Paper Title: United States Army Operational Test Command (USAOTC) Integrated Technologies Evolving to Meet New Challenges – A Study in Cross Command Collaboration

Paper is most relevant to: Live, Virtual, and Constructive (LVC) capabilities

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PAPER ABSTRACT

The United States Army Operational Test Command (USAOTC) conducts, under US Title 10, the operational testing of equipment, systems and system of systems destined for the troops in the field. Operational testing is accomplished by creating a relevant and operational realistic environment in which soldiers and leaders employ systems under test. Increasingly, this environment can only be created by employing the entire span of test support technologies -- modeling, simulation, instrumentation, networks, test control methodologies, and data collection, reduction and analysis devices – in a fully integrated test support enterprise. More simply, the

complex systems of systems being fielded require an equally complex system of systems to test them in live, virtual and constructive (LVC) test environments.

USAOTC's test technology enterprise program, OTC Advanced Simulation and Instrumentation Systems (OASIS), was established to meet these challenges and has resulted in an extremely capable federation of test tools. Recent integration events have demonstrated the capabilities of OASIS to create effective and highly detailed portrayal of contemporary operating environments including elements such as: 1) constructive simulation of fire, effects, attrition, and battle damage assessment on live instrumented insurgent players, 2) insurgent and counter improvised explosive device (CIED) activity, and 3) electronic warfare (attack) portrayal and effects. These capabilities were also demonstrated during a series of operational tests including complex army battle command systems and a Joint Battlespace Dynamic De-confliction (JBD2) event.

USAOTC has been able to achieve this capability via the development and validation of several capabilities within the OASIS enterprise and by the integration of other capabilities from across DoD. In particular, the establishment of the Cross-Command Collaborative Effort (3CE) – a partnership of Army Test & Evaluation Command (ATEC), Training and Doctrine Command (TRADOC), Research Development Engineering Command (RDECOM), and the Program Manager for Future Combat Systems (PM FCS) - has made many new capabilities available as well as providing an extended network of LVC integration engineers focusing on similar problem sets. RDECOM's PM for Modeling Architecture for Technology and Experimentation (MATREX) promulgated many of the key integration standards and methods, via 3CE, that formed the nucleus of the OASIS integration strategy. Other key partnerships, such as with the PEO-Simulation, Training and Instrumentation (PEO-STRI) PM-ITTS Threat Systems Management Office (TSMO) and the Joint Test and Evaluation Methodology (JTEM) and Joint Mission Environment Test Capability (JMETC) offices provided additional methods and expertise required to integrate the diverse technologies.

This paper explores the challenges, successes and selected lessons learned from the on-going integration of a diverse set of architectures, protocols, and technologies from numerous Department of Defense (DoD) agencies into a successful, near-seamless live-virtual-constructive test capability. It also will describe the core capabilities and the events that have clearly demonstrated the ability of OASIS to provide the robust and enhanced capability required to efficiently and effectively support future DoD development, testing, and training objectives and requirements.

ABOUT THE AUTHORS

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1. INTEGRATION CHALLENGES

The United States Army Operational Test Command (USAOTC) conducts, under US Title 10, the operational testing of equipment, systems and system of systems destined for the troops in the field. Operational testing is accomplished by creating a realistic environment in which to surround the soldier while he or she is using the system(s) under test to perform representative . missions and tasks. Very often this environment can only be created by employing the entire span of test support technologies -- modeling, simulation, instrumentation, networks, test control methodologies, and data collection, reduction and analysis devices. This paper explores the challenges, successes and lessons learned of integrating a diverse set of architectures, protocols, live-virtual-constructive tools from numerous Department of Defense (DoD) agencies into a successful near seamless linkage of live-virtual-constructive capabilities. These capabilities resulted in the effective and highly detailed portrayal of: 1) constructive simulation of fire, effects, attrition, and battle damage assessment on live instrumented insurgent players and 2) electronic warfare (attack) portrayal and effects which were demonstrated during a series of operational tests including complex army battle command systems, technology integration events and a Joint Battlespace Dynamic De-confliction (JBD2) event. Specifically, the partnering of the Cross-Command Collaborative Effort (3CE), Army Test & Evaluation Command (ATEC), Training and Doctrine Command (TRADOC), Research Development Engineering Command (RDECOM) – PM Modeling Architecture for Technology and Experimentation (MATREX), Program Executive Office (PEO)-Simulation, Training and Instrumentation (PEO-STRI) PM-ITTS, TSMO, and the Joint Test and Evaluation Methodology (JTEM), provided the expertise required to integrate the diverse technology.

In order to replicate the future realistic operational environment, large amounts of computing power is required and is achieved by utilizing numerous technologies mentioned previously. Typically no single technology tool has the requisite granularity and capability required to represent the numerous aspects of the Warfighting Functions (Movement and Maneuver, Intelligence, Fires, Sustainment, Command and Control, Protection) – thus, multiple tools are required to operate together to create the robust environment in a near-seamless manner.

During April and October 2008, ATEC OTC conducted OASIS JOSIE Integration Events (IE) VIII and IX -- the eight and ninth in a series of IEs to demonstrate a technology tool capability which included a distributed HLA capability (note: JOSIE is a "brand name" derived from the first letters of the "big 5" LVC systems in OTC's inventory – Janus, OT-TES, STORM, IMASE, ExCIS that were the first to be integrated via HLA). OASIS evolved out of the JOSIE integration efforts and now reflects a collaboration of multiple organizations and is depicted below. The major categories of this paper include an overview of these integration events:, focus, event objectives, federation and enterprise tools and members, distributed locations, network architecture, proof of effort (interoperability vignettes), lessons learned, way forward and conclusion.

2. INTEGRATION EVENT OVERVIEW

The overall goal of the integration event was to create a representative environment in which to immerse the representative equipment (not prototypes) operated by representative soldiers. The representative environment was depicted utilizing the federation/enterprise. The federation/enterprise was integrated via a distributed PM-MATREX High Level Architecture (HLA) federated object model (FOM). The MATREX HLA enabled numerous tools and federation members to participate with a flexibility and composability that would allow for insertion and deletion of federation members to support various test support constructs. These events have clearly demonstrated a robust and enhanced capability required to efficiently and effectively support current and future Army testing requirements – and show great potential as well to meet broader DoD development, testing, and training objectives and requirements.

Numerous ramp-up activities were conducted in support of the OASIS JOSIE IEs. All activities followed the Simulation Interoperability Standards Organization (SISO) Federation Development and Execution Process (FEDEP) guidelines for creating HLA federations. First step in the process was establishing the federation requirements and objectives. Objectives included the creation of a federation using the JOSIE LVC systems while keeping the same level of fidelity among the systems. Additional objectives were to use the MATREX version of the HLA RTI software and the MATREX FOM to support the data exchange and interoperability requirements. To accomplish this, a federation scenario was created that met the scenario data requirements for each of the twenty-three HLA federation members. The tactical situation included 4 blue brigade combat teams opposed by 4 threat brigades for a total of 6900+ simulation objects within the synthetic natural environment (SNE). After analyzing the networking requirements of each federate, a network architecture was designed that met all federate needs and represent a typical distributed test architecture.

OASIS IE IX also marked an increased focus on the tactical relevance of the scenario and on areas driven by specific test support requirements (e.g., inclusion of data collection and reporting requirements in the IE that were derived from a near-term test event). Capabilities demonstrated by the federation during the IEs included: situation awareness, interfaces with live players, Real Time Casualty Assessment/Damage Status, sensor detections (virtual and constructive), real-time interface (RTI)-level visualization, fire and effects, electronic warfare depiction, nuclear effects, directed energy effects, and data collection/playback capability representing the federation activities. The OASIS IEs successfully demonstrated interoperability among the twenty-three federate members which resulted in publishing in-excess of 2.6 million HLA object updates and over 60,000 HLA interactions during a four hour scenario vignette.

As a result of capabilities developed and integrated during IEs VIII and IX, USAOTC was asked to participate in the Joint Battlespace Dynamic Deconfliction (JBD2) test event, a DOTE Joint Test and Evaluation Methodology (JTEM) sponsored event that included 15 different Air Force, Army, Navy, Marine nodes to create a distributed live, virtual, and constructive (LVC) joint mission environment for testing. OTC was the only DoD operational testing agency (OTA) participating. OTC at Fort Hood was connected to other test centers and sites via a Secure-Defense Research and Engineering Network (S-DREN) capability and provided fire support simulation and integration expertise, live test participant integration, and battle command system emulation. Lessons learned by OTC, during the planning and conduct of JBD2 provided OTC's technology and network teams data on OTC's own capabilities as well as insights into the challenges of planning and conducting distributed LVC events with joint partners.

3. OASIS INTEGRATION EVENT FOCUS

As part of the evolution of OASIS IEs from just a purely technology focus to a focus on both technology and specific test support objectives, four integration areas of focus – Integration Centers of Gravity – were established with the ultimate goal of demonstrating a seamless network of test support capabilities. The four capabilities areas established as of OASIS IE IX by which OASIS integraion capabilities will be developed and assessed are:

- Live, Virtual, Constructive (LVC) simulation systems
- Data Collection Reduction and Analysis (DCRA) systems
- Tactical systems and networks (Army Battle Command Systems-ABCS, Future Combat Systems (FCS) systems, Global Information Grid (GIG), etc.)
- Test control systems, infrastructure, and networks

Event design – and data collection objectives for the event – were designed to assess the status of the technology enterprise with regards to both vertical integration(ability of like capabilities to integrate; e.g., the ability two different LVC capabilities – a ground combat combat constructive simulation and an ISR virtual simulation to interoperate) and horizontal interoperability (amongst 2 or more different capabilities; i.e., the ability of the LVC federation to interoperate with a family of battle command systems via the tactical network).

4. OASIS INTEGRATION EVENT OBJECTIVES:

A broad set of objectives have been evolved with each OASIS IE; as of OASIS IE IX those objectives are:

- Continue to establish the LVC, distributed, HLA environment in preparation for future test events:
  - (e.g. Warfighter Information Network-Tactical (WIN-T), Distributed Common Ground System-Army (DCGS-A), Unmanned Aerial System – Extended Range/Multi-purpose (UAS ERMP), Armed Reconnaissance Helicopter (ARH), Joint Tactical Radio System (JTRS), Future Combat System (FCS), Aerial Common Sensor (ACS), etc.)
- Ensure all federation members had the appropriate information assurance (IA) authorization (e.g. Authority to Operation (ATO), Certificate of Networthiness (CON), and Memorandum of Agreement (MOA)).
- Continue transition of event focus from technology specific items to also include the other technology centers of gravity.
- Increase scrutiny of providing data for test teams & federation health and welfare.

- Continue to build, insert, and experiment with tools to support ATEC Threat mgr, and ultimately the Threat Commander Concept.
- Continue to foster & develop new partnerships:
  - Threat Systems Management Office (TSMO), Redstone Army Arsenal, AL
  - Night Vision and Electronic Sensors Directorate (NVESD), Ft. Belvoir, VA
  - Nuclear Effects Threat Simulator (NETS) / Directed Energy Threat Environment Simulator (DETES) White Sands Test Center (WSTC), NM
- Explore tools for Communications effects server (CES) (e.g. Role-player Workstation (RPWS))
- Continue to add distributed sites (via Secure-ATEC Test Integrated Network (S-ATIN), Secure-Defense Research and Engineering Network (S-DREN), Satellite Communications (SATCOM) Vans):
  - USA Developmental Test Command (USADTC), Electronic Proving Ground Northwest (EPGNW), Ft. Lewis, WA
  - Research Development Engineering Command (RDECOM), Ft. Belvoir, VA
  - USAOTC, Air Defense Artillery Test Directorate (ADATD), Ft. Bliss, TX
  - USAOTC, Airborne Special Operations Test Directorate (ABNSOTD), Ft. Bragg, NC
  - USAOTC, Transformation Technology Directorate (TTD), West Fort Hood (WFH), TX (Radio Hill, OT-TES)
  - USAOTC, TTD, WFH, TX (ISSS-T)
- Continue to insert new tools/technologies:
  - SATCOM Vans
  - One Semi-Automated Forces (OneSAF) (1st use in JOSIE)(Local & Distributed)
  - Threat Intelligence Electronic Warfare (TIEW) Environment/Threat Battle Command Capability (TBCC)
  - Comprehensive Munitions and Sensor Server (CMS2) (Tactical and Urban Unattended Ground Sensors (T-UGS, U-UGS) Sim in prep for FCS)
  - NETS, DETES (Threat sponsored for FCS)
  - NetScout (Infinistream Console)
  - STARSHIP and Digital Collection, Analysis, and Review Systems (DCARS) (distributed)
  - Multiple sets of “live” players (local & distributed)
- Continue to update interoperability vignettes with new tools and technologies.

5. OASIS IE FEDERATION TOOLS / MEMBERS

Twenty-three federation members participated in IE IX. They are listed in Figure 1 below along with a brief annotation of the roles they played. Colors correspond to the four capabilities integration centers of gravity they represented . A number are listed multiple times as they support multiple centers of gravity.

- Janus – Sim/Stim Driver
- OneSAF – Sim/Stim Driver
- JCATS (Future) -Sim Driver
- ExCIS-FSA – Fires & Effects
- STORM – Blue SA
- OT-TES – RTCA, Live Players
- IMASE-ISSS (F & T) - ISR
- MOSS – Virtual IR
- *Video / Streaming Video
- *TIEW – Threat EW
- *NETS – Nuclear Effects
- *DETES – Directed E Effects

- *CMS2 – TUGS Sensor
- SATCOM Vans - Commo
- STARSHIP
- DCARS
- IFDCs
- *NetScout-Infinistream Console
- Tactical Systems (CPOF, ASAS, AFATDS, FBCB2, etc)
- STARSHIP
- MATREX
- *NetScout-Infinistream Console

Centers of Gravity
LVC Systems
DCRA Systems

Technology Enterprise Tasks
Create the Operational Environment
Enable DCRA

Pedigrees

Figure 1, OASIS Federation Tools / Members

6. FEDERATION DISTRIBUTED LOCATIONS.

Figure 2 below depicts the eight geographically disperse locations utilized for IE VIII & IX. Each creating and/or supporting portions of the representative environment mentioned earlier in the paper. The Ft. Hood locations provided test control and infrastructure, LVC simulations, DCRA, and tactical systems. EPGNW provided, Ft. Lewis, WA provided live and constructive simulations and DCRA capabilities. ADATD, Ft. Bliss, TX, provided Live Instrumented players and the Satellite Communications capability. During OASIS IE VIII, IEWTD, Ft. Huachuca, AZ, provided the constructive player (blue-friendly). ABNSOTD provided video feed information. RDECOM, MATREX, Ft. Belvoir, VA, provided Constructive simulation (OneSAF) play. The event was conducted at the classified secret level with communications being conducted over the S-ATIN (DREN) and Satellite Communications Vans.

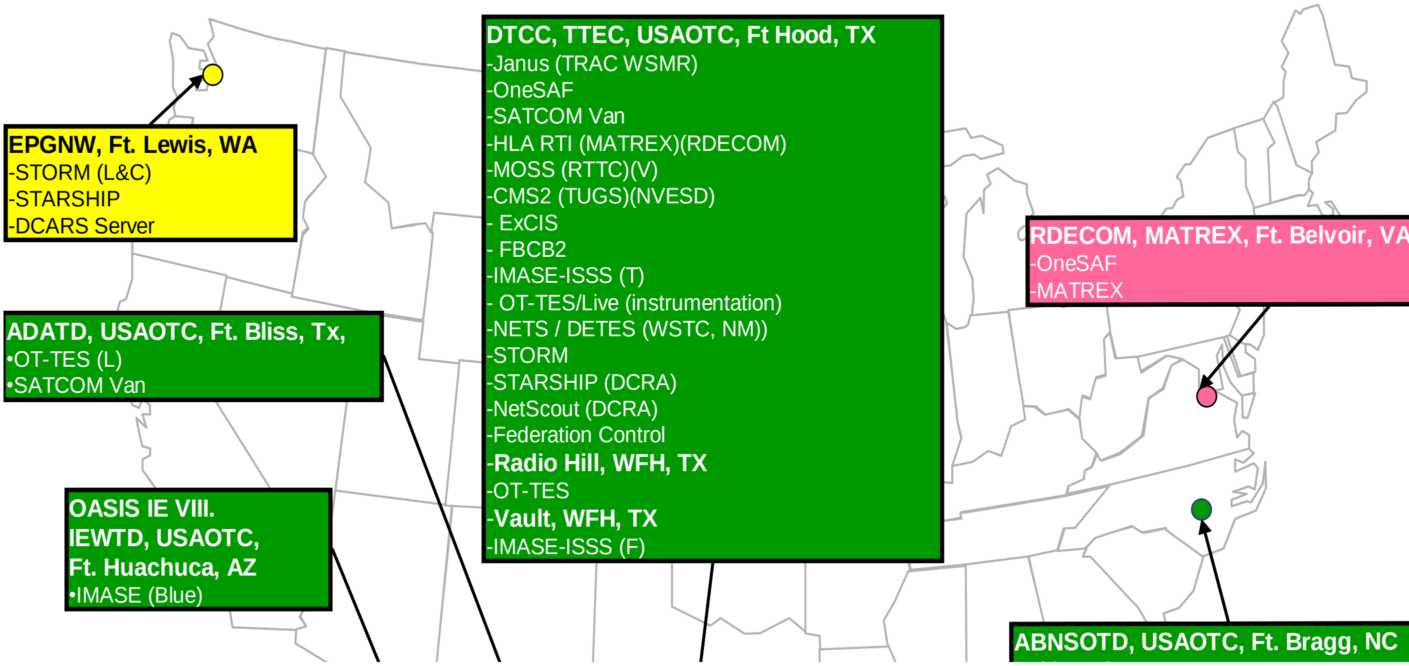

Figure 2. Distributed Locations

7. FEDERATION NETWORK ARCHITECTURE

The federation network architecture shown in Figure 3 below, depicts integration event networks, communications security tools, locations, federation tools and members, and federation centers of gravity.

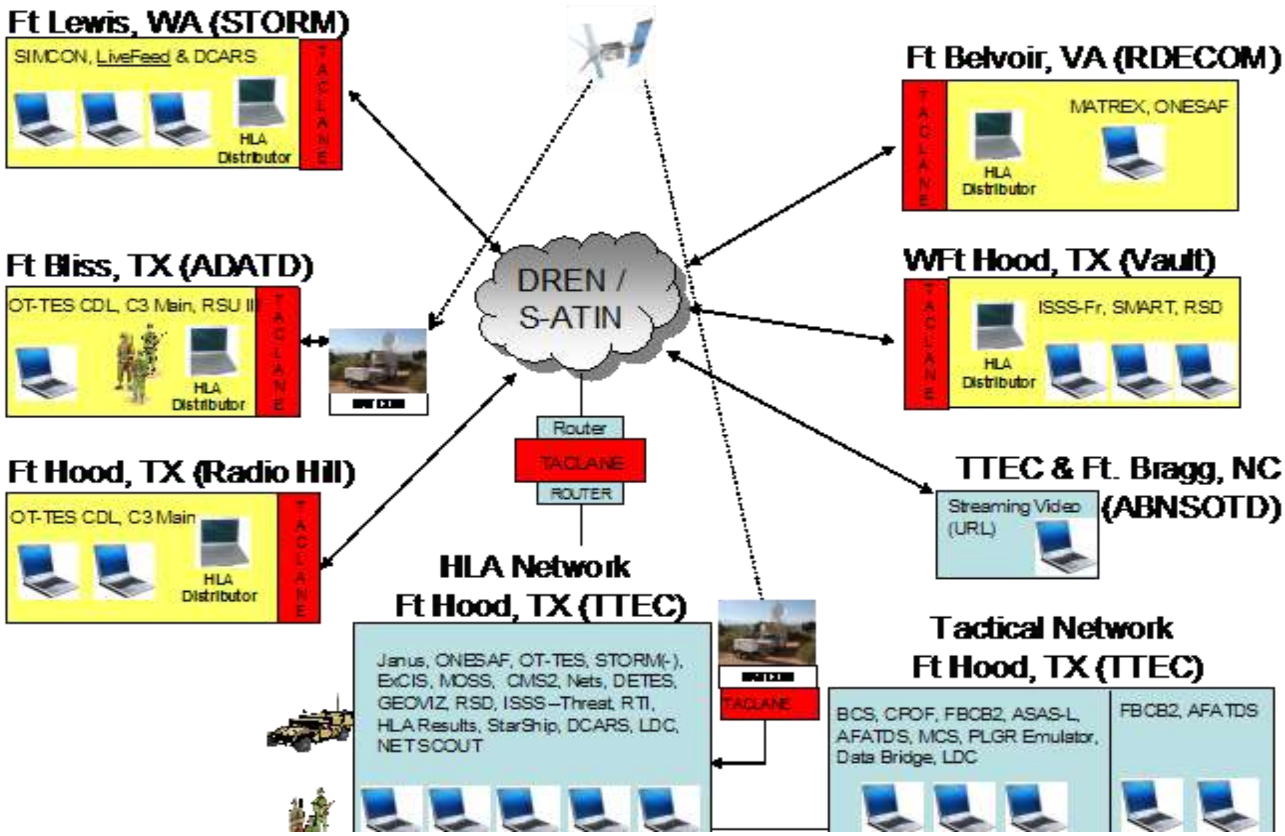

Figure 3, Network Architecture

8. INTEGRATION EVENTS AS PROOF OF CONCEPT EVENTS

As “prove outs,” or a litmus test of capabilities, numerous Interoperability Vignettes were designed and conducted. Their purpose was to explore, scrutinize and prove the seamless integration amongst live, virtual and constructive simulation systems and of those LVC capabilities with tactical systems and networks, DCRA systems, and test control systems and networks - the OASIS centers of gravity. Due to the complexity and numerous vignette moving parts and variables, Department of Defense Architecture Framework (DoDAF) charts were utilized as planning and configuration management tools. Specifically, a System View 10c (SV-10c) proved very helpful. Two interoperability vignettes were demonstrated at the IE VIII & IX events and the third (JDB2) at a joint test event. They are further described below.

Figure 4, Interoperability Vignette 1, Virtual & Constructive on Live

Interoperability Vignette #1. Full and seamless *live, virtual and constructive* exchange. (See Figure 4) *Virtual & constructive* detect *live* vehicles and *live* personnel, engaged and attrited in the *constructive*, attrition reflected on the *live*. A live insurgent high value individual (HVI) and his security force were reported leaving a safe house and believed to be headed to a meeting at a second safe house. 2nd safe house was under surveillance by live friendly (reaction force) and a virtual unmanned aerial system (UAS) with an infrared sensor package (scene generator). The HVI insurgent, insurgent security force, and reaction force were all instrumented with "real time casualty assessment" (RTCA) and were also depicted within the constructive simulation.

The live insurgent OT-TES personnel and vehicles, depicted in the constructive simulation, were detected by both the virtual and constructive UAS and also the Janus scout vehicle (as part of the friendly reaction force). The CMS2, portraying a U-UGS also detected the insurgent vehicle movement within the constructive simulation. The UAS, U-UGS and scout vehicle then nominated the insurgents through the lower tactical internet system (STORM), to the fire and effects structure. The targets were then engaged by AFATDS and ExCIS-FSA, attrited in the constructive simulation, and the engagement reflected on the "live" OT-TES personnel and vehicles by buzzing, flashing lights, and incapacitation of radios and weapons. Engagement and Battle Damage Assessment (BDA) were depicted and viewed real-time by the MOSS Infrared (IR) sensor (at the Ft. Hood, TX Transformation Technology Execution Complex (TTEC)) attached to an IMASE Unmanned Aerial System (UAS) (being flown distributed from IEWTD, Ft. Huachuca, AZ) which overflew the constructive engagement area. Data was collected, reduced and reviewed.

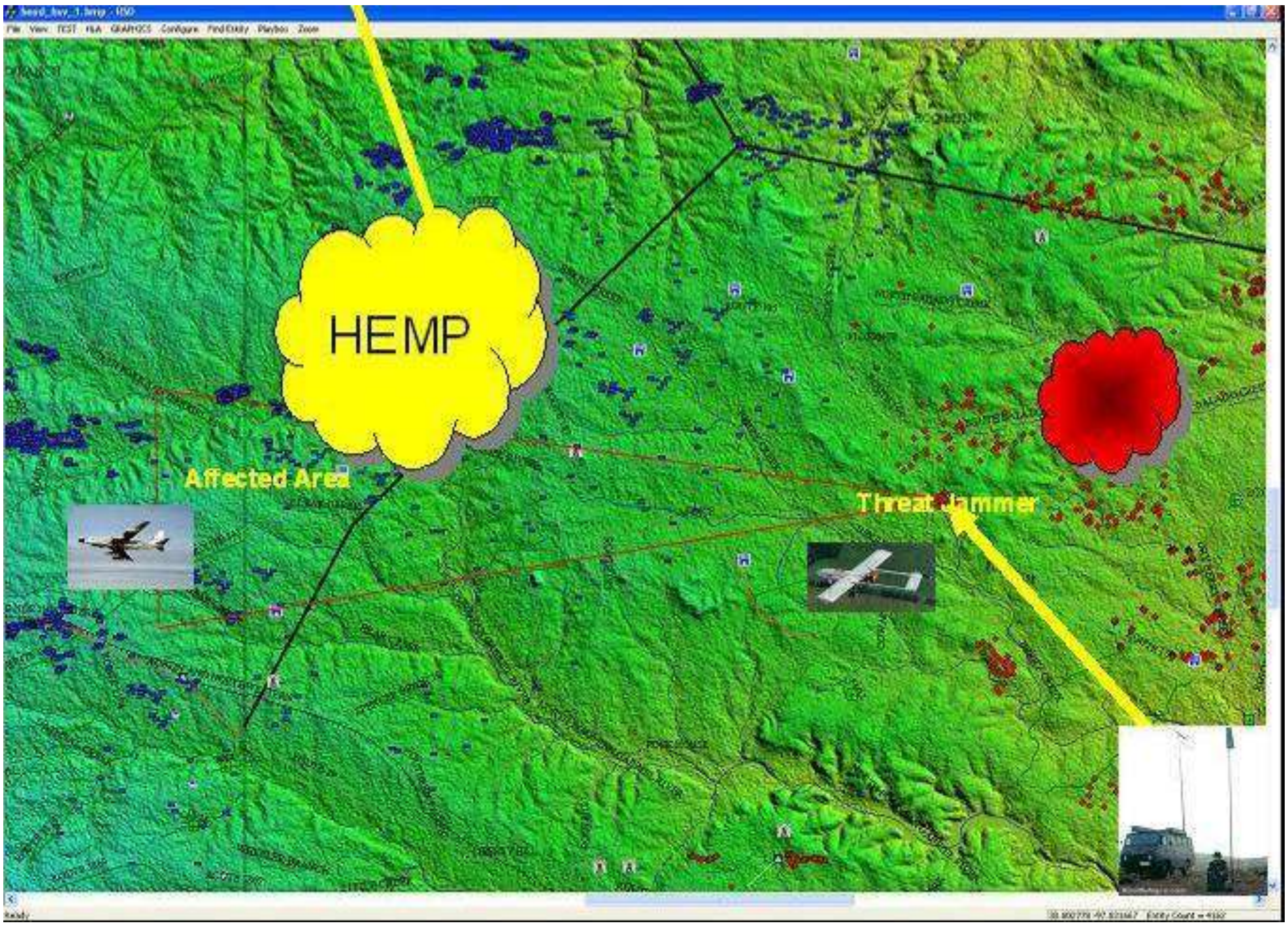

Figure 5, Interoperability Vignette #2, Virtual & Constructive on Constructive

Interoperability Vignette #2, Constructive electronic warfare (EW) jammer detected by virtual UAS and engaged and attrited by constructive fire and effects" (See Figure 5). Interoperability vignette #2 was the initial proof of concept to ultimately portraying threat on blue jamming within the federation. The Threat Systems Management Office turned on the threat jammer using its TBCC. The threat jammer's general location within the federation (Ft. Hood, TX TTEC) was detected and determined by an ISR sensor (flown at IEWTD, Ft. Huachuca, AZ) and the location was refined by the virtual UAS (flown at Ft. Huachuca, AZ) with the MOSS IR scene generator (TTEC, Ft. Hood, TX). A call for fire message was generated against the threat jammer based upon the UAS determined location through the lower tactical internet (STORM), to the fire and effects structure, engaged by AFATDS and ExCIS-FSA, attrited in the simulation, and the engagement reflected within the constructive. MOSS equipped UAS sensor was flown similar to Interoperability Vignette one (above) to conduct BDA. As the threat jammer was engaged and destroyed by blue fire and effects (AFATD and ExCIS-FSA), the threat force launched a high-altitude electromagnetic pulse (HEMP) weapon onto the blue. As the HEMP was employed, DETES tracked the results to ensure blue forces within the federation were appropriately affected, and they were. The effects were depicted visually and textually within the federation members and DETES. Next a rogue insurgency group, in an attempt to escalate the on-going conflict, launched a nuclear weapon onto the threat forces. This detonation was portrayed within the federation and monitored by NETS to ensure the detonation appropriately affected entities within the federation, and they were. The effects were depicted visually and textually within the federation members and NETS.

Joint Battlespace Dynamic Deconfliction (JBD2) Test Event. The JBD2 test event was designed to meet the overall objectives of its three primary sponsors.

-Director Operational Test and Evaluation (DOTE) Joint Test and Evaluation (JTEM) Joint T&E Project: JTEM's goals was to validate its recently-developed methods and processes for testing in a distributed Joint LVC venture.
-OSD (AT&L) Joint Mission Environment Test Capability (JMETC): JMETC's goal was to further mature its baseline infrastructure for supporting system-of-system distributes testing across the Services.
-Army's Future Combat Systems (FCS) Combined Test Organization (CTO). FCS-CTO's goal was to assess the test network, technologies, and distributed environment to be used in future tests for FCS milestone decisions.

In addition to these three sponsors, JBD2 brought together many on-going efforts – from Army and Joint service partners – to advance DoD's vision of employing a fully integrated live, virtual, and constructive test environment. The test scenario focused on seven (7) mission threads representing different combinations of Service warfighting assets (aircraft, unmanned aerial systems, and artillery systems) to execute the Joint Fires and Joint Close Air Support (JCAS) missions. The Operational View-1 (OV-1) Joint operational context to support the execution of Joint fires and JCAS missions is portrayed in Figure 6. The chart portrays the participants' specific contribution to the LVC environment to support the Joint mission threads.

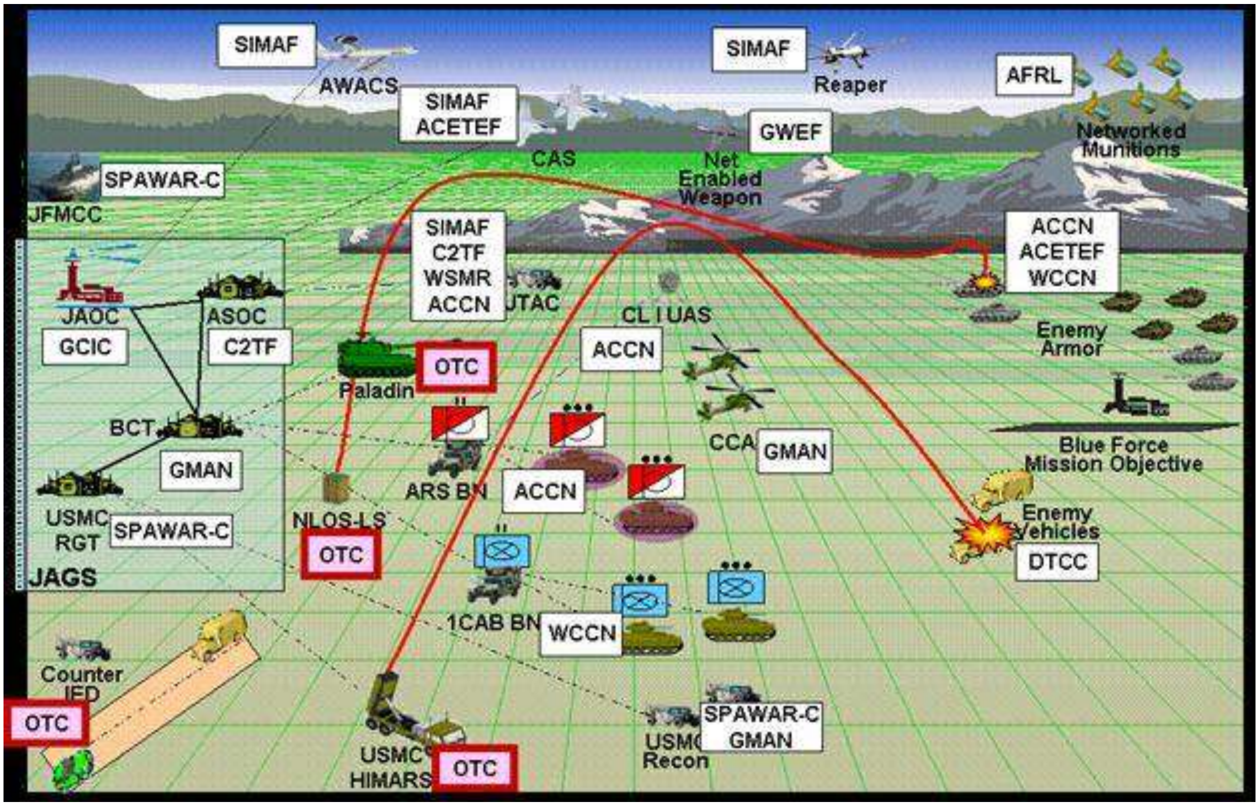

Figure 6, JDB2 Test Scenario & Mission Threads

USAOTC JBD2 goals. USAOTC had four primary goals in participating in JBD2. First we wanted to ensure that critical OTC instrumentation and M&S capabilities were fully integrated into the FCS/CTO distributed LVC federation. Secondly, we wanted to increase OTC technical integration capability. We sought to do this in several areas:

- Establish a JMETC secret defense research engineering network (SDREN) node at USAOTC Fort Hood, TX;
- Gain experience in using the FCS-Combined Test Organization (CTO) OneSAF MATREX FOM in a distributed LVC architecture;
- Reestablish an updated TENA gateway to access distributed Joint test assets.

Third, We also wanted to increase our understanding of DOTE JTEM Joint System-of-System T&E methods by collaborating with AF, Navy, and Marines test organizations in Joint Fires and JCAS mission threads. Our fourth goal was to demonstrate progress toward LVC Jointness while advertising USAOTC capabilities to a wider DoD audience.

USAOTC LVC Technology Contributions to JBD2. USAOTC provided several capabilities in support of JBD2

-*Extensible C4I Instrumentation System (ExCIS)* simulated Non-Line of Sight (NLOS) and other indirect fire systems

-*Operational Test – Tactical Engagement System (OT-TES)*, a real time casualty assessment (RTCA) system was used to replicate terrorist organizations, convoys, and improvised explosive devices (IEDs) operating in the scenario area
-*Role Player Work Station (RPWS)* replicated calls for fire and other battle command traffic on the tactical network
-*One Semi-Automated Forces (OneSAF)* was used as the ground combat simulation.
Of these, the two unique capabilities brought to JBD2 by USAOTC, ExCIS and OT-TES.

9. INTEGRATION SUCCESSES

Each OASIS IE has yielded a number of lessons learned – they are considered successful when those lessons learned are inculcated in improvements to the technology and the methods by which those technologies are employed. Notable amongst OTC's OASIS IE successes are

- Establishment of TTEC's Distributed Test Control Center (DTCC). First opportunity to use the TTEC's newly installed DTCC. In addition to standard DTCC capabilities, it allowed briefees to view JOSIE federate screens and Army Battle Command System (ABCS) Command and Control (C2) screens and scenario events on the enlarged DTCC screens rather than attempt to view on actual screens.
- Migration of capabilities to Native HLA. All federation member systems were native HLA. Meaning no "gateways" or "translators." TTEC tactical operations center (TOC) connected to a "Live" Force XXI Battle Command Brigade and Below (FBCB2) vehicle. This allowed live OT-TES vehicles
- Tactical systems interoperability enability the unit to "see" constructive threats via the FBCB2 system.
- Full integration of Instrumentation capabilities. Although individual JOSIE members have utilized instrumentation for many years, IE V was the first opportunity for the OASIS federation to use Instrumentation to collect data into/out of the TOC and into/out of the "Live" FBCB2 Vehicle.

10. TEST TECHNOLOGY EMPLOYMENT LESSONS LEARNED:

In addition to LVC capabilities demonstrated and successes realized, there were also numerous lessons learned. The following paragraphs provide information on the salient lessons learned while conducting a distributed HLA event.

Information Assurance (IA). Information assurance, by far, was the largest challenge in lashing up the federation within the MATREX high level architecture. Based upon recent IA regulation announcement, all software and hardware must meet new and more stringent requirements in order to receive a DOD Information Assurance Certification and Accreditation Process (DIACAP) certification and/or a Certificate of Networthiness (CON), prior to connection (closed network). If operating distributed, a Memorandum of Agreement (MOA) is required by the owning Designated Authorization Authority (DAA), a General Officer or Senior Executive

Service (SES) civilian, prior to connectivity (open network). As a result much work was expended to ensure the federation operated within IA guidelines.

Distributed HLA. Although HLA had been used locally for numerous OASIS Integration Events, conducting a distributed event produced a number of new challenges to include the RID and the HLA Run Time Infrastructure (RTI). Specifically, the federation techniques, tactics and procedures (TTP) now dictate setting up the RID file prior to the event. E.g. Systems with dual NIC cards must change the ENDPOINT parameter in the RID file to match the IP address of the RTI.

Configuration Management. Configuration management is essential in managing critical federation settings to include: RTI, FOM, and RID files. STARSHIP provided an excellent tool for identifying federation standard discrepancies.

Communications/Collaboration. Voice Over Internet Protocol (VOIP) phones. Continuous communications is needed at all distributed OASIS IE events to ensure enhanced coordination for network and distributed connectivity.

Data Collection. An obvious requirement was data collection, as a key output of any operational testing event. Data was collected using RICS2, DCARS, STARSHIP and NetScout.

Jointness is Important (borrowed liberally from John Diem, USAOTC and Dr. Rick Kass, GaN Corporation, 2009 ITEA LVC Conference Paper, *United States Army Operational Test Command (USAOTC) and the Joint Battlespace Dynamic Deconfliction (JBD2) Test Event –A Look into the Future.*). Number one on is the list of lessons learned from JBD2 was that the eventprovided an excellent training and team building venue for working test-issues with Air Force, Marines, Navy and fellow Army test agencies. Some specific examples include:

- The JMETC team provided great support to get us into the JBD2 federation. JMETC worked with us on a very tight schedule to establish SDREN node connection at OTC Fort Hood. When it was decided that we need IA certification to use their TENA gateway on our network, Joint Mission Environments Test Capability (JMETC) developed the information to satisfy the Army's IA "networthiness certificate."
- In addition JMETC representatives worked closely with us to get our live entities (OT-TES) and fire-support entities (ExCIS) enumerations into TENA gateway library. Then several distributed Army and a Navy sites stayed late at night during one of the final spirals to test our fire support detonations enumerations across TENA federation Jeff at GMAN.
- The Marine Corps site at SPAWAR Charleston and Army site at Redstone Arsenal continually worked with us so we could continue to adjust our ExCIS simulation to changes in their AFATDS configurations to ensure fire support connectivity with Marine and all Army sites.
- Several Air Force and Naval air worked many hours with us to help us master the air-support request (ASR) 9-line to get JCAS ordnance delivered on our live IED event during test scenario execution.

<u>Importance of Integration Spirals</u>. We also learned that it takes time and multiple integration spirals to prepare for a joint-mission environment test especially when integrating over 40 unique LVC applications and systems at 16 distributed sites in 4 time zones. Towards the end of the technical spirals we did accomplished technical integration. However, we needed more time for operational integration, especially since we were attempting new Joint Fires and JCAS procedures for this test that had not yet been attempted in actual operations.

<u>Differing Time-Zone Challenges</u>. Finally, and only partially in jest, we found it was a lot easier to participate in a large distributed event when you are in the same time zone as the event director. Those East or West-coast test sites had to adjust their daily start and stop times. This is not always easy to do when support contractors are involved.

11. TAKE AWAYS & WAY AHEAD

At the end of OASIS IE IX we asked each attendee to carry back to their organization these key points ("Take Aways"):.

1. OASIS is Relevant and Ready: OASIS and TTEC capabilities are robust and mature with full integration of:
   - LVC
   - Robust DCRA
   - Event Visualization
2. Partnerships are essential:
   - Users: 3CE (RDECOM-PM MATREX, FCS, ATEC, TRADOC)
   - Developers : PEO-STRI (PM-ITTS, PM CONSIM, PM TRADE)
   - Neighbors: III Corps & Ft. Hood, USA Intelligence Center & Fort Huachuca, AZ.
3. Geographic and interoperability flexibility is key: Distributed operations and multiple protocols are facts not assumptions about future test events
4. OTC has an expanding event horizon: WIN-T, JBD2, DCGS-A, ERMP, ARH, One Tactical Engagement Simulations System (One-TESS)
5. Our way forward includes:.
   - New Partners: FCS Simulation Environment (FSE) Topographic Engineering Center (TEC), TSMO, Army Capabilities Integration Center (ARCIC)
   - Additional distributed locations and connectivity:PM-MATREX, EPG-Lewis, Redstone Technical Test Center (RTTC), FSTD-Ft. Sill, ADATD-Ft. Bliss/WSMR, ABNSOTD-Ft. Bragg, SDREN, Information Operations Range (IOR)

Additional Protocols and Capabilities: JCATS, OneSAF, TENA, DIS / PDU gateway, InterTEC, JLCCTC ERF, BLCSE

6. Increased focus on Functional Centers of Gravity: Increased DCRA and Visualization, Communications Effects Server (CES), ISR
7. Increased focus on ability to replicated an asynchronous, contemporary operational environment

12. CONCLUSION.

Overall, OASIS integration events have been very successful. The IEs have clearly demonstrated a number of successes for USAOTC technology centers of gravity and its numerous federation partners. Foremost among them was the creation of a representative test environment which included the seamless integration of live and constructive and virtual within a robust and high granularity environment. This was enabled by the capability provided by PM MATREX HLA and their responsive workforce. The OASIS Integration Events proved clearly and conclusively that high granularity LVC simulations from multiple organizations can be linked together in a federation (local and distributed) to provide the requisite environment required for operational testing. Additionally, this federation can also be utilized in whole, or piece parts, location immaterial in support of training and experimentation events.

Perhaps the greatest success of the OASIS IEs is that they have help inform and define OTC's technology acquisition process immeasurably. Based on these lessons learned, OTC has now established specific focus to provide resources and technology support to the integration of capabilities – not just the acquisition of specific capabilities. OTC has also established, with PEO STRI PM ITTS, a Program of Record – OASIS Enterprise Integration Systems – to acquire – preferably as GOTS and COTS – the tools needed to develop, integrate, and operate a distributed test support technology enterprise. The OASIS IEs have demonstrated the power of the spiral acquisition process – and will continue to do so as the OASIS Integration Events transition from proof of principle and proof of concept events to major annual pacing events in the life-cycle of all OTC test support technology.

Acronym List

ABCS	Army Battle Command System
ABNSOTD	Airborne Special Operations Test Directorate
ACS	Aerial Common Sensor
ADATD	Air Defense Artillery Test Directorate
AFATDS	Army Field Artillery Target Data System
API	Application Programming Interface
ARH	Armed Reconnaissance Helicopter
ASR	Air Support Request
ATC	Advanced Testing Capability
ATO	Authorization To Operate
BDA	Battle Damage Assessment
C2	Command and Control
CAT:UT	Center for Agile Technologies: University of Texas
CFF	Call For Fire
CDL	Common Data Link
CERDEC	Communications Electronic Research Development Command
CES	Communications Effects Server
CMS2	Comprehensive Munitions and Sensor Server
CON	Certificate Of Networthiness
COP	Common Operating Picture
CTO	Combined Test Organization (FCS)
DAA	Designated Authorization Authority
DCARS	Digital Collection, Analysis and Review Systems
DCGS-A	Distributed Common Ground System - Army
DCRA	Data Collection, Reduction and Analysis
DETES	Directed Energy Threat Environment Simulator
DIS	Distributed Interactive Simulation
DoD	Department of Defense
DODAF	Department of Defense Architecture Framework
DOTE	Director Operational Test & Evaluation
DREN	Defense Research and Engineering Network
DTC	Developmental Test Command
DTCC	Distributed Test Control Center
EPG	Electronic Proving Ground
EPGNW	Electronic Proving Ground North West (Ft. Lewis, WA)
ExCIS-FSA	Extensible C3I Instrumentation Suite – Fire Support Application
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat System
FEDEP	FEderation DEvelopment and Execution Process
FOM	Federation Object Model
FSE	FCS Simulation Environment
HEMP	High altitude Electro Magnetic Pulse
HLA	High Level Architecture

HVI	High Value Individual
IE	Integration Event
IED	Improvised Explosive Device
IEWTD	Intelligence Electronic Warfare Test Directorate
IMASE	Intelligence Modeling and Simulation for Evaluation
IOR	Information Operations Range
ISR	Intelligence, Surveillance, and Reconnaissance
ISSS	IMASE-Simulation & Scoring Subsystem
ISSS-T	IMASE-Simulation & Scoring Subsystem (Threat)
Janus	-Not an acronym
JBD2	Joint Battlespace Dynamic Deconfliction
JCAS	Joint Close Air Support
JMETC	Joint Mission Environment Test Capability
JOSIE	-Not an acronym, a brand name
JTEM	Joint Test and Evaluation Methodology
JTRS	Joint Tactical Radio System
LDC	Local Area Network Data Collector
LVC	Live, Virtual, and Constructive
M&S	Modeling and Simulation
MS&I	Modeling, Simulation and Instrumentation
MATREX	Modeling Architecture for Technology, Research, and EXperimentation
MOA	Memorandum of Agreement
MOSS	Multi-spectral Optical Sensor System
NETS	Nuclear Effects Threat Simulator
NVESD	Night Vision Electronic Sensors Directorate
OASIS	Operational Test Command Advanced Simulation and Instrumentation Systems
OneSAF	One Semi Automated Forces
OneTESS	One Tactical Engagement Simulation System
OPFOR	Opposing Force
OTA	Operational Testing Agency
OT-TES	Operational Test Tactical Engagement System
OV	Operational View
PDU	Protocol Data Units
PEO-STRI	Program Executive Office – Simulation, Training, and Instrumentation
PM	Program Manager
PM-ITTS	Program Manager - Instrumentation, Targets and Threat Simulators
RDECOM	Research and Development Command
RSD	Real-time Situation Display
RTI	Run-time Interface
RTTC	Redstone Technical Test Center
RTCA	Real Time Casualty Assessment
SA	Situation Awareness
SAF	Semi-automated Forces
SATCOM	Satellite Communications
S-ATIN	Secure-ATEC Integration Network

SDD	System Design Description
SES	Senior Executive Service
SISO	Simulation Interoperability Standards Organization
SNE	Synthetic Natural Environment
STORM	Simulation Testing Operations Rehearsal Model
TBCC	Threat Battle Command Capability
TEC	Topographic Engineering Center
TENA	Test and Training Enabling Architecture
TIEW	Threat Intelligence Electronic Warfare
TOC	Tactical Operations Center
TRADOC	Training and Doctrine Command
TSMO	Threat Systems Management Office
TTD	Transformation Technology Directorate
TTEC	Transformation Technology Execution Complex
TTP	Techniques, Tactics and Procedures
T-UGS	Tactical – Unattended Ground Sensors
UAS-ERMP	Unmanned Aerial Systems – Extended Range / Multi-purpose
USADTC	US Army Developmental Test Command
USAOTC	US Army Operational Test Command
USATEC	US Army Test and Evaluation Command
U-UGS	Urban-Unattended Ground Sensors
VOIP	Voice Over Internet Protocol
WDC	Wide Area Network Data Collection
WFH	West Fort Hood
WIN-T	Warfighter Information Network – Tactical
3CE	Cross Command Collaborative Effort

Biographies

John W. Diem is currently Chief of the Simulation and Integration Division, Transformation Technology Directorate, USATEC/USAOTC. He has been a user, developer and integrator of simulations in support of battle command and intelligence systems testing and training for over 25 years. He is a former Military Intelligence Officer, is a founding member of the Army's Simulation – C4I Integration (SIMCI) process team, and was a developer of the Army's Digital Training Strategy. He holds Master of Science and Bachelor of Arts degrees from Texas A&M University, College Station, TX.

Lori A. Butler is currently the OASIS-JOSIE Integration Engineer for USATEC, USAOTC, Transformation Technology Directorate, Fort Hood, TX. She is an Operations Research Systems Analyst (ORSA) and has extensive test and evaluation and software development expertise while performing duties as the IMASE-ISSS software development lead. She holds a Master of Science in Information Technology from Tarleton State University and Bachelor of Science Degree in Science Education from the University of Delaware.

Jimmie S. Smith is currently the OTC Analytic Simulation Instrumentation Suite (OASIS) Integration Manager for the USATEC, USAOTC, Transformation Technology Directorate (TTD), Fort Hood, TX. He has provided manager oversight to an number of large and pervasive technology integration events. He has extensive program management experience and M&S experience in the areas of ISR testing and ISR training. He is a former Infantry and Military Intelligence Officer. He holds a Master of Business Administration from Golden Gate University, San Francisco, CA, and a Bachelor of Applied Resources from Troy State University, Troy, AL.