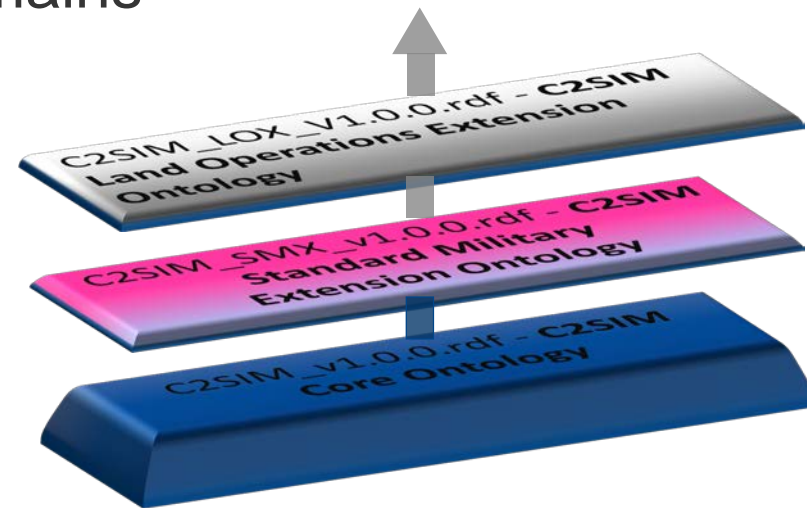
Core Ontology: C2SIM_v1.0.0.rdf

- Logical Data Model
- core set of elements common to C2 and Simulation Systems
- standard way to combine and add domain specific knowledge



C2SIM_SMX_v1.0.0.rdf - C2SIM Standard Military Extension Ontology

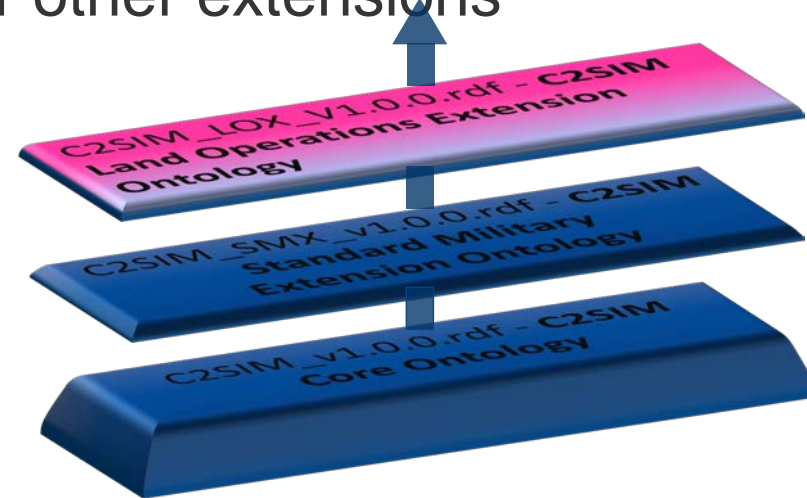
- imports C2SIM Core
- provides additional concepts and relations common to all military domains



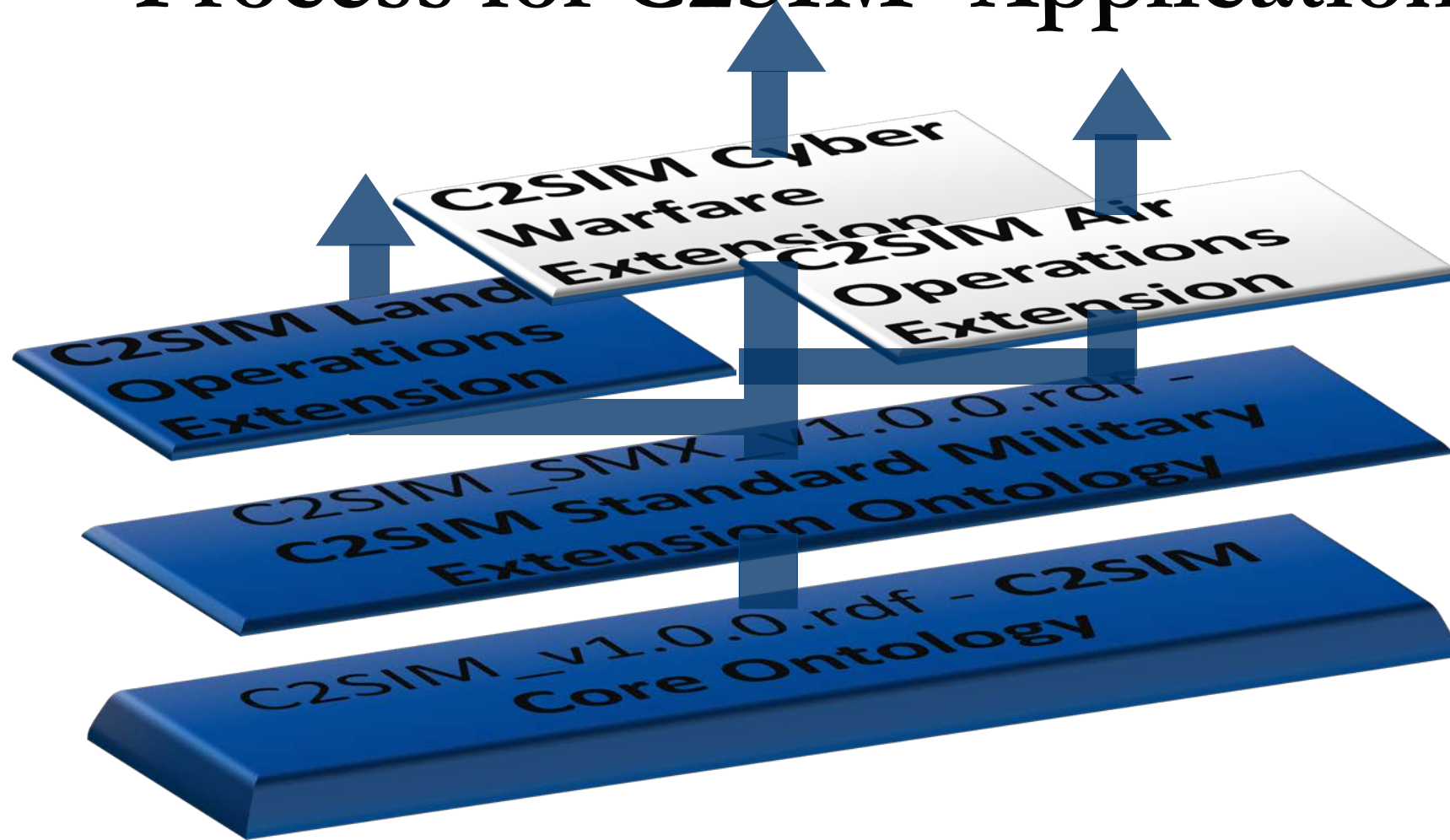
C2SIM_LOX_V1.0.0.rdf

C2SIM Land Operations Extension Ontology

- imports SMX and Core
- adds information specific to land operations
- example for other extensions



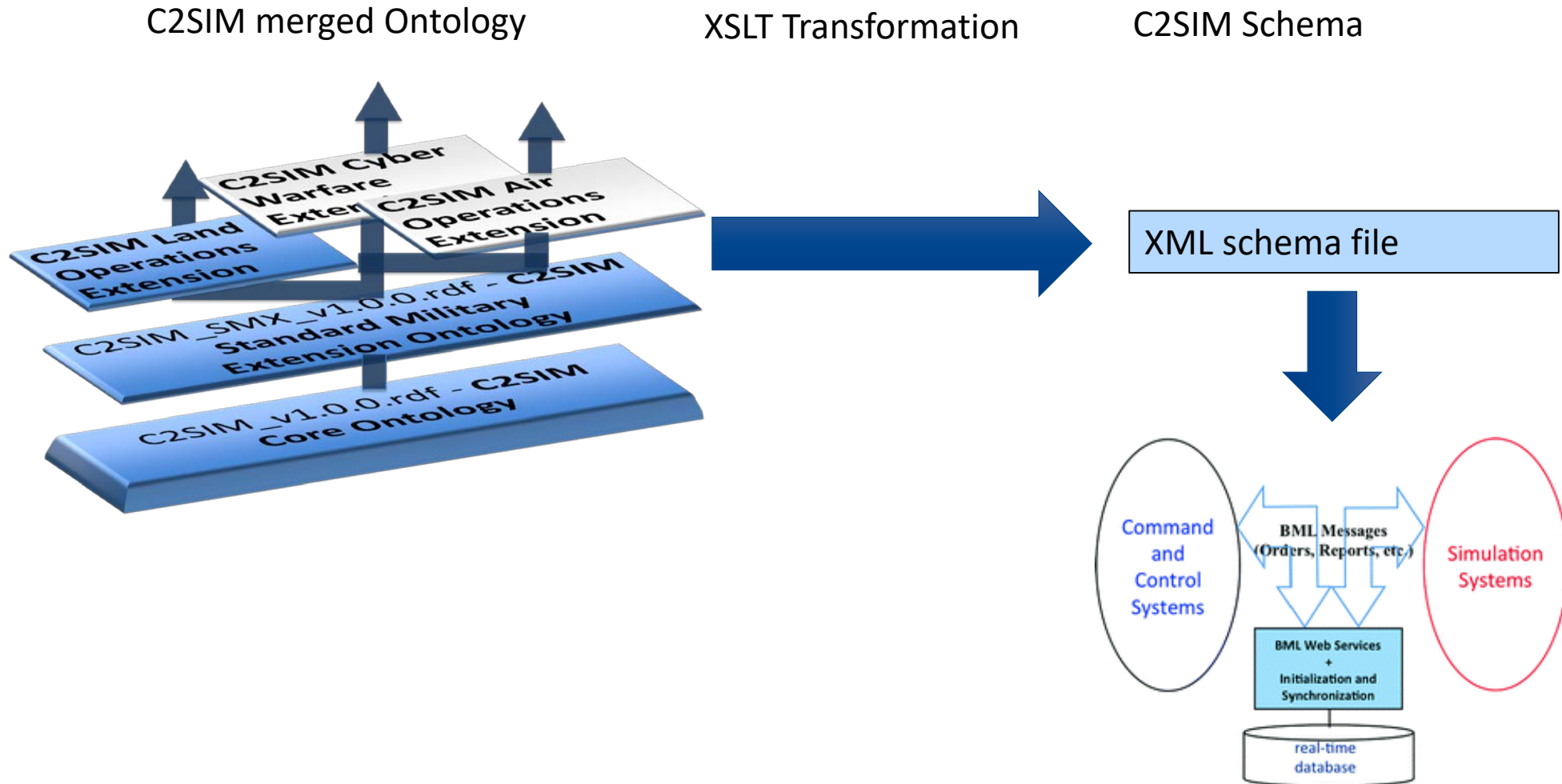
Process for C2SIM- Application



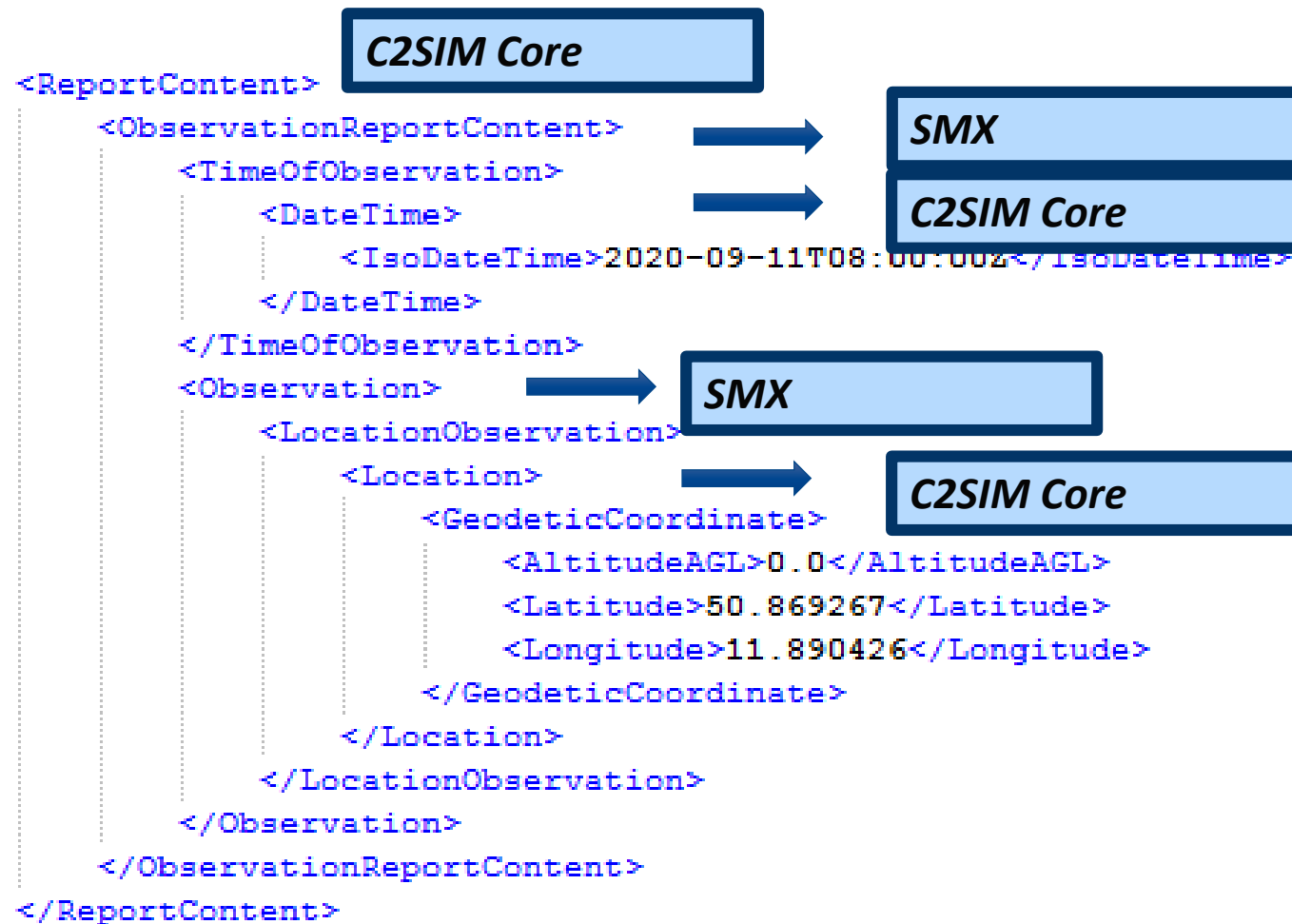
Procedure for extending C2SIM

- choose ontology of interest (Core + e.g. SMX)
- merge ontologies of interest
- import one or more C2SIM ontology files that the extension is building upon
- create a new ontology file (e.g., using Protégé or some other tool).
- declare a new namespace for this extension ontology.

Data exchange with schema



XSD Schema



XSD-Schema

```

<MessageBody>
  <DomainMessageBody>
    <OrderBody>
      <FromSender>00000000-0001-0037-0000-000000000000</FromSender>
      <ToReceiver>00000000-0001-0342-0000-000000000000</ToReceiver>
      <IssuedTime>
        <IsoDateTime>2020-12-08T09:26:31Z</IsoDateTime>
      </IssuedTime>
      <OrderID>311dd7fc-73af-4d1a-8351-7bf012cb7f27</OrderID>
      <Task>
        <ManeuverWarfareTask>
          <Location>
            <GeodeticCoordinate>
              <Latitude>50.99114</Latitude>
              <Longitude>11.98973</Longitude>
            </GeodeticCoordinate>
          </Location>
          <Location>
            <GeodeticCoordinate>
              <Latitude>51.058514</Latitude>
              <Longitude>12.143538</Longitude>
            </GeodeticCoordinate>
          </Location>
          <UUID>6418304f-c239-4ed2-ab24-30127180befb</UUID>
          <PerformingEntity>00000000-0001-0342-0000-000000000000</PerformingEntity>
          <TaskActionCode>ATTACK</TaskActionCode>
        </ManeuverWarfareTask>
      </Task>
    </OrderBody>
  </DomainMessageBody>

```

C2SIM- Core

LOX

C2SIM- Core

C2SIM Communication

- Messages coded in eXtensible Markup Language (XML)
 - Data structured as “tree” expanding from root
 - Each data element has descriptive “tag”
- Communication via “Web Service” server
 - Technology grew out of World Wide Web (WWW)
- Input REpresentational State Transfer (REST)
 - Document submitted in temporary TCP/IP connection
- Output Streaming Text-Oriented Message Protocol (STOMP) to subscribing group of clients
 - Document forwarded via sustained connection to all C2 & simulation systems subscribed to “Topic”

Roles of C2 and Simulation Client Systems

C2 systems

- Produce orders/requests and consume reports
- Send orders to server by REST
- Subscribe to reports from server by STOMP
- Ideally, able to start/pause/stop simulation

Simulation systems

- Consume orders/requests and produce reports
- Subscribe to orders/requests from server by STOMP
- Send reports to server by REST
- Controllable to start/pause/stop simulation
- Produce log of activities for replay/restart

C2SIM Reference Implementation

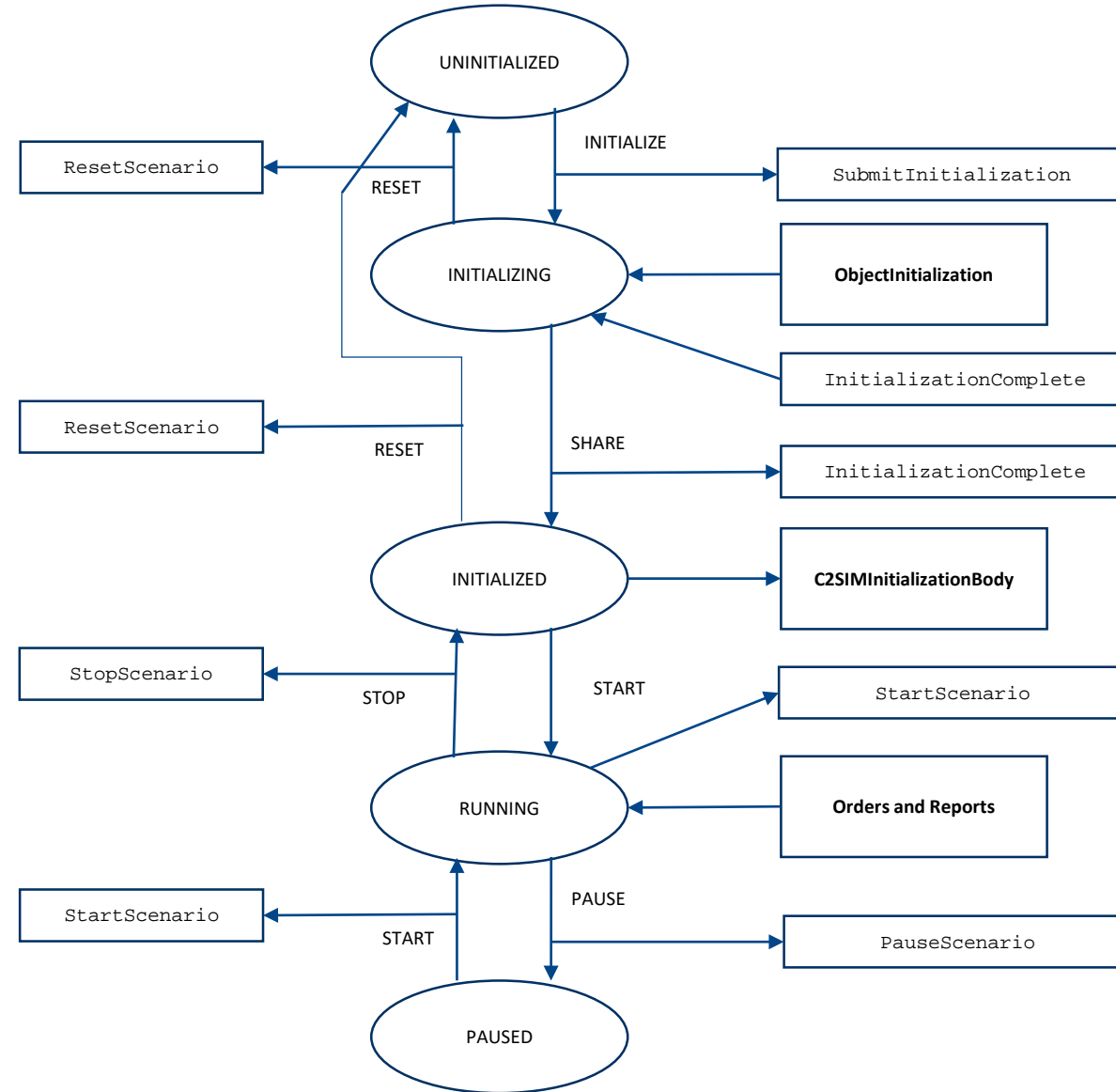
Open Source Java Server Functions

- Supports a *Coalition* of C2 & simulation systems
- REST input, STOMP publish-subscribe output
- Client Library assists integration (Java and C++)
- Translating feature allows MSDL/C-BML compatibility
- Translates reports and orders among C2SIM standard, C2SIM developmental, CBML Light and IBML09
- Translate between MSDL and C2SIM initialization
- Supports C2SIM synchronization messages for coalition and recording
 - Initialize, Ready, Start, Stop, Pause
 - Reloads latest initialization on restart
- Logs all transactions and supports playback

Open Source COTS Server Environment

- Centos 7 Linux Server
- running in a VMWare Virtual System
- Tomcat 8.0.30 Web Service Application Server
- Apache Apollo 1.7.1 STOMP Messaging

C2SIM Standard Coalition Control



Distributed C2SIM Servers

- How:

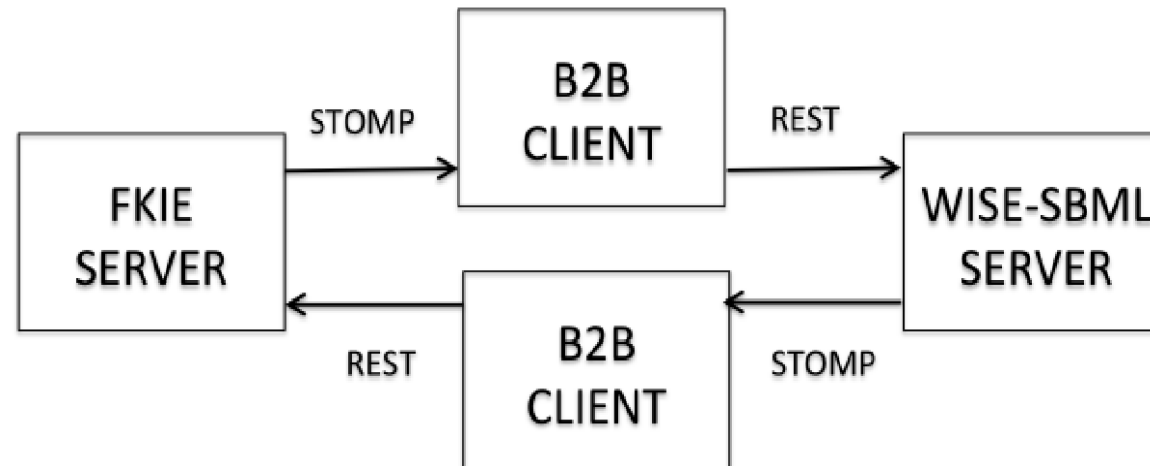
- Build an interface that subscribes to another server and forwards its published documents
- Simple implementation: back-to-back (B2B) client
- Ensure that forwarded messages cannot loop

- Why:

- Reduced network load by clustering
- Sharing publish workload

Back-to-Back Clients

- Building block for distributed servers:

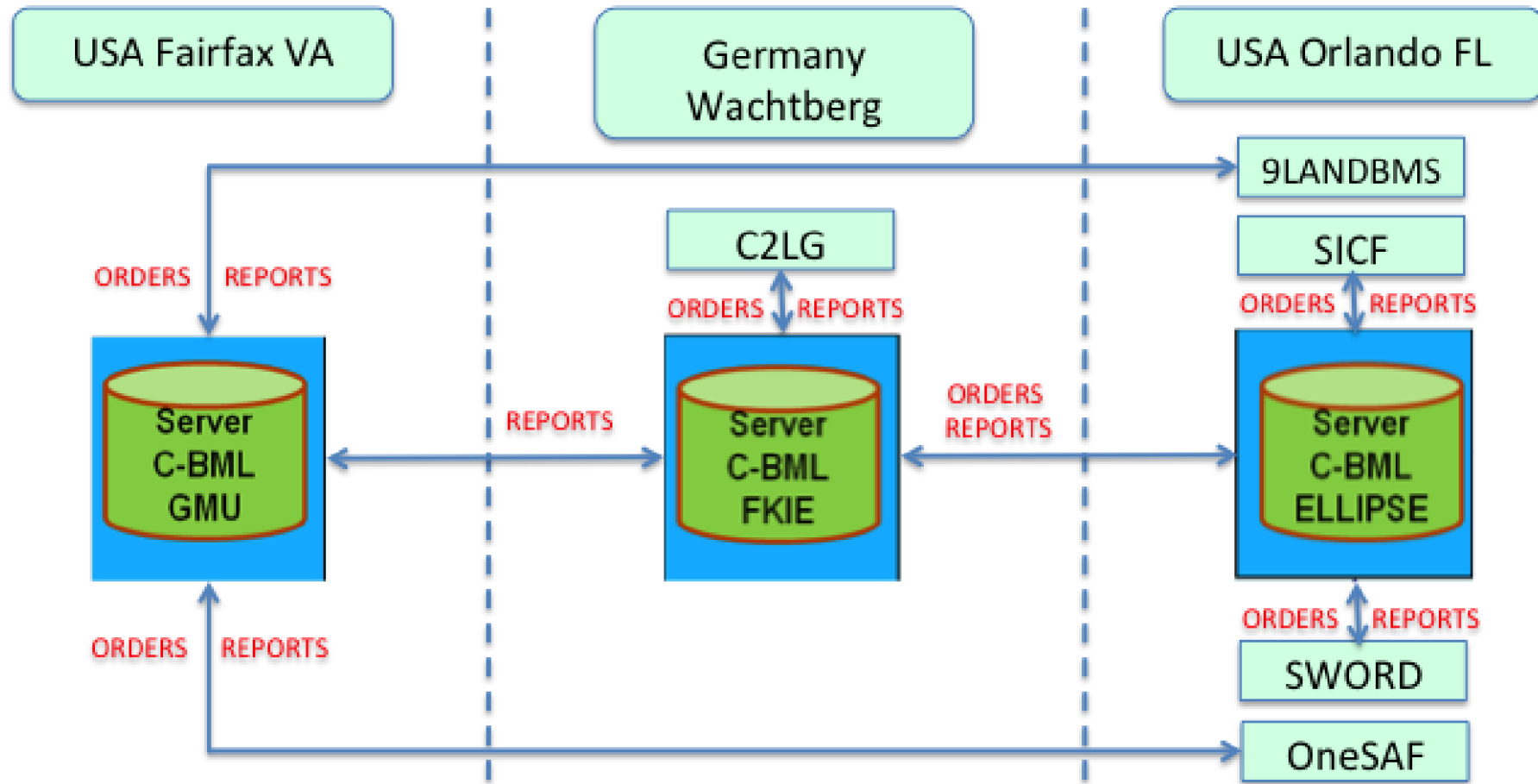


- Used in:
 - MSG-085 Final Demonstration (USA-Europe)
 - I/ITSEC-2014 Demonstration (France-Germany-USA/Sweden)
 - CWIX 2019 C2SIM testing and MiniEx (USA-MSCOE)

Precluding Distributed Server Loops

- Label each published message with ID of forwarding server(s)
 - Install filter in server and/or B2B client
 - Drop any message receiving server has already forwarded
 - Supported by C2SIM Reference Implementation
- Configure servers in a star (tree)
 - Guarantees no “back-door” loops make multiple delivery via different path than first delivery

Three-Server Demo I/ITSEC 2014



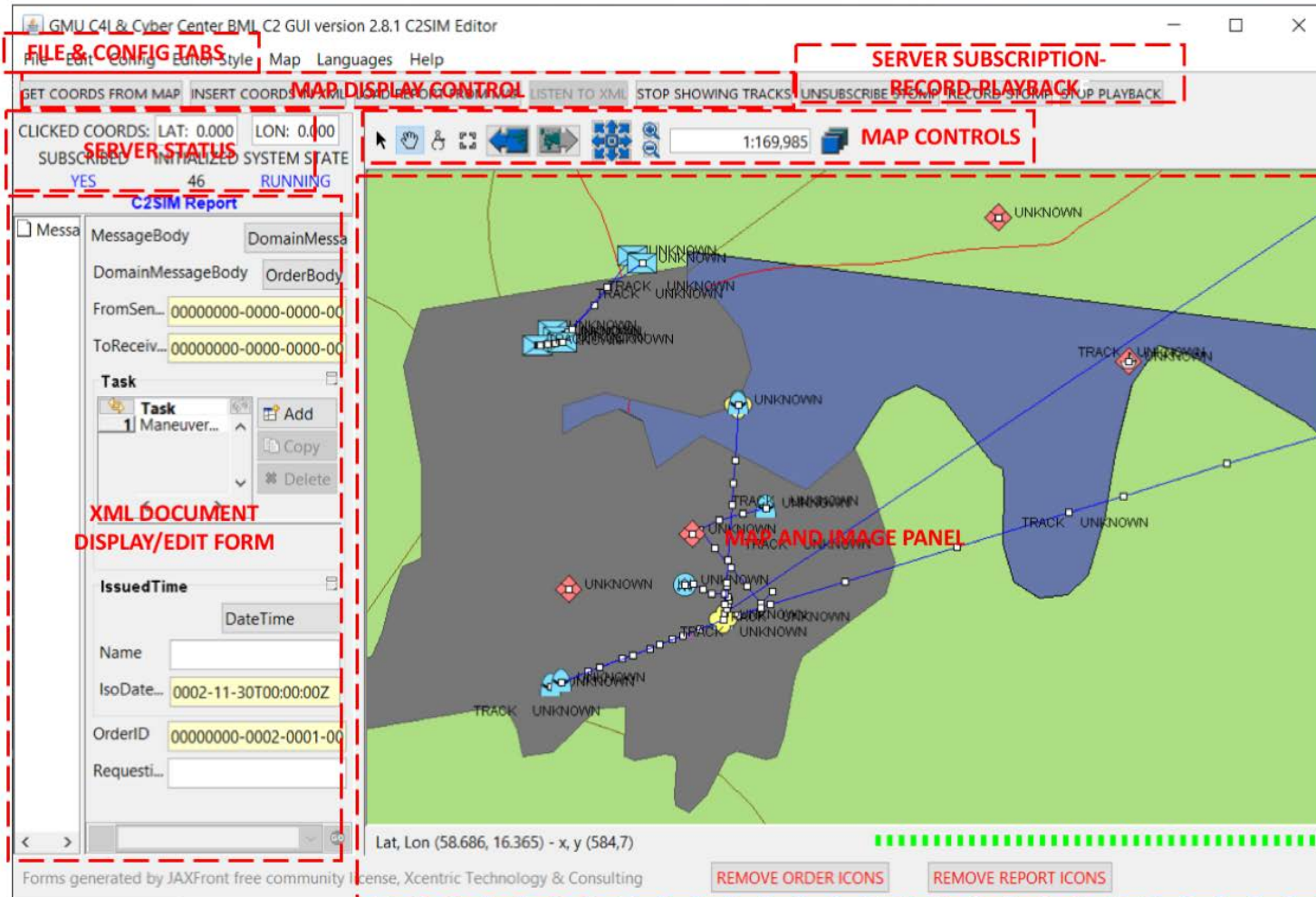
C2SIM Reference Implementation Client Libraries

- Implement common messaging functions
 - Support IEEE FIPA
 - Support REST and STOMP
- C2 and Simulation client implementation simple
 - Instantiate REST and STOMP modules/connections
 - Send and receive REST (similar to webpage I/O)
 - Listen for STOMP (blocking or non-blocking)
- Available for Java and C++ on GitHub [OpenC2SIM](#)

C2SIMGUI Editor

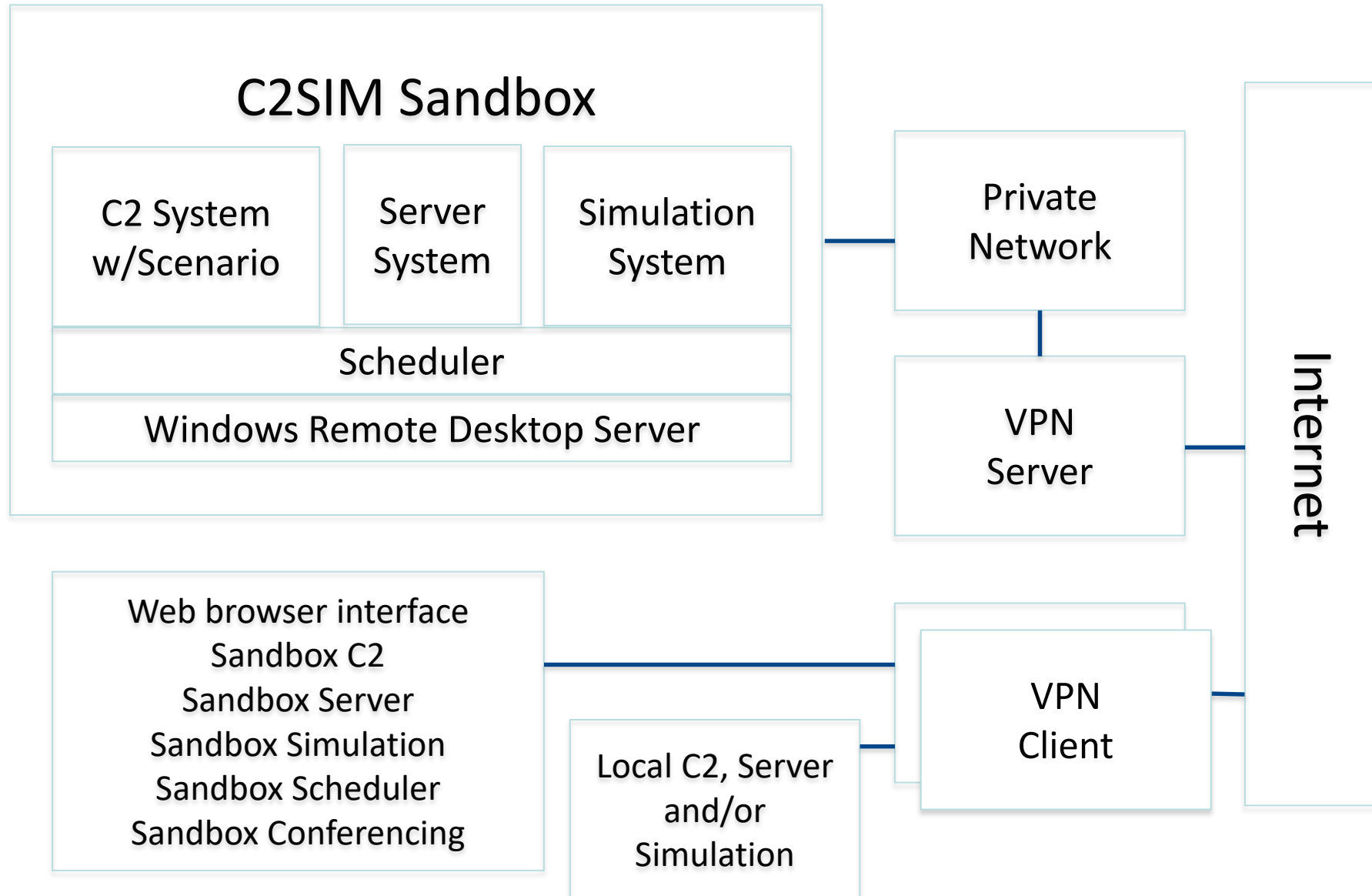
- Interacts with a C2SIM server by
 - creating and/or editing XML Order and Report files
 - pushing such files into the server
 - subscribing to receive such files
 - displaying their tactical graphics (unit icons and related graphical control measures) on a map or image
 - sending and receiving C2SIM synchronization/control messages
- Open source software available on GitHub OpenC2SIM
 - inspired by Fraunhofer-FKIE C2LG GUI that is not available open source
 - C2SIMcontrol implements coalition/recorder control subset for C2 users
- ***NOT*** a real C2IS but has been used experimentally as surrogate for one
- C2LG GUI and C2SIM GUI used in CWIX 2022 & 2023

C2SIM GUI Layout from User Guide



C2SIM Sandbox

- Assembled to support distributed development by MSG-145
- Contains a complete C2SIM system
 - C2SIMGUI as surrogate for C2IS
 - Reference Implementation C2SIM Server
 - MÄK VR-Forces Simulation
- Available over OpenVPN system
- Includes Jitsi but more often used with Zoom
 - Jitsi server can be inside VPN; Zoom is commercial
- Accessible as remote desktop inside VPN
 - User needs only Google Chrome to access Sandbox
- VPN can include C2 or Simulation under development



Ways to Use C2SIM Sandbox

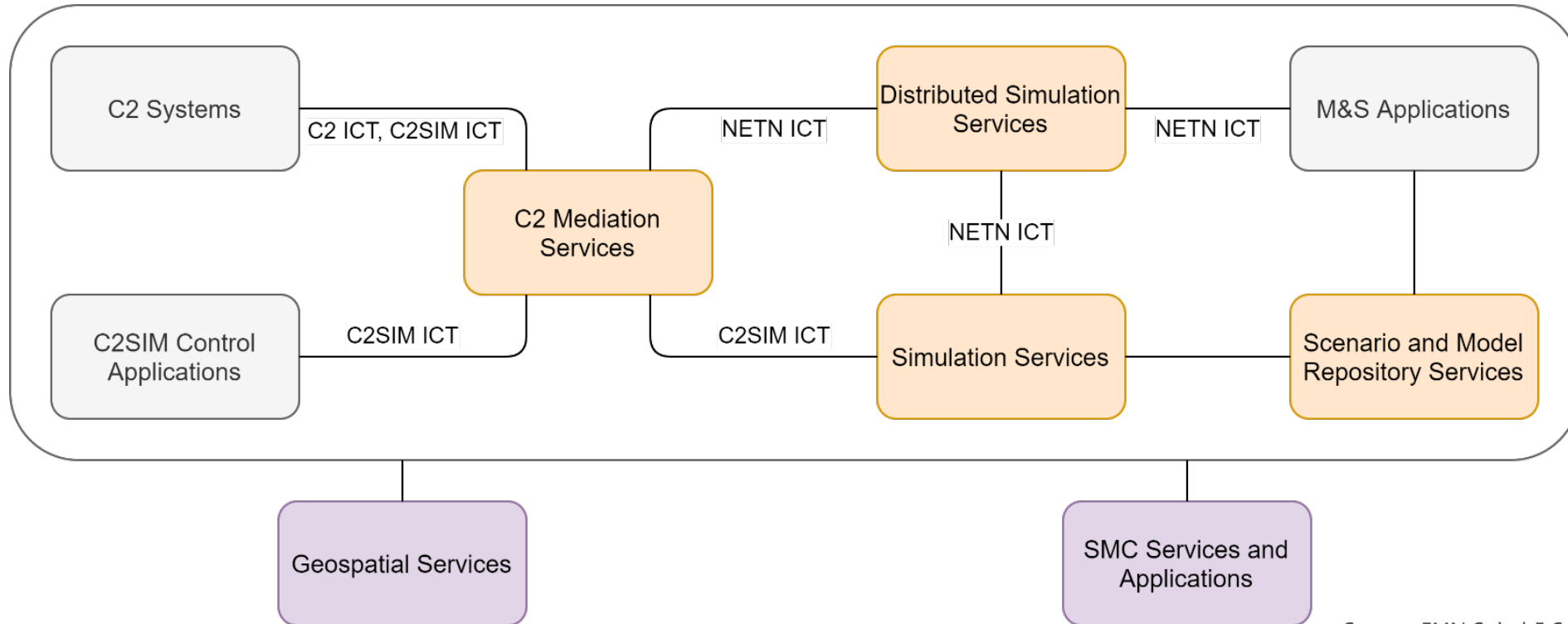
- C2SIM demonstrations
 - Initially IBML09
 - C2SIM standard as soon as we can prepare it
 - With generic scenario (others if contributed)
- C2SIM testing
 - Test C2 with Sandbox Server and Simulation
 - Test Server with Sandbox C2 and Simulation
 - Test Simulation with Sandbox C2 and Server
 - Test C2-Simulation Coalitions with the Server
 - Distributed configurations of all sorts
- C2SIM validation with SISO
- Limited-scope C2SIM-based exercises
- Future possibility: C2SIM as a Service

Hands-on Walkthrough VRForces with C2SIM

- Start VRForces on your desktop
- Start c2simVRInterface on your desktop
- Start C2SIMGUI on your desktop
- Use the GUI to send a test C2SIM Order
 - File → Open & Push → C2SIM Order → Test Order
- Observe Order execution on VRForces GUI and C2SIMGUI

Questions on C2SIM?

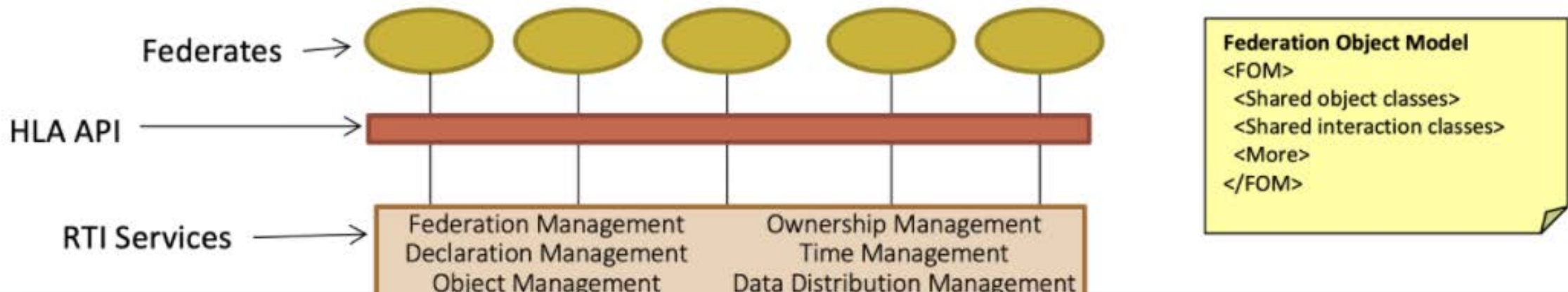
C2SIM with HLA in FMN



Source: FMN Spiral 5 Service Instructions for Modelling and Simulation, 2022.

C2: Command and Control; C2IS: C2 Information System; C2SIM: C2 Systems – Simulation Systems Interoperation; ICT: Initialization, Control, Tasking and Reporting interactions; M&S: Modelling and Simulation; NETN: NATO Education and Training Network

HLA Concept



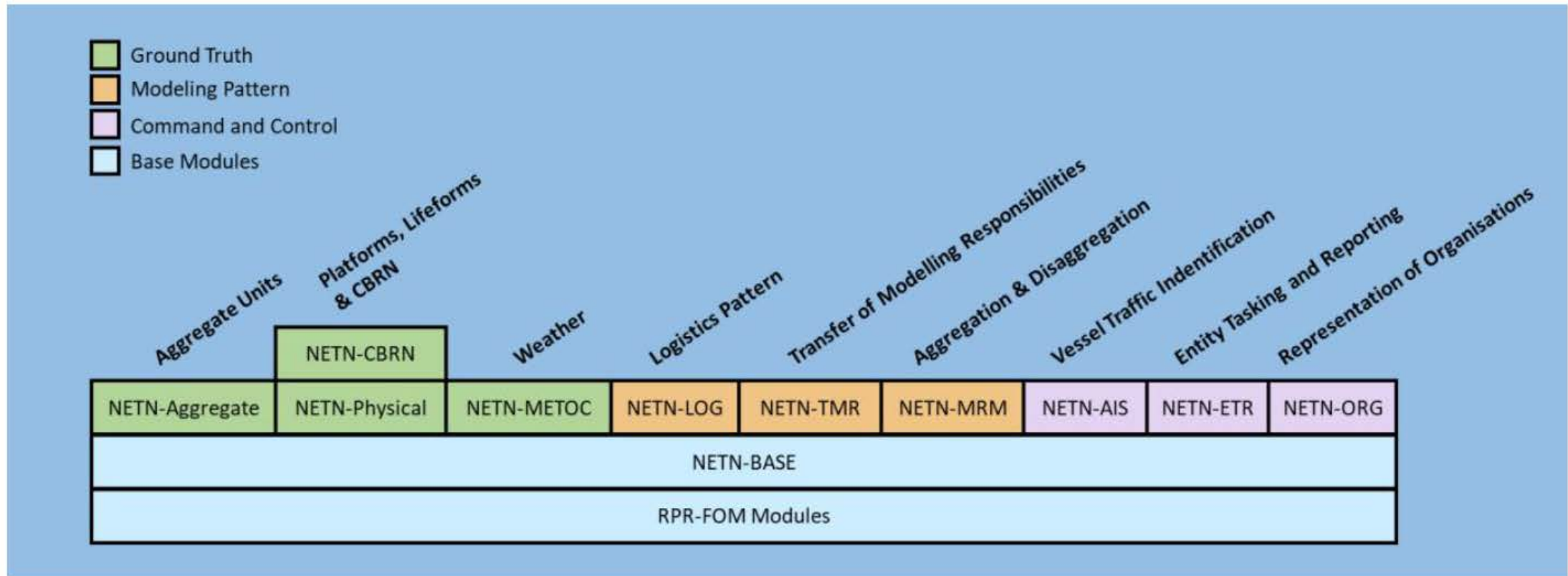
API: Application Program Interface; FOM: Federation Object Model; RTI: Run-Time Infrastructure

Source: 2021 Simulation Innovation Workshop HLA Tutorial

NATO Education and Training Network Federation Object Model (NETN-FOM) **Distributed Simulation for NATO Training**

- Data model for exchange of data and interactions across a NATO federation of simulations running under HLA
- Designed as a set of function-specific modules (see next slide)

NETN-FOM Data Architecture



Source: Lofstrand, B., Herzog, R., Kuhn, T., Behner, H., and van den Berg, T.: "Evolution of NATO Standards for Federated Simulation," Paper 2020-SIW-025, Simulation Innovation Workshop, February 2020.

NETN Examples from CWIX 2023

- Get these from Tom can den Berg

SWORD Description and Demo

by Dr. Beatriz Garmendia-Doval of MASA

MASA GROUP

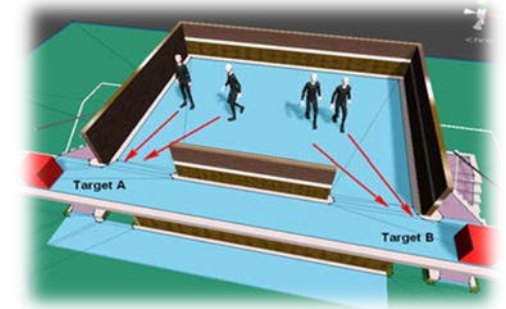
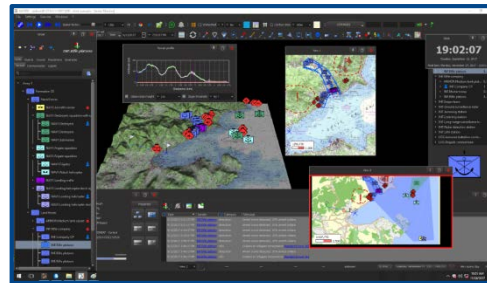
Empowering life



Specialized in
Modeling Human
behavior and
military doctrine

A C.O.T.S .
Simulations
solutions Provider

Targeting the fields
of Defense, Security
& Robotics

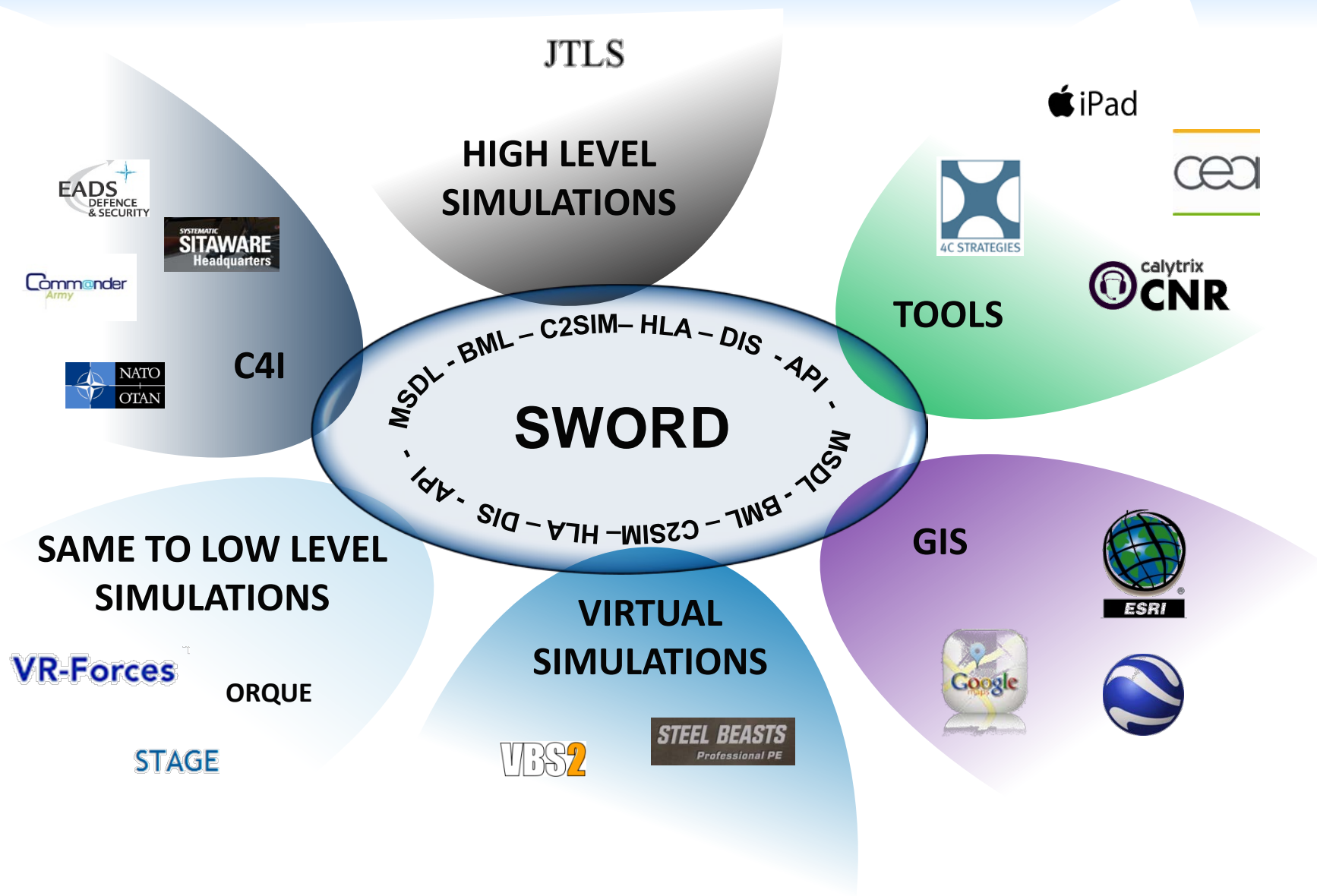


MASA SWORD is a constructive, aggregated and automated simulation

- Constructive because it simulates both human beings and equipment
- Aggregated because it represents groups of entities and not single entities
- Automated because the simulated entities have intelligent and autonomous behaviors thanks to the use of Direct AI, MASA's Artificial Intelligence engine.

MASA SWORD interoperability features

organization



MSG-194 SWORD C2SIM Connector

organization

- The connector was updated for C2SIM approved standard V1.0.0
- The connector can read C2SIM initialization messages and update UUIDs and coordinates to reflect them in SWORD
- The connector can receive C2SIM missions and transform them into SWORD orders that can then be simulated by SWORD
- As the units move and interact due to the simulation of the C2SIM missions, the positions, status and observations are sent back as C2SIM reports

High Level Architecture Tools

- Will add here the GUI of Pitch pRTI and Pitch Web View with descriptions

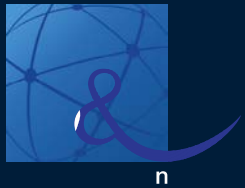
HLA Walkthrough

- Start VRForces with HLA on your desktop
 - It will join the Workshop federation automatically
- Start Pitch Web View on your desktop
 - SWORD is already in the Workshop federation
 - Should show VRForces as participants join
 - You should see objects generated by SWORD on the VRForces GUI
- Add one ground object and one air object to your VRForces GUI
 - Each desktop should show all of the objects
 - Observe task execution in SWORD

HLA Questions?



NORTH ATLANTIC TREATY ORGANIZATION
SCIENCE & TECHNOLOGY ORGANIZATION



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The screenshot shows the NATO STO website homepage. At the top left is the NATO OTAN logo. To its right is the text "NORTH ATLANTIC TREATY ORGANIZATION" and "SCIENCE AND TECHNOLOGY ORGANIZATION". On the far right is a "Sign In" link and social media icons for YouTube, Facebook, LinkedIn, and Twitter. Below the header is a navigation menu with links for "ORGANIZATION", "NEWS", "PROGRAMME", "ACTIVITIES", "PUBLICATIONS", and "CONTACT". The main content area is titled "NEWSROOM" and features a large banner for "2022 HIGHLIGHTS" with the subtitle "SCIENCE AND TECHNOLOGY ORGANIZATION". The banner image shows a person's profile with digital data overlaid. To the right of the banner are two smaller news items. The first is titled "NATO STO hosts wargame on Space Deterrence ..." and features an image of a satellite. The second is titled "2023 COLLABORATIVE ..." and features an image of a satellite launch. Below the second news item is the text "NATO STO releases 2023 Collaborative Programme of Work Report ...".