Abstract: Overview of Modeling and Simulation (M&S) Capabilities at the Assessments & Modeling Group (AMG) in NRO's Survivability and Assurance Office (SAO)

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NRO

Focus Area #1 - M&S Enabling Resilient Space Capabilities
Track #1 M&S Techniques/Analysis for Resilient Space Capabilities

SAO is NRO's leading organization for space survivability and resilience. Within SAO, AMG's role is to establish a baseline understanding of counter space threats, from direct ascent missiles and other ground-based systems, to various space-based threats. AMG performs kill-chain, campaign, and architecture modeling to inform NRO resilience strategies. In order to do this, AMG operates a unique multi-level security (MLS) high performance computer (HPC), develops and maintains a suite of resilience-focused M&S tools, staffs multiple teams of analysts addressing various aspects of space resilience, retains a collection of over 200 completed technical studies, and has collected over a petabyte of reusable modeling data. AMG provides these and other resources to both NRO and partner programs from across the DoD and IC. The presentation will provide a descriptive overview of these resources and examples of several recent studies that highlight how these capabilities have been be used.

DAF M&S Summit Abstract

Title: OptDef - Optimization, Design of Experiments & Analytics for Simulation Models

Authors: Ben Thengvall, Ph.D, OptTek Systems; Mike Deskevich, Ph.D., OptTek Systems

Abstract: OptDef software greatly increases simulation analyst effectiveness and efficiency by providing optimization, design of experiments (DoE), and analytics capabilities for constructive Department of Defense (DoD) simulation tools. OptDef wraps simulations and provides an intuitive user interface to set up, execute, and analyze the results of a simulation study.
It is free for US government use. OptDef is a cross-platform, Java application with a plug-in interface that is already integrated with AFSIM, STORM, SEAS, and many other DoD simulation models. Its architecture allows integration with additional simulation tools with limited effort.

OptDef allows an analyst to choose multiple simulation inputs to vary and then apply one or more objectives and constraints. OptDef combines advanced AI/ML-based metaheuristic search methods and mathematical programming techniques to drive iterative simulation runs with different simulation input combinations. Then the tool automatically applies different statistical and data mining techniques to provide insight into the influence of the variables on the objectives and to identify good and bad regions of the design space.

Uses of OptDef will be described and an overview of product features will be provided including automating single and multi-objective optimization, DoE, and batch runs, post-run statistical and graphical analysis tools, and parallel simulation execution.

Mission Focus Areas: Digital Engineering & Modeling and Simulation Techniques/Analysis

Technologies of Interest: Decision Support Tools, AI/ML, Data Analytics
Possible Focus Areas / Tracks for this presentation:

Focus Area #1 - M&S Enabling Resilient Space Capabilities, Track 1 - M&S Techniques/Analysis for Resilient Space Capabilities

Focus Area #2 - M&S Integrating Space Capabilities into Multi-Domain Operations, Track 1 - M&S Techniques/Analysis for Multi-Domain Operations

Focus Area #3 - Transformational M&S Enablers, Track 3 - Emerging M&S Technologies

Advancing Robotic Space Station Design and Simulations Using a System of Systems Framework

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Robotic space stations offer the promise of a modular, persistent platform that is extensible and dynamically reconfigurable based on short-term needs. These robotics space stations may be well-placed at strategic locations within Cislunar space to provide space situational awareness. To be truly useful, these stations will need to operate autonomously in the event communication is cut off from Earth. Many of the required tasks may be dull, dirty, and dangerous. We are modeling these stations as a system of system, with many autonomous robots, sensor units, and programs working cooperatively to maintain constant readiness and effectiveness. Simulations are critical at two levels for the development of these systems and for their adaptation to new and unexpected scenarios. At one level, they are used to model the life and operational behavior of complex interactions within the station. Utilizing these models, robots are designed to monitor the health of space station components and can better predict and troubleshoot expected failures. Further physics modeling is being used to forecast disasters and secondary impacts. At a second level, we are simulating the complex interplay between these componential systems to better structure and understand the overall dynamics and feasibility of the robotics space station concept.

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MISSION FOCUS AREAS

- Warfighter Integration
- Command and Control
- Resilient Space
- Modeling and Sim

FOCUS AREA #1 - TRACK #1 M&S Techniques/Analysis for Resilient Space Capabilities

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ABSTRACT

Behavioral **A**nalysis **S**imulation and **T**raining develops an architecture for applying competing AI algorithms to virtual constellations of spacecraft in a red vs. blue adversarial engagement. The outcome creates a virtual environment to train operators on Tactics, Techniques, and Procedures for improving decision-quality and courses of action in crowded and high-threat environments.

Events in low earth orbit occur at a speed, density, and nature where adversaries may use pre-programmed actions that occur more rapidly than current response envelopes can account for. Responses are constrained by sensor processing time, human analysis, chain of command processing, network latencies, and physical alignment, which inhibit resiliency in space systems. In today's satellite command and control (C2) architecture, by the time we are aware the adversary has started a hostile action it is likely too late to counteract. M&S training scenarios are key to enabling combat-ready forces.

BAST develops the architecture for using AI-powered M&S for training defensive operations, reconstitution, and ultimately for closing the loop of constellation C2 in the future.

BAST will leverage Saber's existing Space Cockpit application and C2 architecture, using real-time data to visualize the space domain. Space Cockpit is currently deployed to high-side networks via Platform One's CATO.

2023 DAF Modeling and Simulation Summit

Focus Area #1 – M&S Enabling Resilient Space Capabilities

Track #1 M&S Techniques/Analysis for Resilient Space Capabilities

"Airpower Anytime, Anywhere with Resilient Positioning, Navigation, and Timing"

Roger Hart, Spirent Federal, March 3, 2023

Abstract

The USAF supports all aspects of airpower, which includes five core missions: air superiority; global strike; rapid global mobility; intelligence, surveillance and reconnaissance; and command and control. A key underpinning technology for fulfilment of these five core missions is Positioning, Navigation, and Timing (PNT). The PNT capabilities crucially depend on the Global Positioning System (GPS). GPS-based airpower enablers are threatened by jamming and spoofing which can be mitigated by Navigation Warfare (NAVWAR) countermeasures. NAVWAR countermeasures must undergo extensive modeling and simulation to test against PNT stress scenarios. Spirent provides simulation testing solutions involving high-precision physical modeling, high-rate computer simulation and high-fidelity radio-signal and inertial sensor emulation in support of legacy and modernized GPS classified signals. Spirent's lab-based testing offers realism and exact repeatability for modeling and simulation of maneuvering platforms and spinning munitions, allowing testing from normal operations to error conditions and corner cases. Spirent's software and hardware are used to test Controlled-Radiation Pattern Antennas (CRPA) and GPS/Inertial) against multiple jammers and spoofers acting on high-dynamic moving platforms. This presentation surveys the PNT modeling and simulation capabilities and presents examples of realistically simulating signals under high dynamics motion.

Abstract Submission: FPGA Cyber Risk Assessment
and Mitigation through Model Based Systems Engineering

Greetings, please see below for our submission on risk assessment and mitigation of FPGAs using MBSE.

Focus Area #1: M&S Enabling Resilient Space Capabilities

Track Number #1: M&S techniques/Analysis for Resilient Space Capabilities

Field Programmable Gate Arrays (FPGAs) have become an integral part of space systems due to their flexibility and ability to be reprogrammed in orbit. These reprogrammable devices enable designers to implement complex algorithms and mitigate radiation-induced failures in a cost-effective and time-efficient manner. However, their programmability also makes FPGAs susceptible to cyber threats which can lead to critical failures. The consequences of such failures can be catastrophic. Therefore, assessing the cyber risks associated with FPGAs is crucial. The consequence and probability of cyber risks need to be evaluated to understand the potential mission impact. This assessment requires a comprehensive understanding of the vulnerabilities and threats to FPGAs, as well as the potential attack vectors that adversaries might exploit. This presentation will introduce an undergraduate capstone project in Model Based System Engineering in which students developed a cyber-threat assessment tool that considers threats throughout an FPGA's lifecycle then produces a risk matrix encompassing all assessed threats. The presentation will also cover the scope of the project, the development process, key concepts, lessons learned, and potential applications to government acquisition programs.

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