

# FCS Modeling and Simulation Supports 21st-Century Soldiers

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**T**he Future Combat Systems (FCS) modeling and simulation (M&S) live, virtual and constructive simulation framework is enabling and supporting 21st-century Soldier weapons and force development, readiness (training and logistics) and battlefield mission preparation analysis for decisive mission execution.

Network-centric operations require the capability to maneuver forces in urban areas under "complex" terrain conditions that include tall buildings, underground garages or basements, and other concrete and steel structures that can hinder normal radio communications. Operational models such as CASTFOREM and OOS are addressing these and other urban terrain challenges to enhance FCS capabilities now to eliminate potential vulnerabilities in the future. (U.S. Air Force photo by SMSG Kim M. Allain.)

FCS is the Army's flagship Simulation and Modeling for Acquisition, Requirements and Training (SMART) program. The SMART concept brings all stakeholder communities together using an Advanced Collaborative Environment (ACE) to support an integrated M&S capability. The M&S strategy's core — achieved by the FCS Lead System Integrator (LSI), One Team Partners and Program Manager Unit of Action (PM UA) — is a collaborative effort aimed at developing and maintaining a consistent and credible FCS-equipped UA System-of-Systems (SoS) simulation representation. The FCS Simulation Framework (S2F) will meet the program's life-cycle requirements while enabling the execution of concurrent systems engineering development; producing and/or acquiring software and hardware products; executing a broad range of test, experimentation, analysis, training and operational applications; and providing support to the FCS capability spin-out concept.

The FCS M&S strategy emphasizes product line and tool kit commonality, repeatable processes and reuse throughout FCS internal development and the Army. Critical to M&S acquisition support is the concept of standards and an SoS simulation architecture that guides the acquisition of M&S assets that will be documented in the FCS product line repository.

### Supporting the UA Operational Context

The FCS S2F must replicate at effective levels of fidelity and resolution everything that is represented in the operational space — including embedded M&S — as communicated in the FCS Operational Requirements Document. Also, it must virtualize, synthesize and functionally enable all items in the natural operational environment encountered by the FCS, including

terrain; weather; gravity; and chemical, biological and nuclear components. The S2F must also consider the FCS embedded tactical software, including battle command, mission rehearsal, course-of-action analysis and training. Creating the S2F involves selecting, modifying and developing M&S tools — using a program-approved, structured make/buy process — from the M&S community at large. One of our challenges in this area is to transition the Army M&S components that were created for Cold War contexts to the network-centric warfare contexts for the Future Force.

### Network-Centric Warfare Simulations

Over the past 5 years, the Army M&S communities have made significant changes in their warfare representation. The operational simulations used by today's Army have their historical roots in the emergence of force-on-force simulations in the 1950s. However, prior to 2000, many Army models represented warfare as the classic Cold War engagement duel between combat vehicles and opposing forces. Vehicles

moved into line of sight (LOS) of each other, spent time in the detection process and then fired and assessed system damage. But today, and for the immediate future, network-centric warfare will ensure that FCS vehicles have extensive knowledge of the enemy at beyond-LOS (BLOS) ranges and possess the capability for instant network fire access to many friendly engagement resources from BLOS.

In 2000, it became apparent that the new concept of network-centric warfare would require significant changes in operational simulations. That change will include a focused partnership to support FCS requirements between the Army analysis, training and testing communities; Program Executive Office for Simulation, Training and Instrumentation (PEO STRI); U.S. Army Research, Development and Engineering Command — principally the Communications-Electronics Research Development and Engineering Center (CERDEC); and the Army Materiel Systems Analysis Activity (AMSAA) — and PM UA M&S Management Office (MSMO).



BG(P) Charles Cartwright (left), PM UA, and Dennis Muilenburg, Boeing Vice President and FCS PM, receive ribbon-cutting assistance from PackBot — the robotic prototype for the Small Unmanned Ground Vehicle being developed for FCS — to mark the FCS SoSILL's official opening at the Boeing facility in Huntington Beach, CA. Seated from left are Dan Zanini, FCS Deputy PM, Science Applications International Corp.; LTC Joseph L. Yakovac Jr., Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics and Technology; and Jim Albaugh, President and Chief Executive Officer, Boeing Integrated Defense Systems. (U.S. Army photo courtesy of PM UA.)



Future M&S must assess the operational effectiveness of how tactical information is transported to combatant commanders and account for the operational effects that information has on the decision-making process. Here, Soldiers from 1st Battalion, 15th Infantry Division, provide perimeter security during search-and-seizure operations near Samarra, Iraq, May 29, 2005. (U.S. Air Force photo by SMSG Kim M. Allain.)

Many changes to operational models throughout the Army have occurred, including the Combined Arms and Task Force Evaluation Model (CASTFOREM) and the OneSAF Objective System (OOS).

CASTFOREM is the Army's principal analytic combat model representing platform- and personnel-level entities at brigade and in a battlespace that considers the geometries of complex terrain and the atmospherics of multi-spectral regions. It is the principal model for FCS operational analysis and is used in almost all trade studies affecting the UA force structure. It plays all aspects of a battle and is routinely called upon to answer questions about numbers, types and placement of equipment in the UA.

The OOS, and its predecessor the OneSAF Test Bed (OTB), have been used extensively to provide an FCS battlespace that drives human-in-the-loop testing of the "fighting network-centric" concept. During the exacting FCS development process, OTB has been upgraded to simulate many of the FCS' subsystems. These certified representations of FCS vehicles will be moved to OOS as this

large-scale constructive simulation system replaces OTB.

### CASTFOREM

The architecture for the Army's CASTFOREM analytical combat model is stochastic. It often requires 20 to 30 UA force-on-force battle runs to generate a representative view of the distribution of battle parameters. Prior to 2002, the principal development in CASTFOREM was in the play of individual weapons, sensors, command and control of individual units, and the necessary upgrades to the natural battlespace affecting weapons and sensors. Today, CASTFOREM's FCS network represents:

- The number of Joint Tactical Radio System (JTRS) radios, their location, type and waveforms available.
- FCS network performance and its ability to dynamically reconfigure by determining subnets and gateways into adjacent regions.
- The impact of foliage, distance and terrain on the network and its ability to maintain connectivity.
- The quality of service that enables high-priority traffic to receive preference.
- Unicast versus multicast message transport environment reliability.

- The ability to dynamically reconfigure the ad hoc network with new members and gateways in a region.

While these are principally FCS network physical characteristics, CASTFOREM simulates these characteristics in a battle environment providing valuable insights into FCS network-centric operational effectiveness. The model has been used to:

- Examine the transport of tactical information and account for the operational effects of information not being processed in a scenario context, as well as assess how messages influence decisions.
- Assess how netted fires can be used most effectively.
- Assess the importance of sensors of all types, including unattended ground sensors (UGSs) and unmanned aerial vehicles (UAVs), in supporting maneuver operations.
- Investigate the threat force's ability to interrupt the network and the resulting impact on operations.

Through the efforts of the U.S. Army Training and Doctrine Command Analysis Center (TRAC), CERDEC, AMSAA and PM UA, CASTFOREM has become an important tool in assessing the

FCS network's impact and design. PM UA is currently supporting improvements to CASTFOREM, focusing on developing an urban network operations capability using JTRS radio signals to propagate in urban areas and the complex terrain that buildings present. This capability will further move CASTFOREM toward representing the full spectrum of FCS operational capabilities.

**OOS**

Programmatically, OOS has been developed based on the Army's need for a single simulation to drive all platform-training simulators and is a real-time, distributed, platform-based simulation that can run in either a stochastic or deterministic mode. OOS has been selected to provide embedded training on all FCS vehicles as well as to provide the battlespace in the developmental environment of the System-of-Systems Integration Laboratory (SoSIL).

In FYs 05 and 06, PM UA, PEO STRI and the LSI began a focused effort to develop a network-centric capability in OOS. Specifically, the LSI developed the Communications Effects Server (CES), a network simulation providing explicit representation of JTRS radios and the ad hoc network. Most importantly, OOS is being readied to accommodate communications effects in its portrayal of key FCS tactical messages in the battlespace. Federating a CES with OOS will provide

the FCS program with a fully network-centric UA battlespace representation.

**M&S Acquisition Support Aspects**

Operational M&S used in acquisition must be credible and consistent with operational contexts and must include models and simulations that are not operational in nature. To support that qualifier, verification, validation and accreditation (VV&A) of M&S assets will be performed. The proper VV&A pedigree is an important component of the make/buy process. To assist in providing part of the data set that will be required to support any accreditation decision, uses of M&S in support of the FCS System Development and Demonstration (SDD) phase will be tapped for usage data to support the VV&A activities, leading to an accreditation decision. These program activities include:

- Trade studies
- Force effectiveness analyses
- Integrated mission tests
- Technical field tests
- Limited user tests
- Experimentation
- Product development

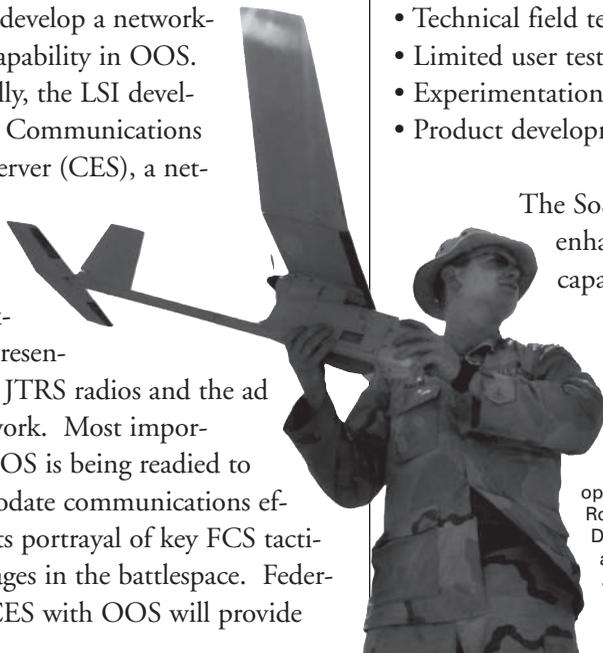
The SoSIL, combined with enhanced Army M&S capabilities, provides an

integrated acquisition support capability to develop, analyze, integrate and test the FCS SoS.

The SoSIL is the collection of laboratories and test facilities housing the hardware and software required to develop, analyze, integrate and test various FCS program systems. Each FCS system will be represented and developed as a separate article. The SoSIL concept will interconnect the laboratories, including One Team Partner sites developing these articles, and Army sites used in other SDD activities through a secure wide area network supporting real-time seamless data, voice and video service distributed test capability across the United States. Capabilities also include categories for data transmission, such as viewing portal data, software updates and ACE data. The SoSIL is centrally integrated through Boeing's facility in Huntington Beach, CA.

The FCS program uses SMART applications to confirm design concepts and/or discover required design changes early in the design phase, allowing for timely and efficient engineering changes. The continued, sensible reuse of M&S across and within FCS development will provide a set of integrated M&S capability, which facilitates and enables all aspects of procurement, fielding and maintenance throughout the FCS program's life cycle.

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PM UA is assessing the importance of sensors of all types, including UGSs and UAVs, in supporting FCS network-centric maneuver operations. Here, CPL Jerry Rogers, 1st Amored Division, prepares to launch a Raven near Taji, Iraq, July 19, 2005. (U.S. Air Force photo by TSGT Russell Cooley IV.)

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