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EQUIPMENT, TRAINING & SUPPORT

Sue McClung and Jim Jones of the Joint Technology Center/Systems Integration Laboratory explain the new simulation technology for the surveillance industry.

## Up and away

The multiple unified simulation environment (MUSE)/Air Force synthetic environment for reconnaissance and surveillance (AFSERS) simulation system is the primary virtual intelligence, surveillance and reconnaissance (ISR) and unmanned aerial vehicle (UAV) simulation used within the Department of Defense (DoD) for command and staff level training for the joint services.



The tactical exploitation of national capabilities (TENCAP) MUSE was added to incorporate capabilities of the army's tactical exploitation system (TES) alongside its legacy systems such as the enhanced tactical radar correlator. MUSE/AFSERS consists of a surrogate ground station configured for the ISR system being simulated, air vehicle and datalink simulation, and a visualisation system used for payload and sensor scene generation. The simulation can be configured so that it is able to operate either as an embedded or stand-alone ISR system trainer that communicates directly with the actual ISR ground system.

Standard national imagery and mapping agency (NIMA) products, such as digital terrain elevation data (DTED) and controlled image base (CIB) are the primary source data used for terrain visualisation. The generic ISR ground station simulation utilises the defence intelligence infrastructure - common operating environment (DII-COE), the joint mapping toolkit (JMTK), and can communicate to a variety of joint command, control, communications, computers and intelligence (C4I) systems similar to the tactical system. The simulation models the Predator, Hunter, Shadow and Pioneer unmanned aerial vehicles (UAVs) and U2, and has recently added the P3 Orion, weapon systems video (WSV), Global Hawk UAV, joint stars and a generic vertical takeoff and landing (VTOL) UAV.

The MUSE/AFSERS model consists of a payload visualisation system, air vehicle and datalink simulation, and a reconfigurable ISR ground station surrogate with tactical messaging capability. The visualisation system generates synthetic payload scene electro-optical (EO), infrared (IR), synthetic aperture radar (SAR) video and/or imagery of



the three dimensional battlefield with simulated static and mobile ground, sea and air targets. The six degree of freedom (6-DOF) air vehicle and datalink model simulates the dynamics of the ISR air vehicle and associated sensors that are controlled by operators at the surrogate or tactical ground station. The joint technology centre/systems integration laboratory (JTC/SIL), located at the US Army aviation and missile command (AMCOM) at Redstone Arsenal, developed the MUSE/AFSERS system.

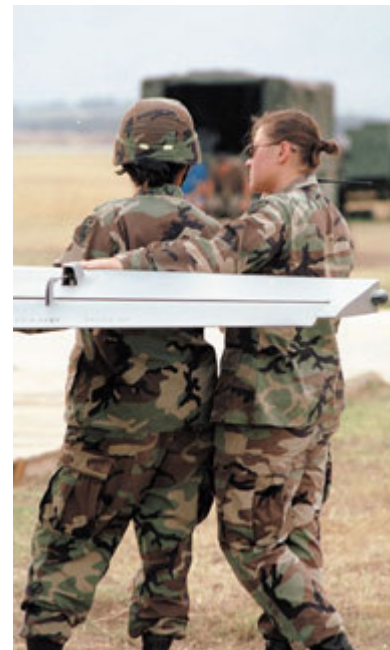
The JTC/SIL was established in 1994 for the DoD family of UAVs to be a centre of technical excellence for tactical, medium-altitude, endurance and future UAVs. It also was intended to provide a cost-effective testbed for UAV technology assessment including insertion, demonstration and transfer to assist the programme executive office for cruise missiles and UAVs, UAV project managers, prime contractors and users. For the UAV, the MUSE/AFSERS is but one element of an integrated lab architecture that evaluates UAV and ISR system technologies during prototype, integration, and test phases. The JTC/SIL capitalises on its unique system integration capability, prototyping facilities, and the MUSE/AFSERS in order to evaluate a system's military utility in constructive, virtual and live exercises. The architecture focuses on solving long-range, joint interoperability issues and also provides solutions that will maximise the operational flexibility of the systems that are in the process of being evaluated or tested.

JTC/SIL prototyping and integration activities included the Hunter UAV downsized ground control station (DGCS) prototype, Hunter UAV interim trainer, outrider UAV interim trainer, the tactical control system (TCS) land based shelter configuration, a TCS trainer and a system integration and test environment for the Shadow 200 TUAV. The JTC/SIL recently developed the Shadow 200 TUAV GCS prototype and institutional mission simulator (IMS) that was fielded to the Black Tower training facility at Fort Huachuca in Arizona.

### JTC/SIL lab architecture

The MUSE/AFSERS development and sustainment effort assists in the validation of joint requirements oversight council (JROC) UAV concepts. The MUSE/AFSERS provides an immediate flow of information to the Warfighter to develop tactics, techniques and procedures (TTPs) and concept of operations (CONOPS) for the intelligence collection and exploitation system that it simulates. This capability allows the warfighters to experiment with relatively inexpensive assets before the actual ISR systems are deployed. This allows for the obtaining of critical operational insights in a low-risk training and rehearsal environment. In addition to this, it optimises the use of actual ISR assets that are not normally available for training.

The MUSE was developed in early 1994 as a Hunter UAV simulation suite for a technology demonstration at the National Training Center (NTC) at Fort Irwin, California, and subsequently it was used as a Hunter Short Range UAV interim trainer. It served as a Hunter UAV workstation for man-machine interface (MMI) evaluation studies. Since then the MUSE has evolved into a broad-based simulation suite that has been upgraded to include new UAV and ISR platforms and sensor models, theatre and national capabilities, tactical communications and advanced mission planning capabilities.



During its spiral development and upgrade process the MUSE/AFSERS has supported users in over 80 military exercises and demonstrations over the last six years. The primary components of the MUSE/AFSERS, are the payload visualisation system, air vehicle simulation and the various tactical or simulated ground stations that interface to the MUSE/AFSERS. The following section offers a summary of each component.

## Source data for visualisation

The MUSE/AFSERS is a distributed interactive simulation (DIS) that is high level architecture (HLA) compliant. In addition to this, it can receive entity data from DIS simulations such as modular semi-automated forces (ModSAF), JANUS and the DIS version of JQUAD GG (ground game). MUSE/AFSERS is fully integrated with the suite of constructive models under the joint training confederation (JTC). The JTC suite of models, such as USAF air warfare simulation (AWSIM), USA corps battle simulation (CBS), USN research, evaluation and system analysis simulation (RESA), USMC marine air-ground task force (MAGTF) tactical warfare simulation (MTWS), the joint information operations center's JQUAD, and USA tactical simulation (TACSIM) and the high resolution system stimulator (HRSS) deaggregation system, provide entity target location and state data for the MUSE/AFSERS.

## Imagery visualisation systems

The MUSE/AFSERS visualisation system is a commercial-off-the-shelf (COTS) product that generates an electro-optical (EO)/infrared (IR) payload video scene with overlays for the platform being flown. The JTC/SIL video interface design document (VIDD) for MUSE/AFSERS is openly available to visualisation system vendors for the developing of an interface to the MUSE/AFSERS. At the moment, most of the MUSE/AFSERS systems that are in use utilise the MetaVR virtual reality scene generator (VRSG). The terrain database for the visualisation system is developed either with high-resolution imagery, such as controlled image base (CIB) from the national imagery and mapping agency (NIMA), LANDSAT, and SPOT, or made synthetically with representative landform textures for the database area. Since most wide area coverage will always contain some defects or sporadic cloud cover, the insertion of imagery from secondary sources is employed to provide a contiguous, complete coverage, when such products are available.



Once the orthorectified and georegistered imagery is obtained, or synthetic imagery is developed, it is then draped over digital terrain elevation data (DTED) from NIMA that provides the elevation postings to in turn create the three dimensional payload scene. Both commercial and government source imagery and terrain development and optimisation tools are used in the database development process. Since MUSE/AFSERS is typically employed in support of warfighters exercising actual contingency mission assignments, a realistic virtual database contributes significantly to user knowledge of the potential battlespace.

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## Operations during an exercise

UAV operators have to use the CSS to control an AV during an exercise, demonstration or training session. The CSS typically takes two operators. One operator is needed to fly the UAV and the other is responsible for controlling the payload. The AVO controls the AV flight characteristics, develops and executes mission plans, responds to AV warnings and errors, interacts with the JMTC map display for situational assessment, and develops and disseminates both tactical reports and images electronically to C4I systems. The second operator, the MPO, actively controls the UAV payload with a joystick. The MPO can slew the payload to different locations on the battlefield at various rates, and zoom to different field of views as well as freeze the image frame for image capture and bring up a tactical report window with a press of a button on the joystick.

## Exercise support

The MUSE/AFSERS has been successfully used in more than 80 exercises and demonstrations over the last seven years. These range from small scale demos and evaluations to large scale joint exercises such as the annual US Forces Korea Ulchi Focus Lens exercise that is held in South Korea each summer. Military intelligence units at these exercises have used the MUSE/AFSERS to assess UAV CONOPs and to develop TTPs for UAV employment. However, a real benefit of the MUSE/AFSERS is that it can be utilised to stress test the real tactical links over which UAV imagery and tactical reports are distributed.

The JTC/SIL MUSE/AFSERS exercise support team assists these units in understanding the connectivity and video and imagery distribution issues that a UAV, TENCAP company, or ISR unit would have to address and solve in a war-time environment. Operational issues, such as how the UAV flight plans are approved and inserted into the air tasking order, dynamic retasking, UAV frequency allocation, multi-platform collection management and UAV maintenance, are some additional areas of operations that are addressed during an exercise.

### **MUSE/AFSERS sites**

The elements of the MUSE/AFSERS system are usually tailored for specific organisations and their operational environment. MUSE/AFSERS sites are shown in Figure 6. Some users employ a MUSE/AFSERS in a fixed lab environment while others support field exercises at combat training centres such as the National Training Center at Fort Irwin, CA. The MUSE/AFSERS is a cost-effective turnkey system for modeling multiple UAVs and national ISR assets in military experiments and training exercises. This reduces the need for maintaining redundant ISR simulations within the DoD but also helps in lowering support and training costs to the joint warfighter.

### **MUSE/AFSERS development and major exercises**

<b>Year</b>	<b>Development</b>	<b>Major exercises/demonstrations</b>
1994	GCS Driver, Hunter UAV Crew Performance Evaluation, Hunter UAV Model	National Training Center Demonstration, Prairie Warrior
1995	Visual Payload, DGCS MMI, Hunter Crew Performance Evaluation, Tactical Control Station - Surrogate (TCS-S), Tactical Communications	JPSD, 2AD Ramp-Up, 4ID BCTP
1996	Predator UAV Model, Pioneer UAV Model, SAR Model, TCS-S Management Station	III Corps BCTP, Prairie Warrior, CL-289 Demo, 101st Airborne, UFL96, Combat STAR, JPSD, AUSA Army Experiment, Unified Endeavor
1997	MUSE Productization, TCS and Predator SBPCS Integration, Outrider UAV Model	Task Force XXI, JWID, Ft. Rucker CEP, UFL97, DIVXXI, FleetEx
1998	Control Station Surrogate (CCS), DII/COE JMTK and TACCOM, TENCAP U2/ETRAC, Windows based GCS Driver, Outrider Trainer TCS Integration	Swift Victory, UFL98, EFX98, Fuertes Defense 98/99
1999	TENCAP MIES, Remote Video Generation, AVSI Interface and TCS Trainer, SAR Upgrade Resolution Enhancements	III Corps BCTP, TMDI, JEFX99, UFL99, Blue Flag
2000	Control Station Surrogate Port to Windows 2000, Shadow200 Model, MUSE/AFSERS Manager, Global Hawk, TUAV Institutional Mission Trainer	2ID WFX, 82nd Airborne WFX, 1st CAV WFX, V Corps WFX, Blue Flag 02, 03, 04, 6th CAV RSOI, Roving Sands 00, SummerEX, UFL 00, JEFX00, 2ID Warpath, Yama Sakura