USAF Distributed Mission Operations (DMO) 2005 NATO M&S Group Conference

Grover Lollar
HQ USAF/XOOTE (Anteon)
1480 Air Force Pentagon
Washington, DC 20330-1480
703-864-0708

grover.lollar@pentagon.af.mil

Orris Hambleton
HQ USAF/XOOTE (SeiCorp, Inc)
1480 Air Force Pentagon
Washington, DC 20330-1480
703-697-9470

orris.hambleton@pentagon.af.mil

ABSTRACT

Contemporary military leaders are faced with numerous obstacles to effective training. This paper examines critical aspects of the U.S. Air Force response to these challenges through its user-directed acquisition and development of a Distributed Mission Operations (DMO) system of systems. The DMO vision is to provide warfighters routine in-garrison access to multiple, simultaneous, and large/small training or mission rehearsal events within a true joint force environment while avoiding the traditional expense and disruption of having to assemble assigned units and opposing forces for training at a common and observable physical location. This paper details the primary components of the DMO system linking real-time, high fidelity live, virtual, and constructive (LVC) simulators and simulations with the real-world mission planning, command and control (C2) and intelligence systems and products needed when units train the entire mission process (Plan-Brief-Employ-Debrief) and as part of larger Joint Task Force (JTF) training and mission rehearsal events. This paper further examines the key methods being used to implement the DMO vision as the air and space elements of the larger Joint National Training Capabilities (JNTC) network of training systems linking live, virtual, and constructive (LVC) air/space components and entities in a common joint synthetic battle space. The primary objective underpinning DMO is enabling warfighters to train as they would expect to fight, maximizing the combat realism available in modern visually immersive simulators that cannot be replicated in expensive traditional live training. It is being established to meet the full range of Air Force Aerospace Expeditionary Force (AEF) and Home Land Defense (HLD) operational training and mission rehearsal needs from tactical-level individual, team, and inter-team training to participation in operational and strategic-level joint command and control events. DMO system capabilities are evolving to meet both joint and air commander's mandates to train and assess mission essential competencies for JTF and other real-world missions offering distributed AEF units routine opportunities to practice high-end cooperative combat skills, within highly realistic constructive threat/natural environments, with a variety of Air Force, joint and coalition forces. Key findings highlight the need for (1) a professional control force to perform scheduling functions, develop scenarios, and conduct systems-based training; (2) the advantages of user-directed development to evaluate, prioritize, invent and evolve legacy training systems and integration solutions in the field; (3) and the call for industry solutions to improve system efficiencies, tools and common/interoperable data sources.

Key Words: Training, Operations, Acquisition, Distributed, Simulation, LVC, AEF, JNTC

Lollar, G.; Hambleton, O. (2005) USAF Distributed Mission Operations (DMO) 2005 NATO M&S Group Conference. In *The Effectiveness of Modelling and Simulation – From Anecdotal to Substantive Evidence* (pp. 7-1 – 7-16). Meeting Proceedings RTO-MP-MSG-035, Paper 7. Neuilly-sur-Seine, France: RTO. Available from: http://www.rto.nato.int/abstracts.asp.

1. INTRODUCTION

The ability of Air Force warfighters to achieve training and mission rehearsal objectives is being established through the Distributed Mission Operations (DMO) program. As a readiness program for contemporary military operations, the objectives identified in the USAF DMO Concept of Operations (CONOPS) [1] are to "train warfighters as they expect to fight; maintain combat readiness at home or deployed; conduct mission rehearsal in an environment as operationally realistic as necessary; and provide support to operations" using real-world operational systems, advanced mission simulators, and constructive simulations to form a networked and distributed synthetic battlefield. The arrival of the twenty-first century has witnessed remarkable transformations in military power with technology complicating the traditional concept of the battlefield. One transformation has been in the use of advanced technology weapons and world-wide media coverage creating the expectation that military operations should achieve rapid results without collateral damage. No military operation is conducted without considering how tactical-level activity impacts the attainment of policy goals. As a result, the targets, tactics and procedures used in combat are often directly shaped by national or coalition policies, a complexity most current Air Force training programs are not designed to address.

Digital technologies have revolutionized nearly all combat and combat support weapons systems. The distinction between information and action has been blurred by the pervasive use of multi-spectral sensors and weapons. The battlefield is a real place but so is the modern "battlespace," the digital battlefield where military power in the continuum from space to sub-surface is applied to a diverse range of missions, all of which may affect the success or failure of military operations. Increasingly, composite forces of integrated teams are used to execute these missions. The application of technology to combat, however, has not simplified the warfighters' tasks but created the need to develop and perfect a highly complex set of skills and cognitive acumen across the joint training continuum.

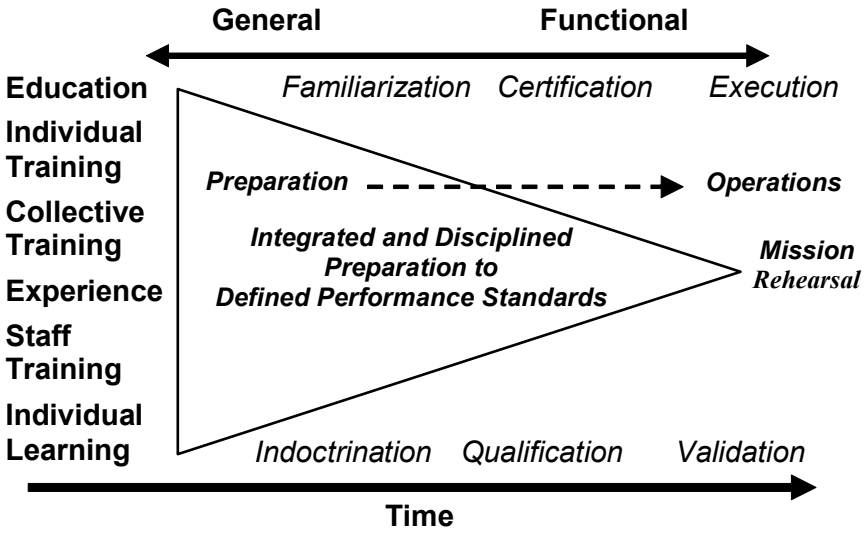

Figure 1-1: Joint Training Continuum Training Capabilities AoA [2].

This paper examines how the Air Force DMO program is harvesting a multitude of advanced development efforts underway throughout the Department of Defense and industry to craft a simulation-based, integrated

system-of-systems for full-spectrum distributed joint training and mission rehearsal in the air and space domain. Section 2 discusses how the realism of virtual mission simulators equipped with advanced visualization systems and integrated with interactive constructive simulations transforms the operational battlefield joint training environment while Section 3 further outlines the DMO program's capabilities and objectives. In Section 4, the paper highlights how the major DMO domains and tasks are used to prepare combat and combat support teams for complex, contemporary military operations supporting Aerospace Expeditionary Force (AEF) rotational tasking and Homeland Defense (HLD) missions. Sections 5 and 6 cover key acquisition and development processes and security issues while Section 7 addresses lessons learned and their implications on the DMO training structure and processes, the prioritization of resources, and some potential impacts on industry as an integrated partner for achieving Air Force DMO system capabilities and practices. This paper was written for presentation to the 2005 NATO Modeling and Simulation Group Conference. It was also presented at the 2005 European Simulation Interoperability Workshop Conference under the title, *USAF Distributed Mission Operations (DMO): Aerospace Expeditionary Forces Training, Mission Rehearsal and Joint National Training Capability (JNTC).*

2. TRAINING TRANSFORMATION

Transforming Air Force readiness through DMO is an ambitious enterprise supporting the "larger interoperability end state where service and joint integrated live, virtual and constructive (LVC) training systems are routinely inter-connected to support joint training and mission rehearsal events" as stated in the DoD Training Transformation Implementation Plan [3]. As such, DMO provides the key air and space domain elements for the creation of a cohesive Joint National Training Capability (JNTC) to prepare for military operations that increasingly require multiple warfighting teams to concurrently employ complex weapons systems on complex missions as part of a complex mix of forces. The original Operational Requirements Document for Distributed Mission Training published in 1997 [4] identified key shortfalls in the ability of aircrews to safely and affordably train the way they will be required to fight using traditional Air Force live and stand-alone virtual systems:

- Safety considerations
- Mission complexity
- Airspace and range restrictions
- Real-world commitments and costs

These factors limit the ability of aircrews to effectively train across the spectrum of Air Force core competencies using aircraft sorties. To significantly expand live training opportunities for these missions would require extensive airspace, large ranges, and more composite training opportunities than are available in today's shrinking airspace and range environments. Additionally, traditional exercise deployments exacerbate the heavy operations tempo already plaguing units and individuals operating for extended periods away from home and families. The DMO program is assembling and integrating Systems-of-Systems (SoS) and Families-of-Systems (FoS) to mitigate many of these constraints and transform Air Force and joint training through the convergence of related technologies.

- Advanced constructive simulation technologies: The use of modern constructive simulations is an essential enabling technology providing operational environments virtual systems and integrating them into a common battlespace with other live/virtual systems, information operations, intelligence/ surveillance/ reconnaissance (ISR) imagery, and command and control (C2) systems. The Air Force uses its Air and Space Constructive Environment (ACE) as the constructive back-plane to integrate

DMO and JNTC LVC elements for the air and space domain of the joint battlespace. The ACE SoS/FoS provides air power, ISR imagery, information operations and integration as an approved set of models and simulation environments that simulate and stimulate critical Command and Control collection management systems and provide the Joint Force Air Component Commander (JFACC) with decision quality information.

- Advanced visualization technologies: The rapidly improving visual realism and fidelity of advanced virtual simulators has already provided significant improvement in training combat skills. In certain key aspects related to the accurate depiction of target, threat and natural environments, the training received in DMO mission simulators exceeds the realism and value of a live training mission and HQ Air Combat Command has already adjusted their training regimens accordingly.
- Advanced distribution technologies: The inter-operability of distributed virtual simulators provides opportunities for routine horizontal training including intra-team and inter-team service and joint training, and for vertical training among National Command Authorities, agencies and units involved in HLD operations when connected to applicable command and control systems and nodes. Although a single common standard is desired, for the foreseeable future, the DMO will continue to depend on a variety of new and legacy systems and infrastructures and will need specialized tools to rapidly implement, monitor and support both High Level Architecture (HLA) and Distributed Interactive Simulation (DIS) based systems along with the interfaces that allow them to work together.
- Live range instrumentation and digitization: The instrumentation of air and ground ranges and their integration into the constructive battlespace promises the ability to combine live with virtual and constructive training. This has been successfully demonstrated in Joint Close Air Support events where both live and virtual bombers have supported live troops on an instrumented ground range but the technology and processes required to prove its value in larger training exercises remain largely theoretical.

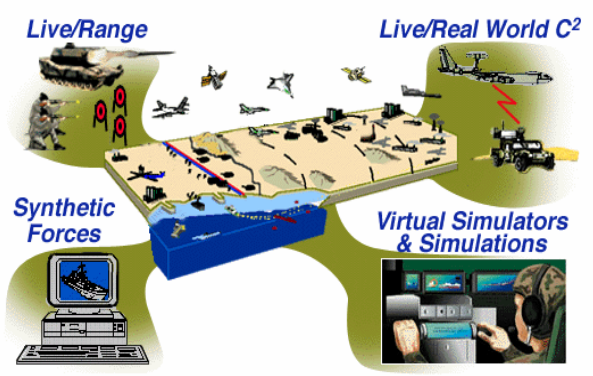

Figure 2-1

Each of the technologies above, along with others being considered, can be combined in numerous scenarios that may significantly expand air force and joint training opportunities available locally to operational units.

DMO may be the only way that warfighters can effectively train to acquire the knowledge and practice the skills necessary to effectively employ complex weapons and weapons systems in a variety of realistic combat environments. Furthermore, the nature of contemporary warfare, both its policy and technical dimensions, is

becoming increasingly complex and the tactical link from sensor to shooter must increasingly be able to pass seamlessly and rapidly through operational-level decision makers. The implementation of DMO must therefore accommodate both horizontal and vertical mission orientation, from both a warfighting doctrine and a technology perspective, and the tactical-operational-tactical decision chain must be part of the range of training environments that are routinely exercised and rehearsed. Many of the LVC technologies needed to integrate and execute DMO exist today and are being refined and evolved to achieve future capabilities as an integral part of DMO and JNTC development. Some will require new solutions and significant additional combined government and industry effort.

3. DMO CAPABILITIES AND OBJECTIVES

The DMO CONOPS objectives are specifically addressed in the USAF DMO Implementation Plan [5] and divided into five major air and space components required to establish AEF and HLD training and mission rehearsal capabilities into DMO:

- Replicate and integrate C2 capabilities, including the Tactical Air Control System
- Replicate and integrate ISR and reconnaissance capabilities
- Replicate and integrate USAF force application capabilities (CounterAir, CounterLand, CounterSea, CounterSpace, Information Ops, and Combat Search & Rescue)
- Replicate and integrate USAF force projection capabilities (Spacelift, Airlift, and Air Refueling)
- Replicate and integrate HLD capabilities

3.1 DMO Capabilities

Addressing the capabilities required in these five components is instrumental in validating, testing, training, and exercising Air Force and joint operational concepts. The DMO environment must therefore accurately replicate air and space operational capabilities within the joint battlespace environment to ensure current and future operational concepts will deliver the right capabilities and produce desired effects in any scale of conflict. The DMO integrated architecture is being carefully crafted to maximize joint warfighting capabilities across all air and space mission areas through two primary capabilities:

- Warfighter Integration (WI) – Allow geographically separated/deployed units and personnel to conduct horizontally and vertically integrated full-spectrum training, mission rehearsal, and operations in a Joint/Coalition force environment against realistic threats.
- Realistic Global Battlespaces (RGB) – Warfighters require on-demand, integrated, immersive environ-ments and operational battlespaces able to accommodate multiple and varying warfighting teams at appropriate levels of detail. Environments must be rapidly generated and tailorable to suit the vast array of potential scenarios requiring rapid database and scenario generation, and battlespace management tools for event planning, briefing, execution, de-briefing and reconstruction operations.

3.2 DMO Objectives

DMO is an innovative process designed to deliver the most cost effective and realistic LVC training possible. It enables the USAF to exercise and train at the tactical and operational levels of war while facilitating unit-level training and can function as a decision support tool for commanders at all levels. DMO has the following training and decision support objectives:

3.2.1 DMO Training Objectives

- Horizontal and Vertical Training – Create flexible, operational environments that will permit warfighters to conduct horizontally and vertically integrated full-spectrum training, mission rehearsal, and exercise theater combat operational plans. Horizontal integration allows training among units/systems operating at the same level (e.g., distributed live/virtual F-15 and JSTARS platforms) while vertical integration allows training among units/systems operating at different levels of C2 (e.g., the production and execution of JFACC Air Task Orders).
- Distributed Combat Environment – Provide war-fighters with immersive, operational environments using appropriate combinations of LVC domains at suitable levels of representation to include the natural environment (e.g. terrestrial and space weather) to accomplish all required levels of training.
- Integrated Command & Control, Communications, Computers, intelligence, surveillance, and reconnaissance (C4ISR) – Integrate C2, ISR, and enabling information technology (IT) systems and environments.
- AEF Pre-Deployment Preparation – Provide spin-up for, and assessment of, deploying forces and Joint Task Force/Coalition operational concepts using expected battlespace scenarios so the fighting force is given invaluable and tailored realistic kill chain experiential training prior to deployment.
- Theater Air Control System (TACS) – Provide a persistent, comprehensive training environment to horizontally and vertically integrate the TACS system of systems with associated service, joint, interagency, and coalition forces to include the Joint/Combined Force Commander. Robust training events and rehearsals conducted in the DMO environment will support established training and evaluation programs including the Air & Space Operations Center (AOC) and JFACC certification process.
- Training Transformation (T2) – Deliver the Air Force component of JNTC.

3.2.2 DMO Decision Support Objectives

- Predictive Battlespace Awareness and Decision Support – Provide warfighters and commanders at all levels with secure, on-demand, integrated, distributed, decision-quality information; realistic combat environments; and the latest predictive battlespace awareness tools, processes, and visualization technologies for after action review, debriefing and course-of-action analysis.
- TACS and JFACC Decision Support and Certification – Provide a comprehensive environment in which the TACS elements, including AOC and JFACC can analyze the execution of a theater war plan and make intelligent, informed decisions on wartime operational concepts and command policies for the development and execution of operational war plans.
- Operational Capability Evaluation – Enable the evaluation of future capabilities prior to and during weapon system development or deployment, and to facilitate the selection or adjustment of operational concepts or tactics as required in a current or impending operation.

4. DMO DOMAINS

The Air Force DMO program is organized into five primary domains, each with specific MAJCOM proponents. This retains control of operational and training resources and priorities with the using commands and establishes a user focus for DMO and JNTC development within the Air Force. The functional capabilities of the DMO domains are driven by the Air Force task list derived from the core competencies and functions of aerospace power established in AFDD 1-1 [6] as a “comprehensive framework that expresses all

Air Force activities contributing to the defense of the nation and its national interests." Operational systems in each of the five domains will either be integrated directly into DMO or replicated as Full Mission Training systems (virtual simulators). The integration of DMO systems to support Air Reserve Component training is included as a sixth area.

4.1 DMO-CAF (Combat Air Forces)

Air Combat Command (ACC) is leading the DMO-CAF effort for the Air Force. ACC, along with United States Air Forces, Europe (USAFE), and Pacific Air Forces (PACAF), the Air National Guard (ANG) and the Air Force Reserve Command (AFRC), are the primary using commands. DMO-CAF also incorporates Command and Control (C2) elements and training primarily focused on the operational level of war. This includes the execution of tactical level processes such as re-targeting, time critical targeting, close air support, and cross cueing of ISR platforms for situational awareness required to meet strategic objectives. As a result, DMO-CAF is enhancing combat readiness across all MAJCOM's and provide a key link between tactical and operational C2 levels. The cornerstone enabler of the DMO-CAF program is the DMO Network (DMON) and the DMO Center (DMOC). The DMON is a "network of networks" connecting Air Force and other service distributed systems to the DMOC where they are assembled into a federation of LVC systems in support of Virtual Flag and joint exercise events. Through the DMOC, Air Force units also participate as distributed elements in other service and joint exercise events connecting through the Joint Testing & Engineering Network (JTEN) node in the DMOC. A key demonstration of this capability was demonstrated in March 2005 at the Joint Red Flag exercise, which combined Red Flag, Virtual Flag, and Blue Flag Air Force exercises with Roving Sands (RS), Black Demon and Joint Service Training Exercise (JSTE) exercises. This benchmark event involved training audiences from all services and 3 coalition countries operating over 4 major networks from 36 distributed sites with live forces operating on two range complexes. Air Force and joint networked system capabilities have grown rapidly to offer real distributed training opportunities supporting a variety of users and mission areas. Current efforts are integrating the following DMO-CAF systems through the DMON and JTEN networks:

- F-15, F-15E, F-16, F/A-22, B-1, B-2, B-52 and AWACS Mission Training Centers (virtual simulators)
- A-10 and F-16 ANG/AFRC units (virtual simulators)
- High Density/Low Availability assets including RIVET JOINT, JSTARS and Predator (virtual simulators)
- Air Operations Centers and Combined Air Operations Centers (live)
- Scenarios, databases and constructive environments assembled into a full-spectrum constructive battlespace established and maintained by Virtual Flag (tactical level) and Blue Flag (operational level) exercise control groups

4.2 DMO-M (Mobility)

Air Mobility Command (AMC) is the lead command for DMO-M. AMC, USAFE, PACAF, Air Force Reserve Command (AFRC) and the Air National Guard (ANG) are the primary using commands. Current DMO-M efforts include DMO ready C-5, C-17, and KC-10 flight/boom operator simulators.

4.3 DMO-SO (Special Operations)

Air Force Special Operations Command (AFSOC) is the lead command for DMO-SO. DMO-SO will eventually integrate LVC systems used by special operations forces with DMO and JNTC networks to fulfill training and mission rehearsal needs including the conduct of special operations within broader combat operations. Current DMO-SO efforts include AC-130U, MC-130E/H/P, MH-60K, MH-53J/K/M, MH-47, and special tactics mission simulators.

4.4 DMO-S (Space)

Air Force Space Command (AFSPC) is the lead command for DMO-S. AFSPC along with United States Space Command (USSPACECOM), North American Aerospace Defense Command (NORAD), and United States Strategic Command (USSTRATCOM) are the primary using commands. DMO-S fills a gap in today's training for command and control (C2) tasks and is a primary component in establishing the capabilities needed to "operationalize" space within the tactical and operational combat environments in addition to its strategic role. DMO-S technologies and solutions will benefit these commands by including operational tasks that are key elements in HLD mission training. Current DMO-S efforts include the integration of the Space AOC, Space Warfare Center, missile warning systems, space surveillance, satellite control, and space C2 units.

4.5 DMO-T (Training)

Air Education and Training Command (AETC) is the lead command for DMO-T. Current DMO-T efforts are procuring Mission Training simulators advanced simulators for AWACS and commercial simulation services for F-16 weapon systems used by both formal training units and operational units. As systems become more capable, participation in DMO exercise events may be included in formal training programs where joint operations or realistic combat is desired as part of the course curriculum.

4.6 DMO and the Air Reserve Component

The Air Reserve Component (ARC) is comprised of the Air National Guard (ANG) and Air Force Reserve Command (AFRC). ARC units are following the leads of ACC, AETC and AMC in respect to their DMO efforts but have training challenges that are different from those facing the active units. Both Air Guard and Reserve units must maintain training capability at the home unit to support their part-time crews and night/weekend operational training. Traveling to centralized training sites uses valuable training time. In addition, the units have a diversified training requirement based on different experience levels and designated specific missions and must retain the flexibility to tailor training to their individual needs. To this end, the ANG has established their own DMO network of virtual simulators connected to their Distributed Training Operations Center (DTOC) allowing distributed participation in routine training scenarios, and available to ARC crews when needed to meet their training schedules. The networks supporting them are part of the larger DMO integrated network for distributed participation in DMO and JNTC exercise events supporting AEF training, and Northern Command (NORTHCOM) sponsored HLD training.

5. ACQUISITION & DEVELOPMENT

DMO capitalizes on today's emerging technologies to elevate training beyond fundamental skills to integrated training and mission rehearsals. The DMO trainers, training systems, and training operations are being acquired through a variety of means, using various types of resources.

5.1 Commercial Training Simulation Services

The most revolutionary acquisition approach is the Commercial Training Simulation Services (CTSS) strategy. CTSS is a new fee for service acquisition strategy in which the training systems are built and owned by the contractors who in turn provide services at a contracted rate. The contractor selected for a particular system owns all hardware and software, and is responsible for all trainer concurrency and technology upgrades to match the latest aircraft configuration. Inherent in the service is the embedded cost of maintaining trainer concurrency. However, CTSS is not the correct strategy for every situation and the initial experience with it indicates a learning curve for both the Air Force and industry partners to properly estimate the costs and responsibilities inherent in CTSS contract arrangements. Traditional acquisition methods are also being used within DMO and some commands have already invested significant resources towards acquiring and operating their own training systems. Additionally, legacy simulators and training systems are being upgraded where feasible to participate in DMO activities.

5.2 DMO Operations and Integration (O&I)

The DMO program contracts for Operations and Integration (O&I) to provide technical and management expertise and the support necessary to define and ensure the interoperability and interconnectivity of federated systems in support of team training. In collaboration with the federate systems providers, the O&I contractor identifies problems and potential solutions for issues associated with DMO systems architecture and integration requirements and that it continues to fully support projected growth. DMO system standards support JNTC efforts that are establishing common standards to address federation interface, integration, and performance standards and processes. They are being established with the participation of Air Force DMO systems stakeholders and conform to DoD and industry policies and practices.

5.3 Research and Development (R&D)

R&D efforts are performed as tasked by the government within the scope of synthetic environment, synthetic forces, HLA, DIS, communications, and visual systems in support of aerospace training. These tasks may be in the form of demonstrations, experiments, studies, analyses, and tools or application software development. Air Force R&D for the DMO program is directed toward future requirements with ACE models and simulations being developed as part of an increasingly coordinated JNTC effort to establish a Joint Training Federation M&S Toolkit consisting of two Federations/Federated Object Models (FOMs); an LVC FOM for tactical level events, and a Joint Multi-Resolution Model FOM for operational level C2 events and analysis [7]. These common efforts have potential for cost savings/cost avoidance by:

- necking-down the numbers of models and systems in current use through modernization without limiting current training capabilities
- incrementally improving training capabilities as improvements/efficiencies are implemented
- minimizing duplication of R&D efforts
- increasing the potential for commercial solutions that meet stringent mission rehearsal requirements
- enhancing simulation interoperability and standardization

As part of the DMO Roadmap process, the DMO Technology Investment Strategy (TIS) represents a strategic, user-focused technology roadmap for guiding R&D investments in technology that can be mapped directly to mission essential capabilities. The goal of the TIS development process should account for critical DMO R&D technologies, but most importantly, provide a technology path that is centered on Air Force mission

areas and tasks. Additionally, the TIS should provided feedback to the user commands highlighting their technology needs as a tool for prioritizing resource allocation decisions.

The TIS should consider available technologies, acquisition strategies, mission essential tasks, joint tasks, and the Training Implementation Plans (TIPs). It is intended to serve as an umbrella that encompasses research and development efforts not only at the laboratory level, but efforts in industry and academia as well. In addition, the TIS assumes that leveraging existing technologies and R&D efforts is part of the investment strategy. To remain relevant, the TIS should be kept current along with the DMO Roadmap reflecting the current funding strategies at Air Force and MAJCOM levels, changing mission requirements at the user domain level, and changes in technology driven by functional and cost efficiency. Periodic TIS reviews document proposed changes submitted to Air Force and MAJCOM level technology insertion boards as they monitor technologies and recommend candidates for transition from research projects into development programs.

There are five major areas of R&D investment where efforts may significantly improve the near term implementation and operation of DMO as it evolves:

5.3.1 Synthetic Forces

DMO requires increased realism in reactive computer generated forces (blue, red and gray), especially as it moves from training to achieve a true mission rehearsal capability. There is also a need for increased integration of computer generated opposing forces to reflect realistic command structures and decision-making. Evolving requirements drive the need for intelligent opposing forces operating in integrated command and control structures representative of the projected operational theaters to provide a realistic, challenging training and, ultimately, mission rehearsal environment for aircrews prior to deployment.

5.3.2 Synthetic Natural Environments

Evolving requirements drive the need for a common and increasingly realistic representation of the expected natural environments in projected operational theaters to provide high fidelity training (and ultimately mission rehearsal) for aircrews prior to deployment. The level of realism in environmental representations increases as DMO training moves across the joint training continuum from familiarization training to mission rehearsal and the execution of operational missions. The achievement of this capability an important aspect of near term R&D efforts and include the realism of limitations introduced by environmental conditions on tasks such as target detection, acquisition and identification.

5.3.3 Runtime Infrastructure

There is a requirement to tailor a high performance runtime infrastructure (RTI) to meet the real time performance requirements of DMO to support training requirements. The RTI and all system interfaces must also continue to evolve to meet the specific needs of the expansion of DMO and JNTC to incorporate instrumented and virtual ranges, opposing forces, threat systems and simulators, and realistic battlespace environments. A need that is specific to the successful integration of widely distributed virtual weapon systems is the extremely low threshold for total internal and external system latency (≤100ms). This “real time” parameter is essential for visual flight operations, targeting and weapons effects in the battlespace and currently prohibits the use of satellite links and limits the usefulness of wide area network for virtual-to-virtual interactions. This also impacts the ability of forward deployed elements to participate in DMO training and mission rehearsal unless conducted solely within regionally established networks.

5.3.4 C2 & Multi-Level Security (MLS)

Interface with real world command and control systems is critical as DMO evolves from support of training to a realistic mission rehearsal capability. DMO communications must evolve into a secure network infrastructure that supports security requirements. Implementation of low latency multi-level security (MLS) capability is also required for mission rehearsal. The primary communication infrastructure for DMO is commercially developed, but DMO must also meet additional specialized military requirement such as the JTA and MLS. The rapidly changing nature of training requirements are dependent on real-world links to the C4ISR infrastructure illuminate the critical need to implement some form of MLS capable of delivering a high fidelity training and mission rehearsal environment for aircrews prior to deployment to the operational theater. Coupled with the continuing commercial development of alternative communication media, this is a critical R&D area and the DMOC has established a DMO MLS Testbed, which has charted a course to achieve near-term MLS capabilities as an interim solution set, which can be improved or replaced as progress is made. Near term, the effort in this area will concentrate on evaluation of requirements for connectivity to real world systems and associated MLS requirements. Capabilities in this area have implemented the first DMO federation linking C2 and strike assets as a baseline for this evaluation. This R&D area will also address technology issues associated with the evolution of the infrastructure supporting DMO as it moves toward all optical networks. Mission rehearsal requires a high level of realism in the representation of real world command and control links. Unless the capability is provided to represent C2 accurately and links are eventually provided to operational C2 systems, proper planning and execution of the mission within real world constraints will not be achievable. MLS plays an important role in training because it is essential to the accuracy and perceived realism of the operational data and real-world situations provided to the training audience.

5.3.5 Enhanced Visual Systems

Visual system technology is critical to obtaining maximum effectiveness from DMO training. Evolving requirements drive the need for increasingly realistic visual representations to provide a high fidelity training and, ultimately, mission rehearsal environment for aircrews prior to deployment. R&D is required to transition research based visual systems to development. New visual system technologies must be demonstrated in operational environments and tested in their ability to meet training requirements.

6. SECURITY

The DMO Program has the potential of being a high-value, high-profile force-multiplier for the USAF and other Services' operational weapon systems. One of the many challenges in the DMO RDT&E and operational integration process is the implementation of highly effective and practical technical security management standards, procedures, and practices. Likewise, it is critical to the ultimate effectiveness of DMO that DOD staff agencies responsible for the planning, RDT&E, and operational integration of DMO programs identify DMO-related security issues and vulnerabilities early in the development and integration process.

The importance of DMO to the warfighter's real-world training and mission rehearsal process makes DMO a lucrative target for foreign intelligence collection efforts. Ensuring protection of critical information will require the application of the DOD's most robust security technology coupled with effective security policy and meticulous adherence to good security practices. DMO systems and subsystems will require constant and detailed surveillance for vulnerabilities as they are initially tested, declared operational and technically reconfigured as components are improved, added or replaced. MLS is a pivotal technology objective required to meet the DMO and JNTC objectives of expanding distributed connectivity to provide coalition training and mission rehearsal capabilities.

7. FINDINGS/LESSONS LEARNED

As DMO has continued to mature and its LVC systems and processes have evolved, several elements have emerged as preliminary "best practices" for managing the DMO program and prioritizing it's diverse resources based on user needs. The flexibility required further highlights the need to continue close, cooperative relationships between government and industry partners to achieving DMO and JNTC objectives.

7.1 Professional Control Force

As DMO and JNTC grows to offers greater and more routine access to distributed training opportunities, the need for a permanent professional control force has emerged:

- as experts in the doctrinally correct application of air and space power.
- to "fly" constructive models to deliver realism to the training audience.
- to provide realistic & interactive opposition forces.
- to replicate (when necessary) higher headquarters, sister services, non-governmental agencies & deployed forces.

This force should not be seen as professional trainers, but as operators that hone their scenario and database generation abilities and control force skills in exercises so they can, when required, assemble a full mission rehearsal within hours rather than days or weeks, and provide a deployable cadre of experts for operational contingencies.

7.2 User-Directed, Program Centric Development

The advances made in the DMO program have largely been accomplished by the imperative to achieve Air Force and Joint exercise objectives. This imperative has been a primary factor in determining priorities for funding DMO systems and improvements, and allowing their operational and tactical training objectives to directly influence the sequencing of DMO system capabilities. This user focus has been combined with a program centric approach that aligns similar joint and service exercise events to promote common training objectives and, where practical, encourages cooperative participation that increases the potential opportunities for joint training. Although DMO and JNTC are separate, centrally managed programs, their development is carefully coordinated with joint, service and agency organizations and the combined effect of the program centric and user focus has benefited both as a process that encourages the coordinated prioritization of exercise and program resources that continuously expand common and complementary DMO and JNTC system capabilities in direct response to the needs of field commanders, as expressed in their exercise and training objectives.

7.3 Industry Solutions and Support

DMO will continue to depend on industry systems and support. However, the commitment to sustain and evolve systems currently in use while simultaneously eliminating redundant and/or overlapping systems and "necking down" to achieve the goals of the Joint Training Federation Toolkit is likely to continue the trend toward commercially developed, government-owned systems. In this emerging environment, several commercial options may be indicated:

- Contract systems and services arrangements similar to the CTSS concept described above. Although currently used to a limited extent within the DMO program, there may be other opportunities that offer both value and stability to both commercial and government interests.

- Commercial tools that can seamlessly integrate many of the diverse new and legacy systems and databases that are likely to remain key elements of DMO and JNTC. This is an important Mission Rehearsal capability objective and drives the need for rapid scenario and database generation tools.

8. SUMMARY

DMO is a reality. Distributed multi-ship fighter mission training has been accepted by the operational community and the use of virtual simulators with realistic constructive environments has already proven successful in helping prepare AEF aircrews for combat. We continue to add and integrate systems and refine procedures for team training with unparalleled realism. We conduct and participate in both horizontally and vertically integrated operational and tactical training events and every Air Force Blue Flag and Virtual Flag exercise continues to expand our ability to conduct full-spectrum joint readiness training and mission rehearsal from the warfighters' home stations. Air Force DMO is the next generation air and space operational readiness program and a benchmark element of the establishment of a fully integrated Joint National Training Capability and hone coalition operations.

9. ACRONYMS

ACC	Air Combat Command (USAF)
AEF	Aerospace Expeditionary Force (USAF)
AETC	Air Education & Training Command (USAF)
AFB	Air Force Base
AFRC	AF Reserve Command (USAF)
AFSOC	AF Special Operations Command (USAF)
AFSPC	AF Space Command (USAF)
AMC	Air Mobility Command (USAF)
ANG	Air National Guard
ARC	Air Reserve Component (USAF)
AWACS	Air Warning and Control System (E-3A)
CAF	Combat Air Force (USAF)
C2	Command and Control
CONOPS	Concept of Operations
CTSS	Commercial Training Simulation Services
DIS	Distributed Interactive Simulation
DMO	Distributed Mission Operations
DoD	Department of Defense (US)
DMSO	Defense Modeling and Simulation Office (US)
HLA	High Level Architecture
HLD	Homeland Defense
I-Plan	Implementation Plan
JSTARS	Joint Surveillance Target Attack Radar System (E-8 Aircraft)

JNTC	Joint National Training Capability
JTA	Joint Technical Architecture
MAJCOM	Major Command (USAF)
MLS	Multi-Level Security
MTC	Mission Training Center (USAF)
NORAD	North American Aerospace Defense Command (US)
O&I	Operation & Integration
PACAF	Pacific Command (USAF)
R&D	Research and Development
RTI	Runtime Infrastructure
TIP	Training Implementation Plan
TIS	Technology Investment Strategy
USAFE	US Air Forces Europe
USSPACECOM	US Space Command
USSTRATCOM	US Strategic Command
USSOCOM	US Special Operations Command

Acknowledgements

The authors would like to acknowledge the assistance and sponsorship of the HQ USAF Operational Training Division and the generosity of the many DMO Integrated Product Team and JNTC Technical Management Working Group members and organizations for their contributions. Special thanks go to the 505th Combat Control Wing leadership and organizations for the innovative and pioneering efforts of their very talented personnel that are briefly highlighted in this paper. Good luck Opie!

10. REFERENCES

[1] "USAF Distributed Mission Operations CONOPS White Paper" 20 October 2003, p 1.

[2] "Training Capabilities Analysis of Alternatives, Volume 1 (OSD/JFCOM)" 30 July 2004. p IX-6.

[3] "DoD Training Transformation Implementation Plan, Appendix 1" 10 June 2003, p AP1-11.

[4] "Operational Requirements Document (ORD), CAF (USAF) 009-93-I-A, for Distributed Mission Training" 8 October 1997, p 2.

[5] "USAF Distributed Mission Operations Implementation Plan" 15 November 2004, p 3-11.

[6] "AFDD 1-1, Air Force Task List (AFTL)"12 August 1998, p 4.

[7] USJFCOM/JWFC Briefing "JNTC LVC Way Ahead" 27 October 2004.

Author Biographies

Grover Lollar is the Director of Business Development for Air Force Programs with the Anteon Corporation and supports the HQS USAF DCS Air and Space Operations as an Executive Program Manager for the USAF DMO Program. Mr. Lollar has been providing support for the USAF DMO Program since it's inception in 1996. Prior to joining the Operational Training Division, he held a similar position in the HQS USAF M&S Policy Division under the DCS Air & Space Operations. Mr. Lollar is a retired USAF officer and holds a BHS degree in Radiologic Technology from the George Washington University and a MA degree in Aviation Management from the Embry Riddle Aeronautical University.

Orris Hambleton is a Senior DMO Systems Analyst with SeiCorp, Inc. supporting the HQS USAF DCS Air and Space Operations as the Technical Manager for DMO and JNTC training systems. Prior to joining the Operational Training Division, he held a similar position in the HQS USAF M&S Policy Division under the DCS Warfighting Integration. He has served as Air Force management coordinator for several joint training efforts including the Joint Simulation System and the OSD Training Capabilities Analysis of Alternatives study. Mr. Hambleton is a retired USAF officer and holds a BA degree in Sociology from the University of South Florida and an MS degree in International Relations from Troy State University.