A Proposed Engineering Process and Prototype Toolset for Developing C2-to-Simulation Interoperability Solutions

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Presentation Overview

- Introduction: the 2RS CIG
- SINEX Approach
- C2SIM DSEEP Overlay
- Recommendations
- Conclusions

NOTE: This is about capabilities, not experiments.

Introduction: The 2RS CIG

SINEX, DSEEP and the 2RS CIG

▸ NATO MSG–085 created a prototype engineering process to develop and maintain a unified C2–SIMulation (C2SIM) Scenario INitialization and EXecution (SINEX) Model

▸ The Requirements, Recommendations and Specifications (2RS) Common Interest Group (CIG) is documenting a formal process and creating a prototype production chain
  ◦ Re-use of existing COTS tools and tools made available by the Multilateral Interoperability Programme (MIP) Block 4 WG
  ◦ Additional objective: create a draft version of a SISO DSEEP Overlay to guide the development of C2SIM Federations.

SINEX Approach

Standardizing SINEX

- ▸ Based on a Systems Engineering best practices

- ▸ Utilizes Model-driven architecture (MDA) tools developed by the MIP

- ▸ The SINEX approach has been proposed as a means to unify into one common standard:
  - ◦ SISO Military Scenario Definition Language (MSDL)
  - ◦ SISO Coalition Battle Management Language (C-BML)

SINEX Key elements

- To develop interoperability standards based on the Standard Development Framework (SDF) of Heffner & Gupton 2013
  - ◦ Formal process guides standard
  - ◦ Highly automated production chain for standards based on the re-use of existing tools developed by the MIP

- Focus on core Logical Data Model (LDM) largely inspired by existing MIP Information Model (MIM)
  - ◦ MIM is the successor to the JC3IEDM

- MDA Transforms to generate Platform Specific Model (PSM)
 - ◦ XML Schemas, HLA FOMs, DIS PDUs, JSON etc...

Why SINEX?

- Advantages over previous MSDL/C-BML Approaches
  - **Provides for modularity** compared to huge monolithic model
    - Uses MIP modular sub-view approach
    - Can easily build models with small footprints for specific uses
  - **Easier to understand** documented UML model compared to previous XML Schema representation
  - **Easier to maintain and evolve** since core model is based on MIM standardized coalition C2 interoperability standard.
  - **Technology agnostic,** since MDA approach can generate various representations of LDM using transforms.
    - E.g. HLA, JSON,

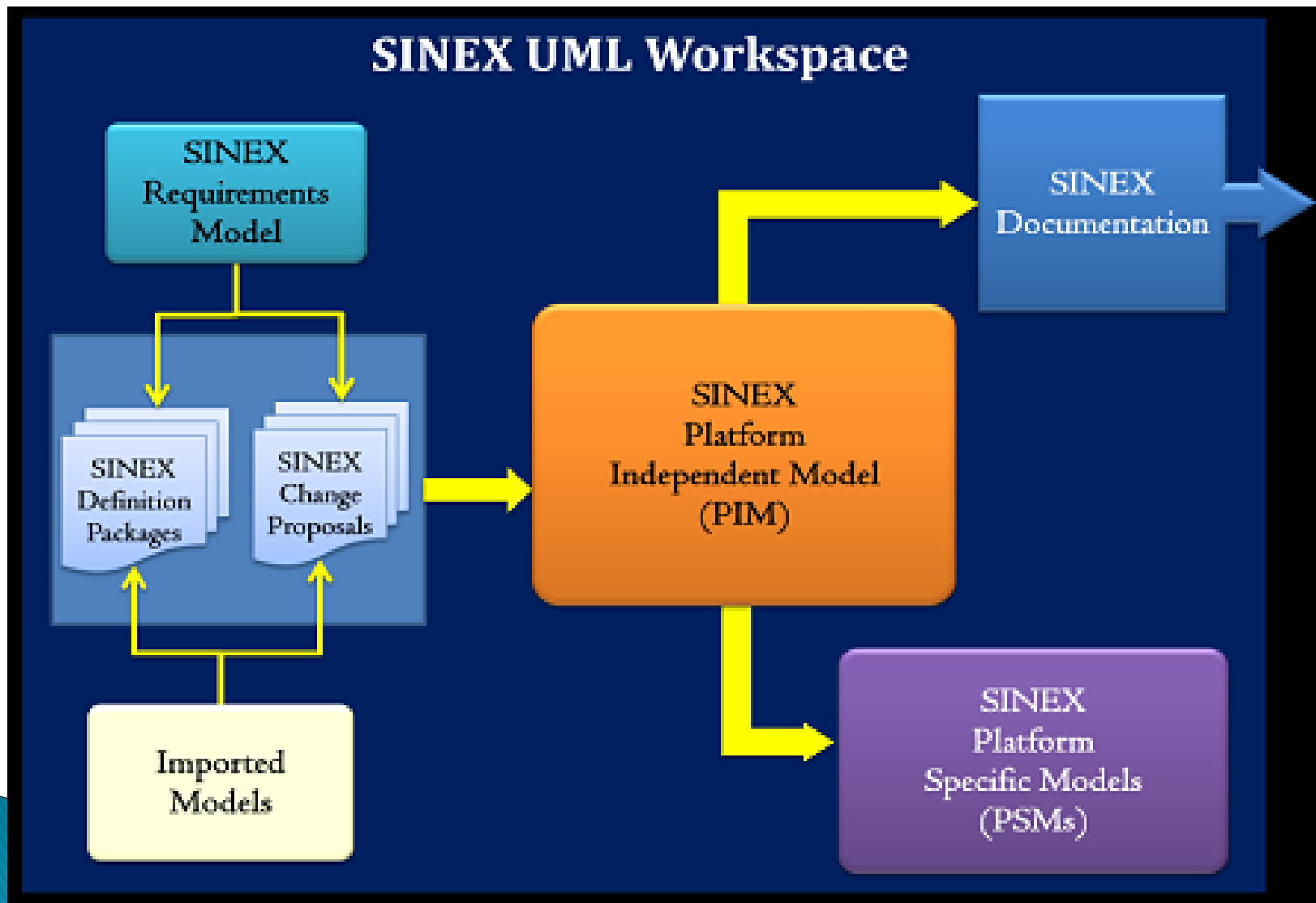- Initial prototype production chain created

SINEX Process Overview
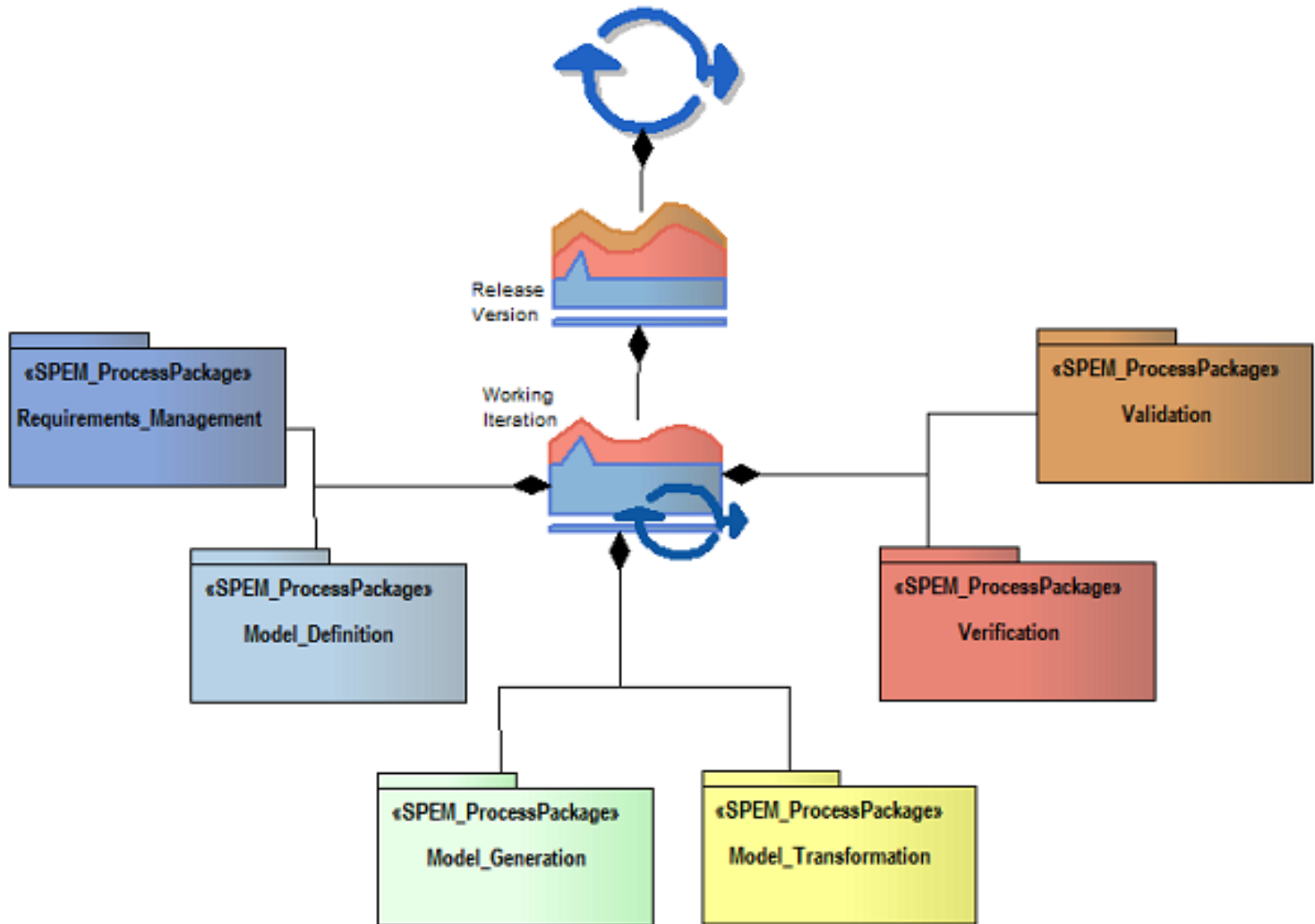
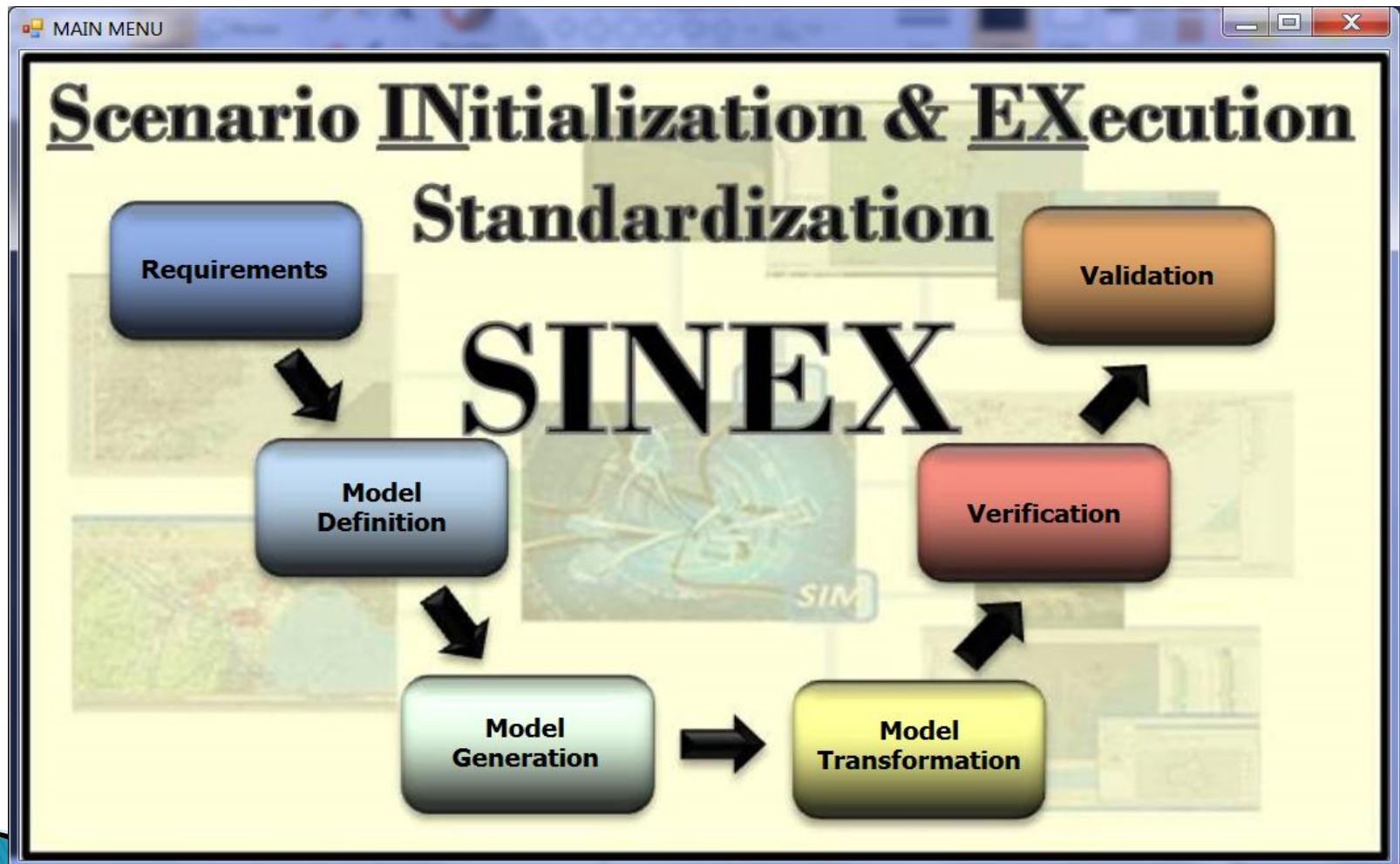# SINEX Production Chain Prototype
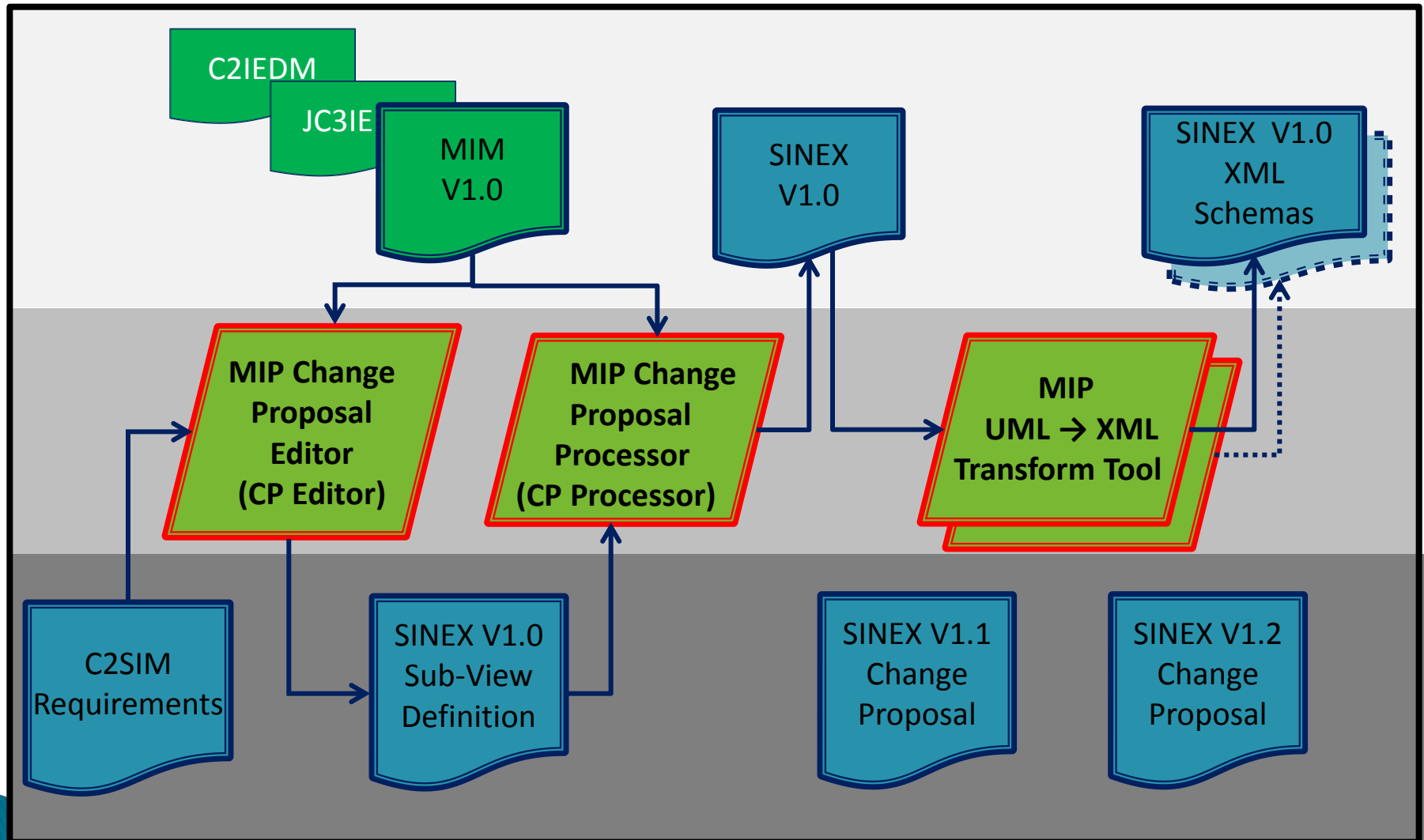
Creation of a SINEX EA workspace

Creation of a SINEX Tool

Prototype Toolset Demonstration

- SINEX toolset demonstrated in NATO booth at I/ITSEC 2013
  - Requirements definition
  - Model definition of a sub-model based on MIM elements
    - Including drag-and-drop of additional elements
  - Model generation
    - Including automatically generated UML diagrams
  - Model transformation
    - Fully automated XML schema generation
- Using SINEX tool requires no UML experience
- Prototype is not yet publicly available

DSEEP Overlay

C2SIM Interoperation

- C2-Simulation Interoperability requires bridging two separate worlds
  - The simulation community uses standards for building simulation federations
    - High Level Architecture (HLA)
    - Distributed Interactive Simulation (DIS)
  - The C2 community interacts within operational environments using a variety of standards
    - Formatted messages such as NATO Allied Data Publication 3 (ADatP-3)
    - Data links (e.g. Link 16)
    - Information exchange data models such as the JC3IEDM
- C2SIM interoperation requires bridging these

Typical C2–Simulation Architecture
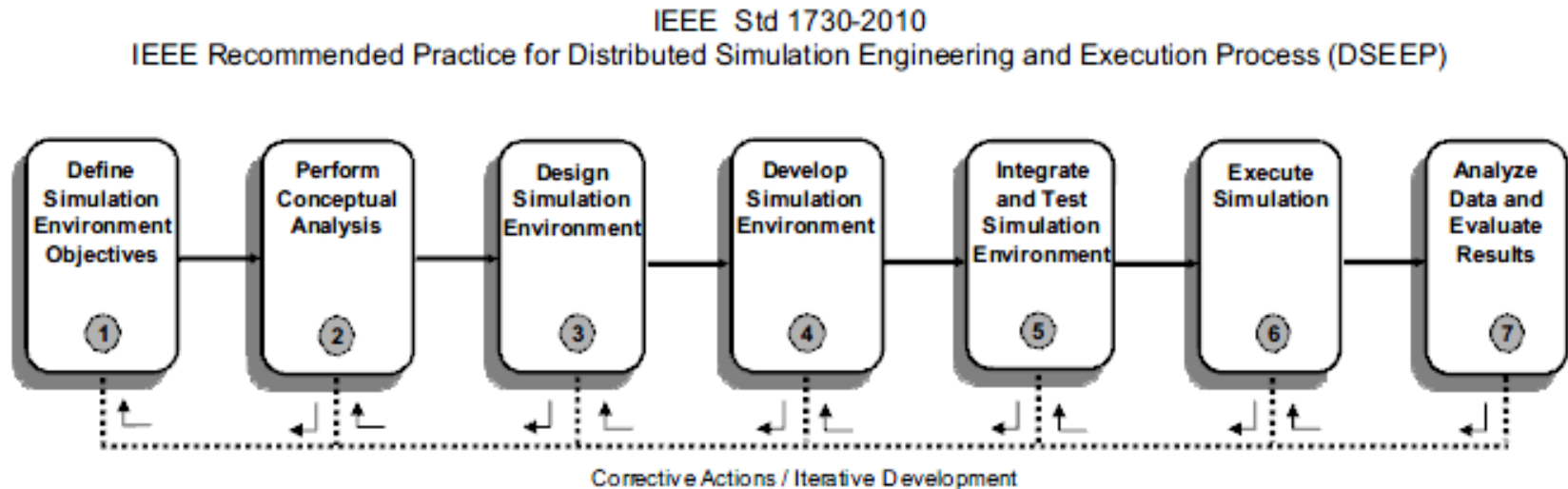## and main challenges
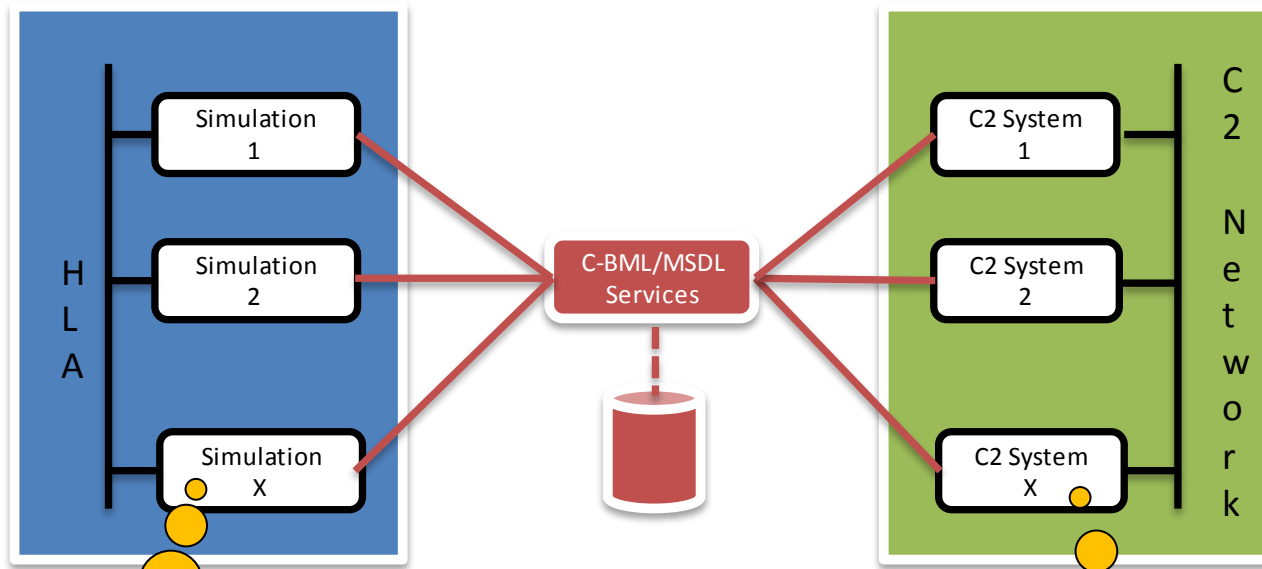
DSEEP and overlays

IEEE Std 1730-2010
IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)
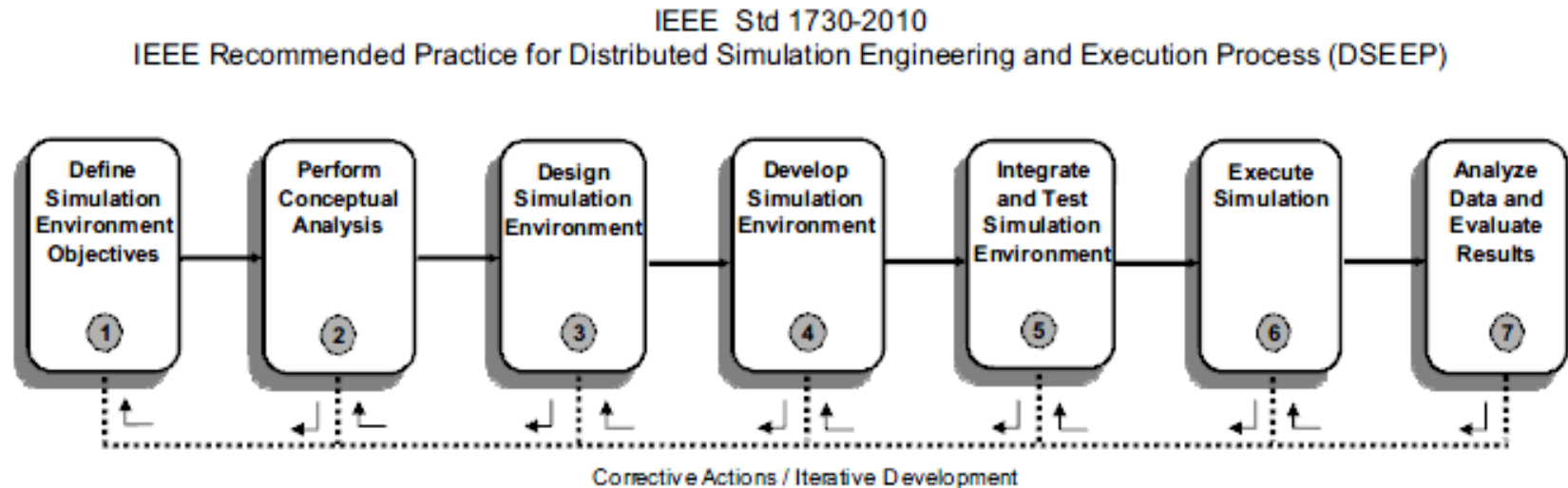

- DSEEP: existing IEEE and SISO recommendations to define and execute distributed simulations
- Already existing overlays (layers): HLA, DIS, DMAO

DMAO: DSEEP Multi Architecture Overlay

C2SIM DSEEP Overlay

IEEE Std 1730-2010
IEEE Recommended Practice for Distributed Simulation Engineering and Execution Process (DSEEP)

Define Simulation Environment Objectives ①	Perform Conceptual Analysis ②	Design Simulation Environment ③	Develop Simulation Environment ④	Integrate and Test Simulation Environment ⑤	Execute Simulation ⑥	Analyze Data and Evaluate Results ⑦

Corrective Actions / Iterative Development

▸ Propose a C2SIM DSEEP overlay for this process:
  ◦ to aid the engineering, the execution and the analysis of distributed simulation environments containing C2 systems
  ◦ to help user community better understand how C2-simulation interoperability standards (C-BML / MSDL) are intended to be used

Overlay overview

- Main contributions of the C2SIM DSEEP Overlay:
  - Description of issues and recommendations related to the definition, development and execution of a federation of C2 and simulation systems
  - Description of the additional inputs, tasks and outcomes for each of the seven DSEEP steps

- C2SIM DSEEP Overlay deals only with C2-Simulation issue, not simulation federation issues

Example of a Training System
A Distributed Multi-Architecture
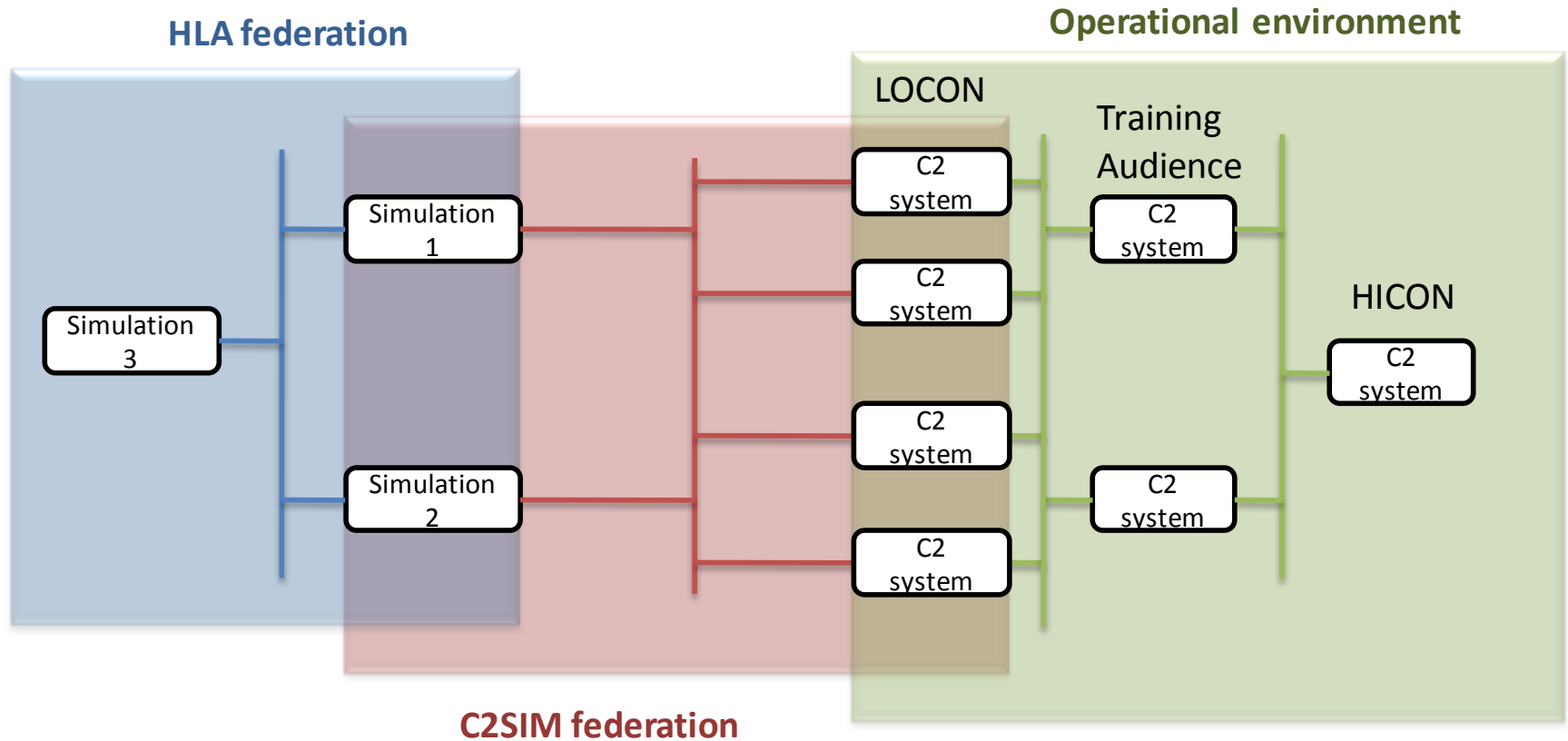
C2SIM Overlay issues

- Stakeholders include both C2 and simulation communities
- C2 system lifecycles duration
- Time management
- Preparation of scenario to initialize the federation
  - Scenario and conceptual model
  - Entities/objects
  - Event timelines
  - Geographical and natural environment
- End-users' perception of federation execution
  - Report message processing
  - Order / request message processing
- Analysis of federation execution
- C2SIM architecture, infrastructure services and data exchange model
- Security of C2 systems

Main issues

Recommendations

Recommendations

- Use SINEX Process for Technical Interoperability Standard Development

- Use SINEX for C2SIM Interoperability Standard

- Build on experience of NATO Technical Activities
  - Prototype and user test before standardizing

- Complete an open source SINEX toolset
  - Including ontology standards (OWL, RDF)

- Continue C2SIM DSEEP overlay development
  - Elaborate on issues already identified
  - Define C2SIM reference architecture

Conclusions

Conclusions

▸ MSG-085 has produced a wealth of experience for C2SIM

▸ Among the most promising of these is the SINEX process that promises to create a modular, extensible process for standardizing C2SIM interfaces, based on UML/MDA and transformation products

▸ The draft C2SIM DSEEP Overlay captures experience, lessons identified and proposes solutions to engineer and execute C2SIM federations. Additional work is needed to finalize it and to define a C2SIM reference architecture

Backup Slides

SINEX Background

- SINEX draws on:
  - MIP Modular Enterprise Architecture Interoperability Solution (Lang, Gerz, Meyer, Sim 2011)
  - SDF which in turn builds on work by the US Intelligence community
- MIP leverages MDA approach using a PIM/LDM
- SDF centers on LDM while maintaining a strong connection with stakeholder requirements
- Transforms are used to derive products from the SINEX LDM satisfying requirements for:
  - Use MIM as primary source of vocabulary
  - Extensibility