

Systems Interoperability Simulation Environment (SISE)

Richard Pei

US Army Communications-Electronics Research, Development and Engineering Center
Intelligence & Information Warfare Directorate
McAfee Center, Building 600
Fort Monmouth, NJ 07703
USA

Richard.Pei@us.army.mil

Rickard Nordenberg

Swedish Armed Forces
Defense Materiel Administration
SE-115 88
Barnergatan 62, Stockholm
Sweden

Rickard.Nordenberg@fmv.se

SUMMARY

The US Army Communications-Electronics Research, Development & Engineering Center, Intelligence and Information Warfare Directorate has an on-going cooperative Project Agreement with the Swedish Armed Forces' Defense Materiel Administration (FMV) that is aimed at the development and application of advanced modeling and simulation (M&S) environment and tools to support research & development of technology covering Communications, Command, Control, Computer, Intelligence (C4I) Sensor and Survivability.

The current efforts of the US-Sweden cooperative project is focused on leveraging M&S technology and capabilities from both nations and incorporates the Coalition Interoperability through standards-based Simulation Environments (CISE) products and /High Level Architecture (HLA) standards to support priority C4ISR M&S and analysis tasks (e.g. scenario-based simulations using virtual environments and hardware-in-the-loop). The technical objective is to develop an US-Sweden (SE) M&S architecture with necessary tools, known as the Systems Interoperability Simulation Environment (SISE). The SISE has been designed based on the IEEE 1516 HLA standard and is being implemented in a highly flexible and scalable architecture such that it can be easily adapted for use by other coalition/allied nations to conduct Systems-of-Systems level studies and analysis in applications related to interoperability and other coalition operational issues. The core SISE capability will be demonstrated in November 2004 through use case simulations in Network-Centric Warfare and Coalition Combat Identification.

1.0 INTRODUCTION

The US Army Communications-Electronics Research, Development & Engineering Center, Intelligence and Information Warfare Directorate (I2WD), headquartered at Fort Monmouth, New Jersey, United States, has an on-going cooperative Project Agreement (PA) with the Swedish Armed Forces' Defense Materiel Administration (FMV) since December 1998. This project is aimed at the development and

Paper presented at the RTO NMSG Symposium on "Modelling and Simulation to Address NATO's New and Existing Military Requirements", held in Koblenz, Germany, 7-8 October 2004, and published in RTO-MP-MSG-028.

application of advanced modeling and simulation (M&S) environment and tools to support research & development of technology covering Communications, Command, Control, Computer, Intelligence (C4I) Sensor and Survivability. The primary objectives of this PA are:

- Develop compatible virtual and Hardware-In-The-Loop (HITL) laboratory capabilities and tools to conduct distributed simulation of C4I sensor and survivability technologies and measure their performance in a system-of-systems (SoS) operational environment against threat air defense systems, precision guided munitions, and targeting sensors.
- Conduct joint distributed simulation excursions of selected C4I and survivability sensors, components, architectures, design principles and systems in one-on-one, few-on-few, and force-on-force simulations and quantifying their performance and synergy for improved force protection and C4I interoperability.
- Identify potential cooperative development opportunities for common C4I sensors and survivability systems.

The PA work is organized into phases and phase 1 of the project was completed 30 April 2001. Phase 2 efforts are on-going and will be completed on 31 December 2004. Phase 3 is planned for calendar years 2005 and 2006 to complete this project.

2.0 PHASE 1 - OBJECTIVES AND RESULTS

The objectives of Phase 1 were as follows:

- Identify potential cooperative development opportunities for common C4I sensors and survivability systems.
- Upgrade virtual and HWIL capabilities to be able to conduct distributed simulation of C4I sensor and survivability technologies, and
- Establish digital communication links between the US and SE laboratories

Phase 1 of the PA effort was completed successfully with all planned objectives met or exceeded. An initial US-SE HLA simulation federation was developed by employing the standard Federation Development and Execution Process (FEDEP). A select set of Sweden models and simulations were developed or upgraded to support HLA and a HLA Gateway utilized to provide interoperability with Distributed Interactive Simulation (DIS) models from the US. Communication link between the US and SE laboratories was established using dedicated ISDN lines to provide simulation data transfer between US/SE federates in a distributed environment.

The Initial US-SE HLA federation developed in Phase 1 was demonstrated at a VIP day held on 20 April 2001. The functionalities of the federation and its models/federates were exercised in a coalition Joint Suppression of Enemy Air Defense (JSEAD) scenario using the distributed simulation network established between the two nation's laboratories. The capabilities of Phase 1 offered valuable lessons learned and provided excellent foundation to build upon for work on the future phases of the PA.

3.0 PHASE 2 EFFORT – DEVELOPMENT OF SYSTEMS INTEROPERABILITY SIMULATION ENVIRONMENT

Building on the success of Phase 1, Phase 2 of the PA is focused on detailed design, development, testing and demonstration of the core capabilities of the Systems Interoperability Simulation Environment or SISE for short. Phase 1's Initial US-SE Federation has been redesigned by applying the design principles,

guidelines and process defined under a separate but related cooperative effort between United States and Sweden named Coalition Interoperability through Standards Based Collaborative Environments.

3.1 Coalition Interoperability through Standards Based Collaborative Environment (CISE)

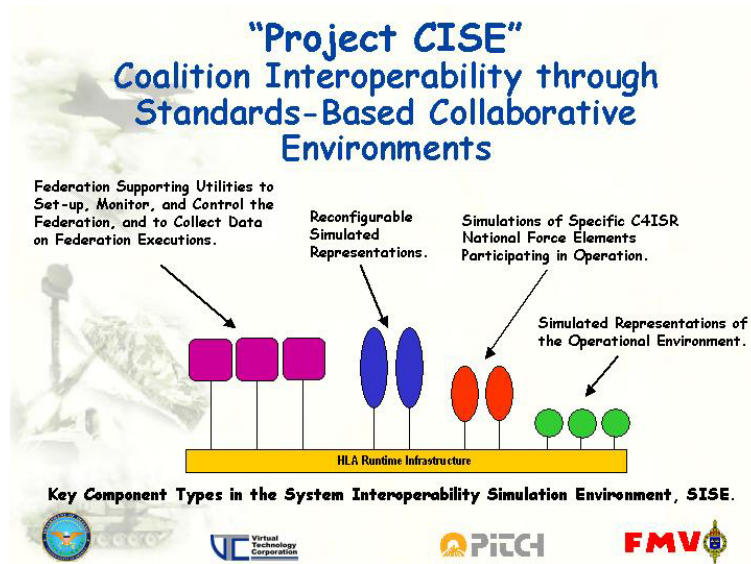


Figure 1: CISE Concept

Modeling and simulation supported by international, commercial standards provides the technical means to create collaborative environments which can be used by coalition partners, throughout the development and employment process, to ensure that systems deployed by partner nations can effectively work together in coalition operations. In the Coalition Interoperability through Standards-Based Collaborative Environments (CISE) project, the US and Sweden have taken the first step in developing a set of design constructs to facilitate the rapid creation of simulation environments to support system integration. These constructs include

- ***A set of design principles to guide the development of systems integration federations.*** Designing a federation involves much more than just developing a FOM. The CISE team has documented an initial set of design issues that should be considered during the development of a SISE.
- ***A starting point for FOM development which offers a structured set of reusable components in the form of a Systems Interoperability Reference FOM.*** The Systems Interoperability Reference FOM was developed based on lessons learned from a number of Swedish and US federations and it is designed to reduce the time and effort required for FOM development and aids in more efficient reuse of simulation components from other federations.
- ***A process which outlines the steps involved in designing a federation to address systems integration issues separating the issues to be addressed by the domain users of the federation from the tasks of federation systems engineering.*** This is recommended process to apply the reference FOM and design issues to the design of a SISE Federation. The first three steps of the standard FEDEP process are supported by two sequential and overlapping activities:

- Depicting the User Problem Space, and
 - Federation System Engineering
- These two activities revolve around two different sets of people and expertise. This separation enables better use of scarce experts in the User Domain and more effective technical engineering of the federation.

3.2 US-SE SISE Federation System Architecture

By applying and using the products of the CISE effort, the core components of the US-SE SISE Federation has been designed and being implemented under Phase 2 of the PA. The system architecture of the SISE Federation is depicted at Figure 2 below:

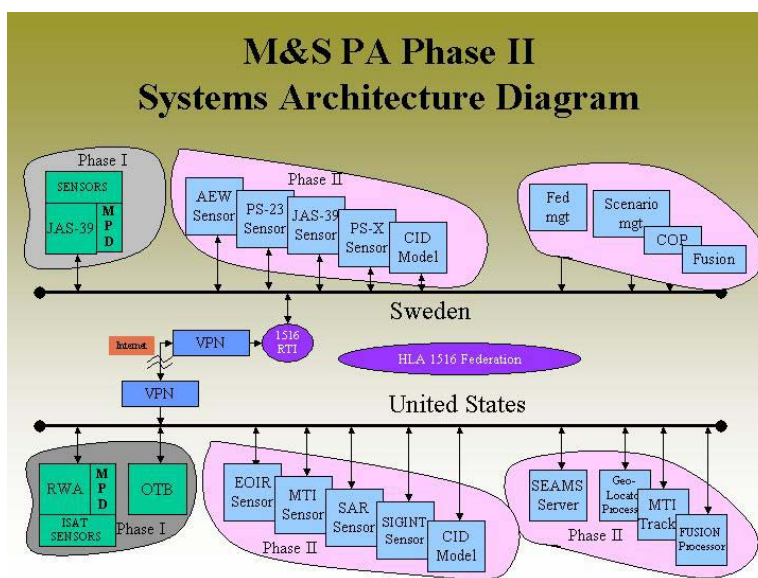


Figure 2: SISE System Architecture

The SISE is designed in accordance with the HLA IEEE 1516 standard and implemented a Service Based Architecture for flexible integration of federates. A US-SE Coalition FOM has been developed and implemented by leveraging and extending the CISE Coalition Reference FOM. Federates from the US-SE Initial Federation from Phase 1 were upgraded to provide HLA 1516 interfaces and new federates providing representations of key US and SE Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), sensors, data fusion, and air/ground weapon platforms were developed and integrated into the SISE Federation.

The Phase 2 SISE distributed simulation network that connects the US Systems Integration Lab at Fort Monmouth, NJ and the SE SMART Lab at FMV, Stockholm has been established using the Virtual Private Network technology.

The other core components of the SISE Federation consists of the 1516 RTI developed by Pitch Corporation, SE and associated federation management, scenario management and data collection tools.

3.3 Testing, Validation, and Demonstration of Core SISE Architecture

The SISE Architecture with its core components being developed under Phase 2 of the PA will be integrated, tested, validated, and demonstrated by executing a realistic coalition operational scenario and vignettes. The US-SE PA Team has considered a variety operation scenarios, to include Cruise-missile Defense, Supporting Society, Joint Ground Combat, Urban Warfare, International Operation, and Territorial Integrity, and has chosen International Operation and Joint Ground Combat as the central theme for the scenario to be used.

Within the context of International Operation and Joint Ground Combat, scenario/vignettes to be executed will focus on representing operations indicative of Network Based Defense, Coalition Combat Identification (CCID), and Single/Shared Tactical Ground Picture functionalities. CCID systems/technologies such as Battlefield Target Identification (BTID) and Radio Based Combat Identification (RBCI) will be integrated with high fidelity Intelligence, Surveillance and Reconnaissance (ISR) sensor models, prototype sensor management, data fusion, Red Force Situational Awareness, Common Operational Picture and command and control systems from both nations into the SISE architecture to provide a representative coalition system-of-systems operational environment.

A demonstration of the core SISE capabilities has been scheduled for 17th November 2004 at the US Systems Integration Lab at Fort Monmouth, NJ and the SE SMART Lab at FMV, Stockholm. Personnel Interested in attending this demonstration at either the US or SE facility should contact the US or SE Project Offices, authors of this paper to make necessary arrangements.

4.0 Plans for Phase 3

With Phase 2 of PA effort to be completed by December 2004, Phase 3 effort will start 1 January 2005 and will last till 31 December 2006. The overall schedule for Phase 2 & 3 is shown at Figure 3 below:

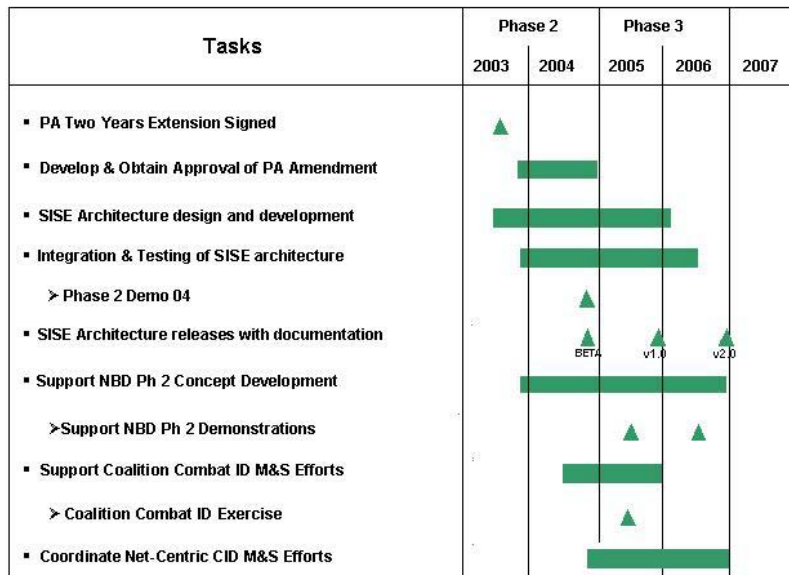


Figure 3: US-SE M&S PA Schedule

Systems Interoperability Simulation Environment (SISE)

The Plan for Phase 3 effort is to develop and integrate new Network Based Defense (NBD)/Net-Centric Warfare (NCW) models, simulators, and prototype software to support the NBD Demo 05 & 06 being planned by the Swedish Defense Forces. The Core SISE Federation will be expanded to support the Coalition Combat ID 2005 Field Exercise in Europe, either in United Kingdom or Germany. SISE capabilities will be continually upgraded to provide more robust simulation management, execution and data collection/analysis capabilities. Plan also is to coordinate with key NATO/Allied C4I programs such as the Shared Tactical Ground Picture Program so that the products of this PA – the SISE can be leveraged and used for M&S tasks to support the research, development and acquisition of joint/coalition technologies and weapon systems.