Proposing a C4ISR Architecture Methodology for Homeland Security

presented by

Monica Farah-Stapleton

Program Director for M&S
HQs CERDEC

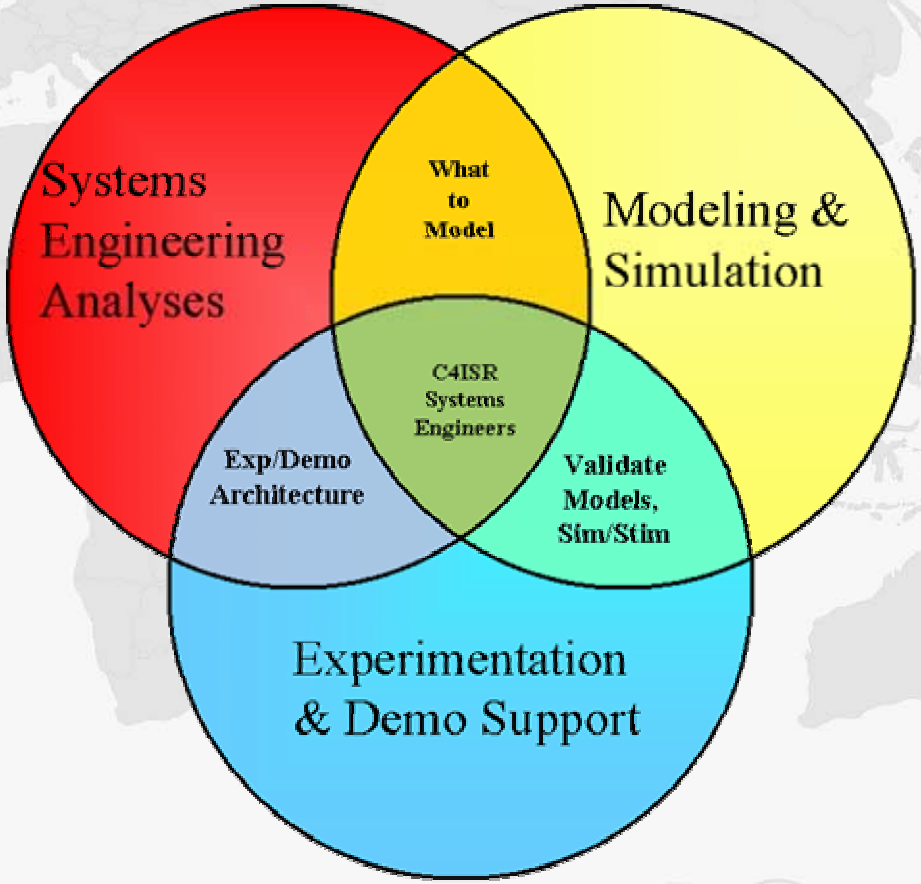
monica.farahstapleton@us.army.mil

Agenda

- System of Systems Construct
- Analyses Methodologies
- Ties to Experimentation
- Challenges

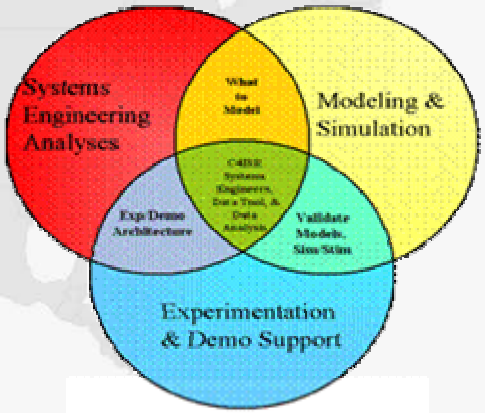
Systems Engineering

- Develop Architecture-Based Investment Strategies
- Develop Science and Technology Roadmap
- Collaborate With Army/DoD/other Organizations to Provide C4ISR Representation (Models and Simulated Architectures) to M&S Community
- Perform Constructive, Virtual, and Live Experimentation



SoS Analysis Approach Using M&S

Systems of Systems (SoS) Analysis Techniques



Problem Statement: Develop a Methodology To Enable Analyses of Current and Future Force System of Systems, Across the Spectrum of ACR, RDA,TEMO, Experimentation and Test Environments.

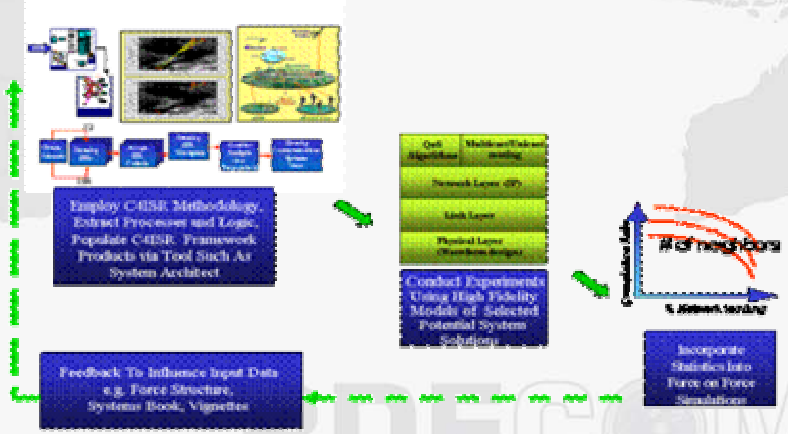
Approach: Perform Detailed C4ISR SoS Engineering Analyses; Populate Architecture Framework Products With Synergized Data; Translate Into Simulated Architectures; Represent Composition of Entities To Be "Played" in SoS Simulation; Integrate Virtual Simulations With Live Test Range and Experimentation Assets Over Highly Distributed Networks.

Payoffs: Synergy Between Different Acquisition Programs of Record; Identification of Gaps/Overlaps to Help Reshape R&D Investment Strategies, AND Operational Concepts; Coupling Virtual, Force, and Component Modeling Technologies With the Test Domain.

Tool Kits

- **DoD Architecture Framework Products:** *Synergized SoS Data Populated in Framework Products (e.g. OV-3, OV-6, SV-2, SV-6), Mined Using Automated Tools (e.g. TCAT, SA)*
- **M&S Environment (MATREX):** *Representation of SoS Concepts and Technologies Derived from a SoS Analysis into a Modeling and Simulation Environment, Enabling Analysis, Technology Trade Studies, and TTP Refinement.*
- **Virtual/Constructive/Live Experimentation:** *Adaptation of Models of Varying Fidelity into Specific Experimentation Environments (e.g. CASTFOREM, JCATS, OOS/OTB, Test Community) While Maintaining Continuity and Pedigree.*

Representative Example Of Employment

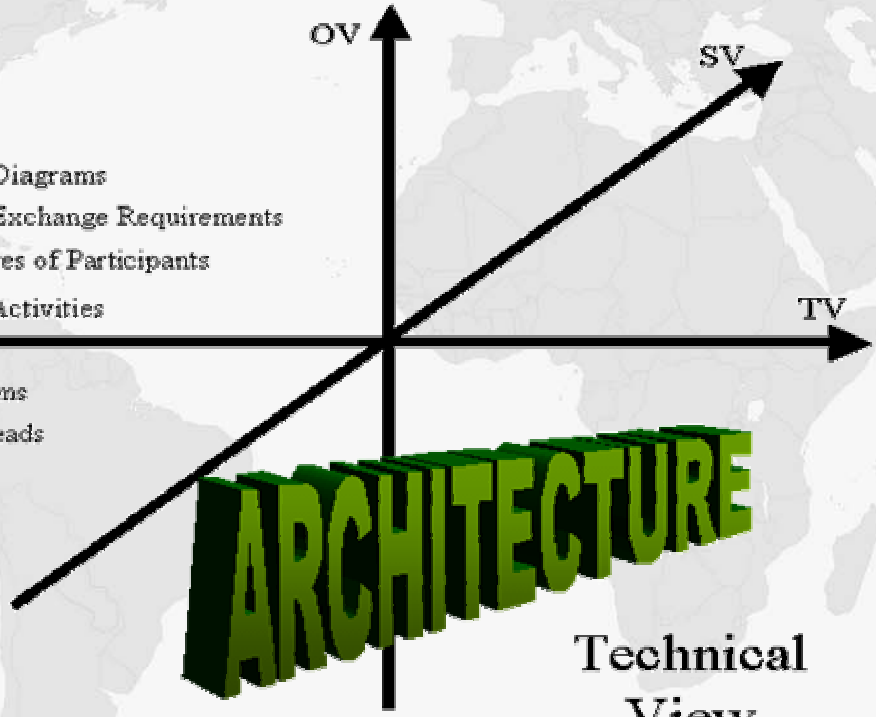


Define: Architecture

The Structure of Components, Their Interrelationships, and the Principles and Guidelines Governing Their Design and Evolution Over Time.

Operational View

- OV-1 TRADOC
- OV-2 Connectivity Diagrams
- OV-3 Information Exchange Requirements
- OV-4 Force Structures of Participants
- OV-5 Operational Activities
- OV-6a
- OV-6b State Diagrams
- OV-6c Mission Threads
- OV-7



Systems View

- SV-1 System Interface Descr.
- SV-2 Communications Descr.
- SV-3
- SV-4 System Functionality Descr.
- SV-5 Functionality to Activity Map
- SV-6 System IERs
- SV-7 System Performance Param.
- SV-8
- SV-9
- SV-10a
- SV-10b
- SV-10c
- SV-11

Architectural Tenets

plus

All Reference Materials

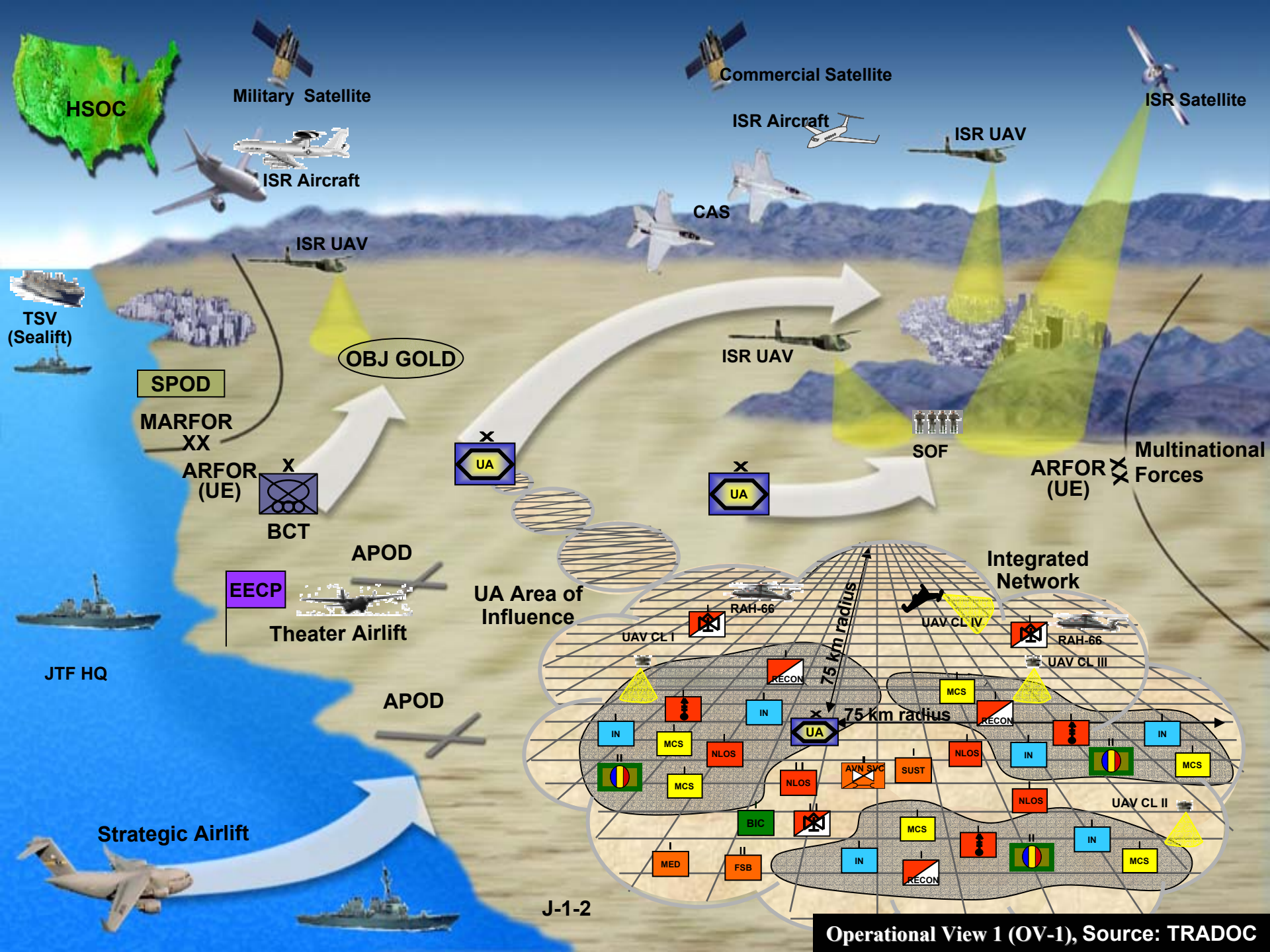
Assumptions

Scenario and Vignette Documentation

Technical View

- TV-1
- TV-2

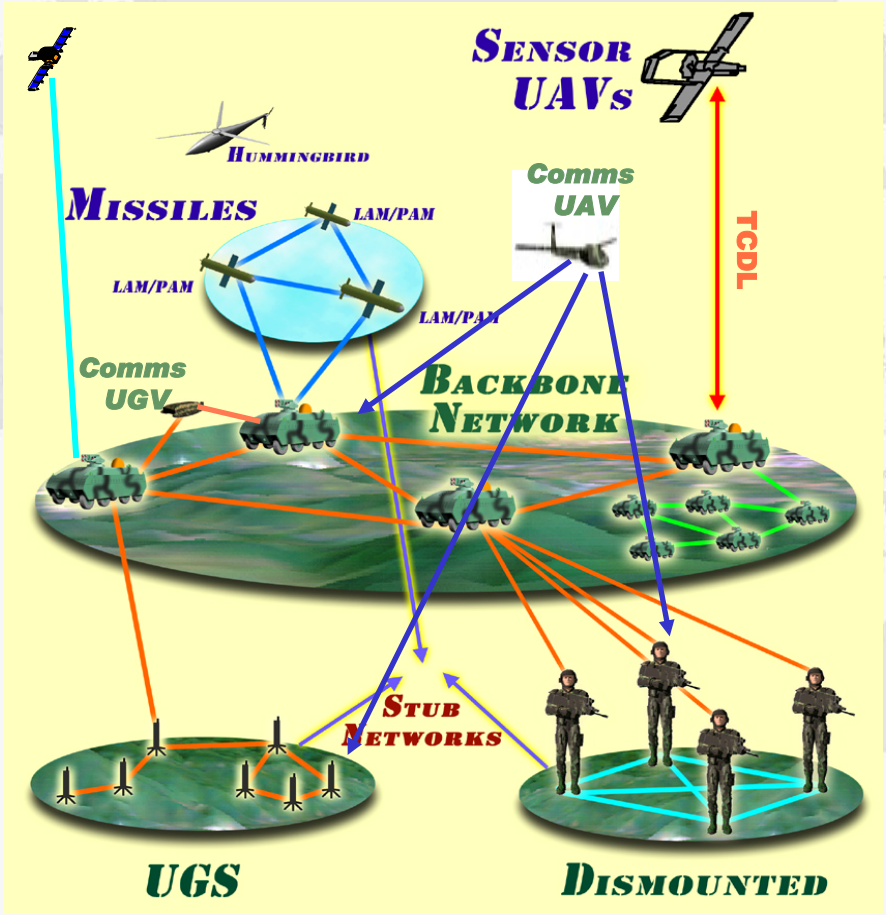
REF: DoD Architecture Framework Version 1.0, Final Draft, 15 Jan 2003



Operational View 1 (OV-1), Source: TRADOC

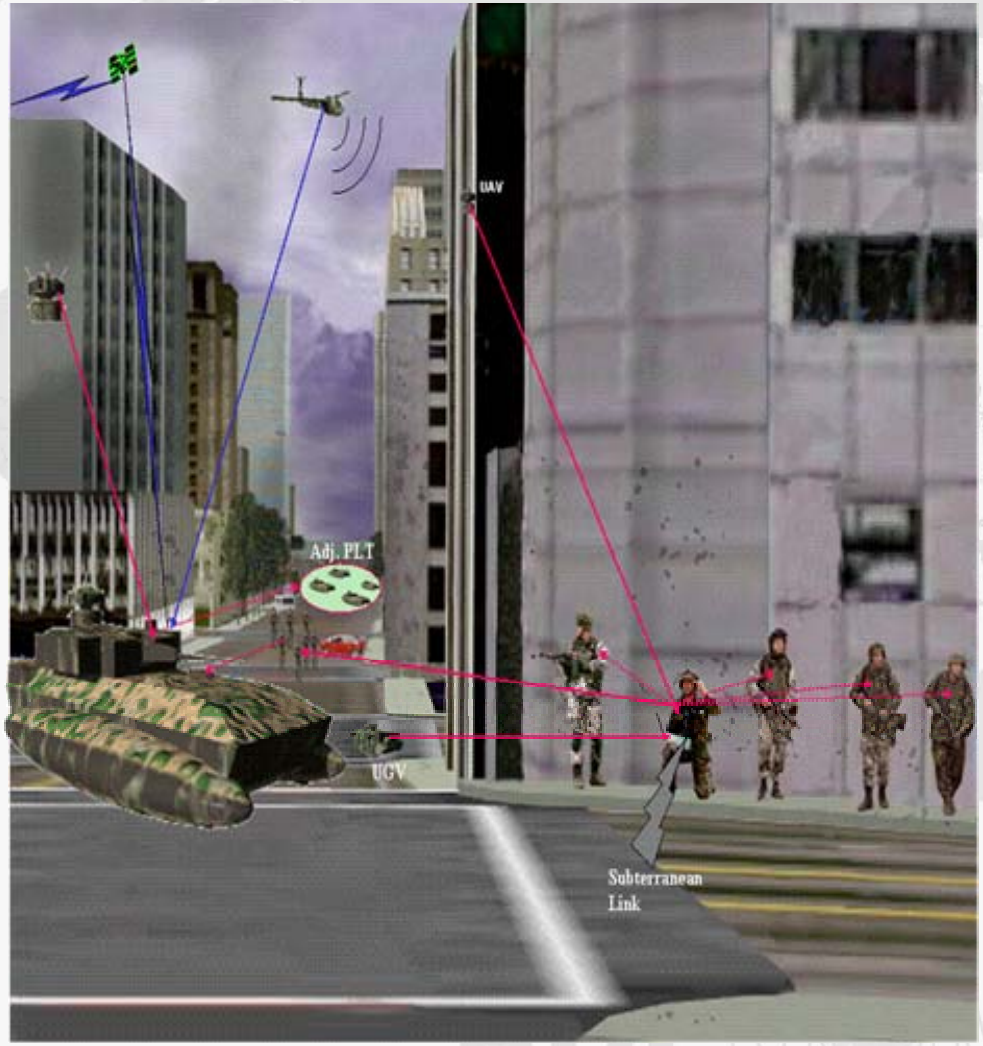
Zoom In: Simulated Architecture For M&S Experimentation

- Perform Detailed C4ISR SoS Engineering Analyses & Populate Architecture Framework Products
- Translate Into Simulated Architecture and Identify Composition of C4ISR Entities To Be "Played" in Simulation
- Identify C4ISR Technologies to be Employed
- Identify Whether Technologies are Explored in RDEC Tech Base, or Other Venues
- Identify Whether Technologies Are Currently Represented By Models
- If Yes: Obtain/Employ Models
- If No:
  - Employ Surrogates
  - Create Models
- Identify Specific Experimentation Environment Needs:
  - Employ Algorithms and Performance Curves in Combat Models
  - Provide C4ISR Effects Simulations

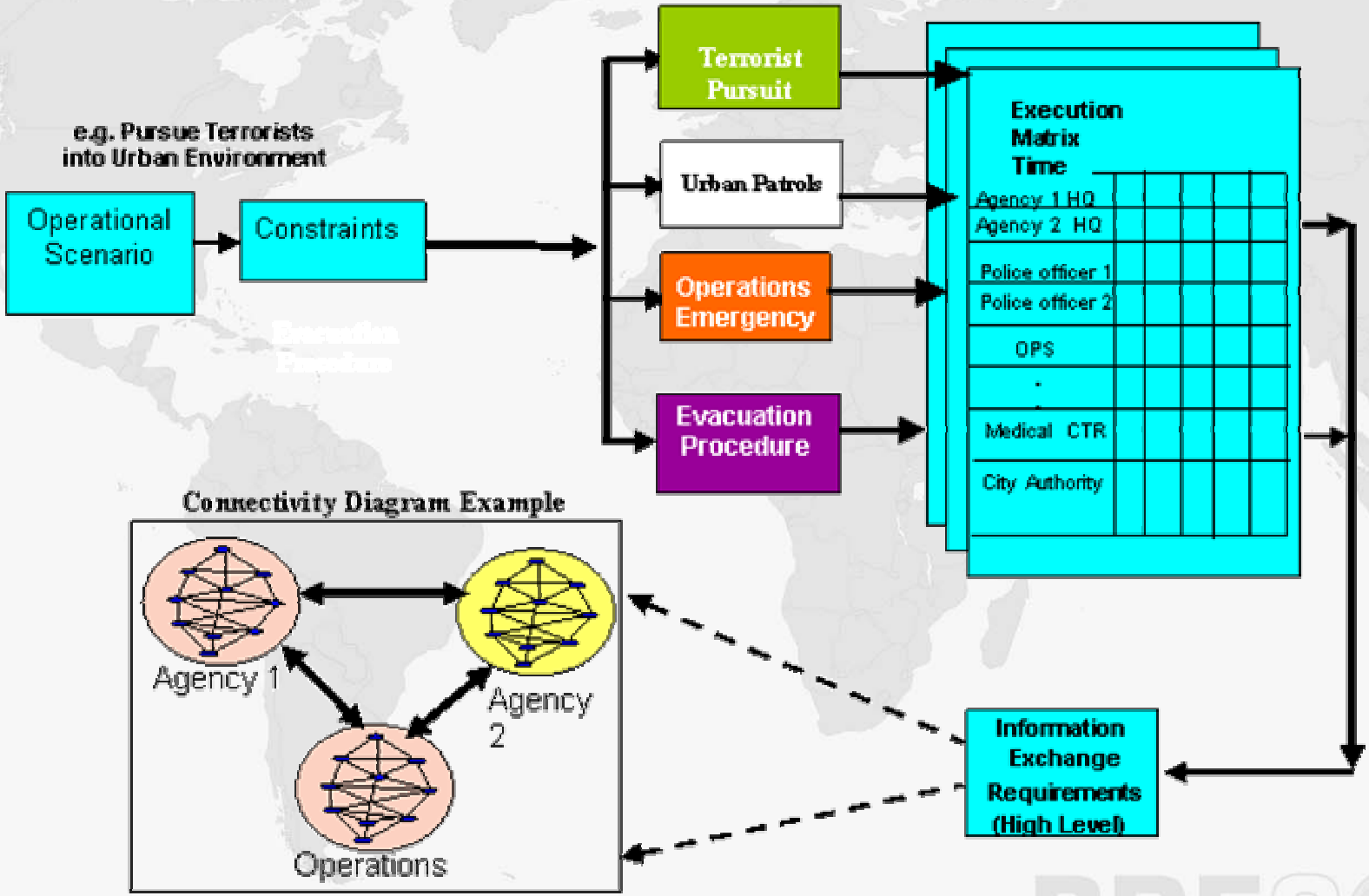


Zoom In: Close Fight Simulated Architecture

- **Perform Detailed C4ISR SoS Engineering Analysis**
- **Apply Process of Previous Slide**
- **Include Subterranean Propagation and "Enabling Models", e.g. Power, Navigation**
- **Technologies and Experimentation Strategies are Directly Applicable to HLS Problem Space**



Architecture Development Methodology

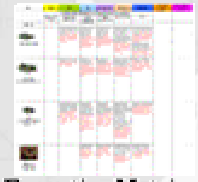


C2 and Sensor Architecture Development Methodology

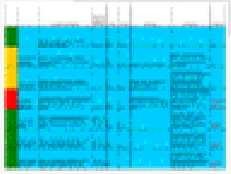
Technical and Operational
SME input

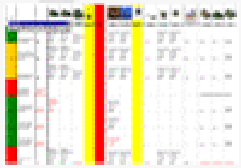
C4ISR
Architecture
Tenets

Systems Book



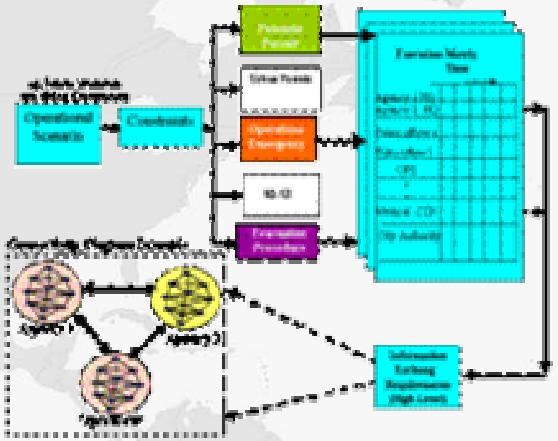
Execution Matrix
(OV-6c)

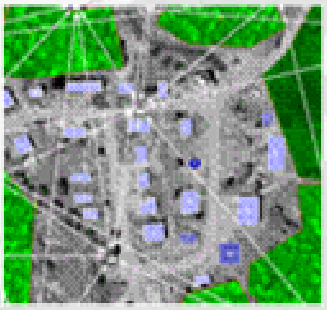


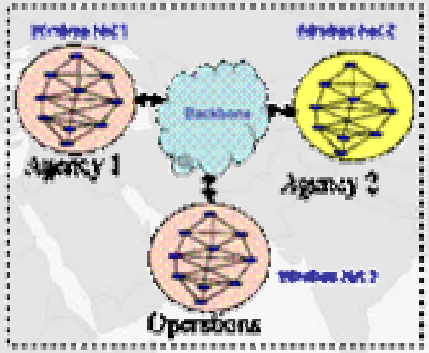


C2 and Sensor
Function Table and Entity C2 and Sensor Profile
(SV-4)

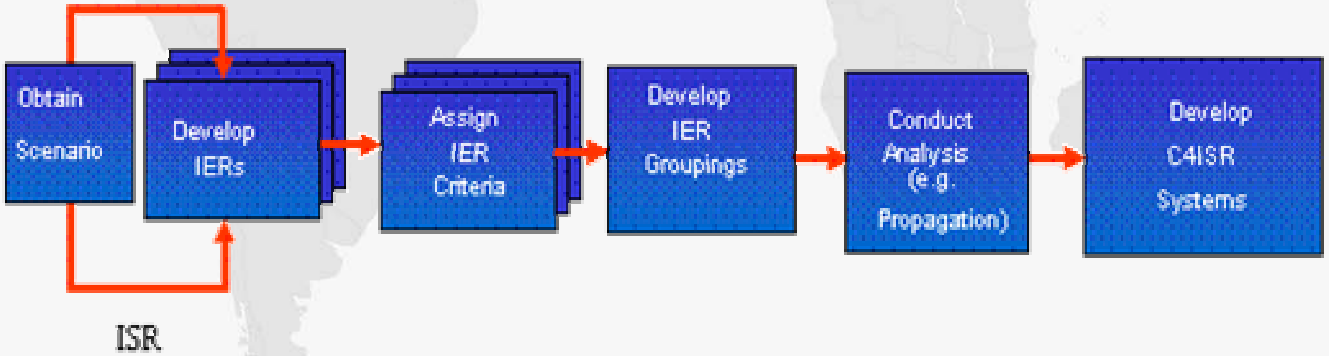
Communications Network Architecture Methodology







C2

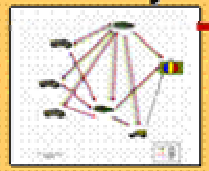


ISR

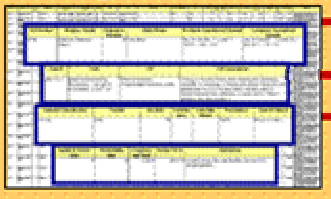
Translate OVs into SVs

OVs

OV-2 Connectivity Diagrams



OV-3 Operational IERs



OV-6b State Diagrams

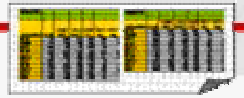
OV-6c Mission Threads

OV-5 Task List

Other Inputs

Experiment Results

Bandwidth Estimates



Fielding Schedules

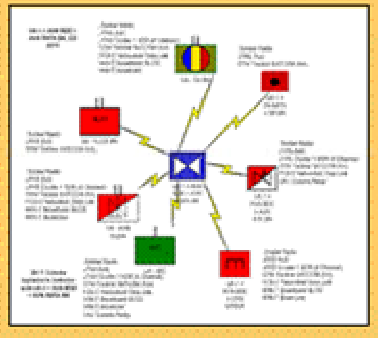
System Requirements, Capabilities, O&Os, ORDs

SVs

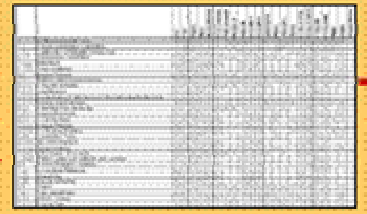
SV-2 Communications Description Document

Functional Comms Architecture from Dismounts through UE for Future Force: Requirements and Emerging Solutions

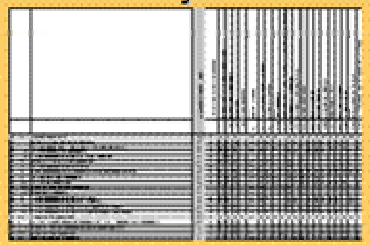
SV-1 Comms Interface Description



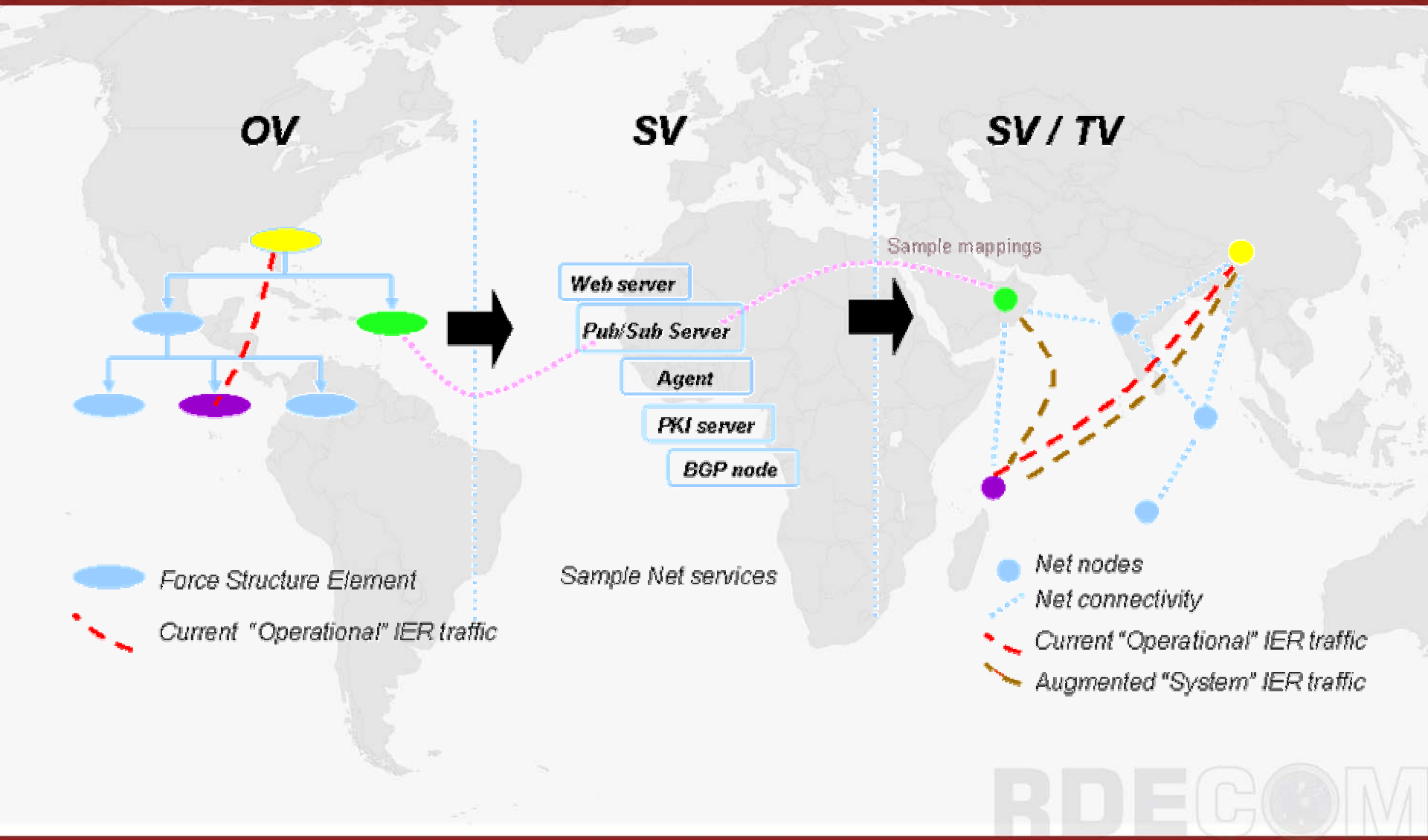
SV-4 C2 Function / Platform Mapping



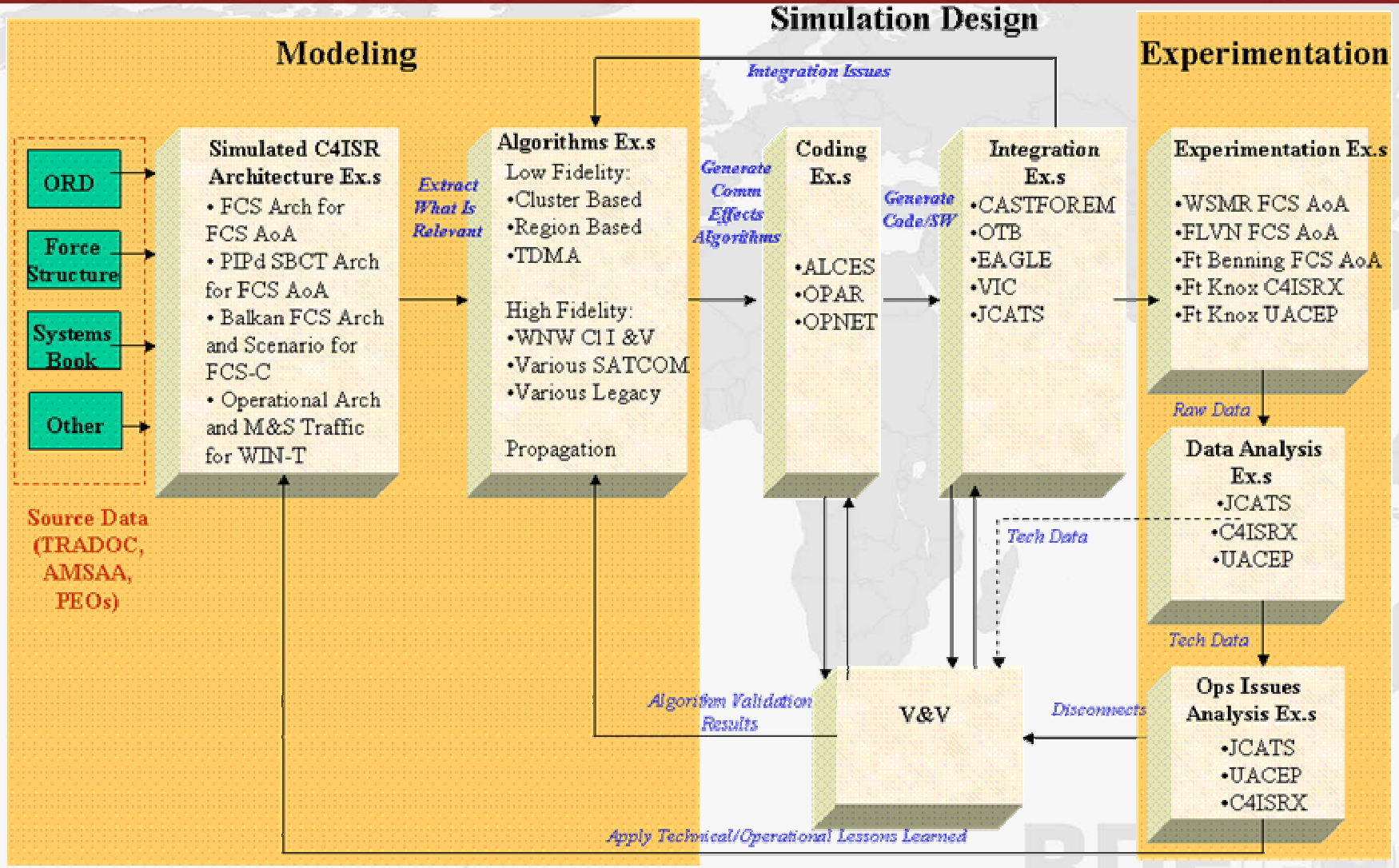
SV-5 Operational Traceability Matrix



C2/ISR Information Dissemination Constraint Example



C4ISR Effects Modeling Process: Comm



Challenges

- **Continuous Adaptability**
  - Systems to be modeled are continuously evolving
  - There is a tradeoff between the accuracy of a model and the model's capability to adapt to changes in the system that is being modeled
- **Model the System of Systems**
  - "Simulated Architecture" is Model of System
  - Corresponding C4ISR Effects Cannot Be of Higher Fidelity Than Fidelity of Architecture Itself
  - Not All Details of System Design are Relevant to Goals of Each Experiment.
  - Ensure Translation of Data Captured in C4ISR Framework Products Reflect Architecture to Level of Fidelity Relevant to Experiment Design (Extract Appropriate Simulated Architecture)
  - M&S Requirements Should Be Included During Architecture Development to Make Extraction of Simulated Architecture Comprehensive (and Easier)
  - Represent Technologies Identified in the Simulated Architecture (e.g. Algorithm Design)
- **Design the SoS Simulation**
  - Software Development
  - Simulation System Integration
- **SoS Experimentation Environments**
  - Design and Support Experiment
  - Perform Effects Data Analysis
  - Perform Operational Metric Analysis
- **Ensure VV&A**
  - For Not Only Individual Components But Also Entire C4ISR Federate, Across Varying Levels of Fidelity
  - Why is it a Credible Model (i.e. Representation of Technology/Process)

Contact Info

- **Monica F. Farah-Stapleton**

CERDEC, RDECOM, Ft Monmouth
Email: Monica.FarahStapleton@us.army.mil

- **Dr. James Dimarogonas**

The MITRE Corporation
Email: jad@mitre.org

- **Dr. Paul J. Deason**

TRADOC Analysis Center, WSMR
Email: paul.deason@us.army.mil

- **Rodney Eaton**

TRADOC Analysis Center, WSMR
Email: rodney.d.eaton@us.army.mil