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DISTRIBUTED MISSION OPERATIONS: TRAINING TODAY'S
WARFIGHTERS FOR TOMORROW'S CONFLICTS

by

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ABSTRACT

Adequately training war fighters of the twenty-first century requires integrated joint-service training in environments of contested and degraded operations. The purpose of this paper is to examine the historical development of distributed mission operations, including the effectiveness of U.S. war fighter training in a distributed mission environment to meet current and future training requirements. The scenario-based methodology is employed to examine current distributed mission operations capabilities and develop future applications that will suitably address the concerns of limited training venues. The analysis will illustrate that distributed mission operations can provide training in an environment of contested degraded operations without the limitations observed due to safety considerations in live event environments. Additionally, the analysis reveals that distributed mission operations can overcome the fiscal limitations of live joint-integrated training and improve quality of life for U.S. war fighters. Recommendations include an investment in the overall distributed mission operations enterprise to ensure virtual environments across the Services can effectively integrate in a distributed environment and the need for cyber force involvement in future enterprise efforts.

Introduction

Over the past decade, members of the Armed Services have witnessed an increasing reliance on joint-service interoperability. As a result, U.S. military leaders are faced with the challenge of ensuring their war fighters are prepared to operate in a joint service environment while enduring fiscal restraints as discussed by General Martin Dempsey, U.S. Army, in a 2014 Chairman of the Joints Chief (CJCS) of Staff Notice.¹ More simply put, today's U.S. war fighters need to routinely practice their tactics and techniques in a joint environment. This will enable integration and training across the Services (Army, Navy, Marine and Air Force) to achieve more realistic preparation for operational combat than can be attained through any single Service training venues.

Further, travel demands have been particularly significant on war fighters since 9/11. In fact, temporary duty (TDY) rates for high demand, low-density platforms such as the E-3, E-8, AC-130, aircraft carriers, and electronic warfare assets often exceed one hundred twenty days per year and "deployments are having significant effects on Air Force members' families and shaping their willingness to continue military service at the cost of these relationships."² Thus, as the need for more frequent joint service training events increase, requiring even higher TDY rates, the Services may face a tough retention challenge as members make choices to improve their own quality of life.

Additionally, there is a heightened emphasis on the accomplishment of quality training in environments of contested and degraded operations (CDO). The aforementioned CJCS Notice stated "our adversaries are studying how we operate and are employing hybrid/asymmetric capabilities and creating contested environments that require us to develop new capabilities."³ In

order to respond to the latest threats of our adversaries, U.S. war fighters must identify and subsequently train to newly developed tactics and allow full execution of tactical responses, rather than simulated responses to simulated threats.

Unfortunately, flight safety concerns have historically limited the U.S. war fighter's capability to fully exercise all tactics in response to CDO or conventional threats. Airspace limitations in large force exercises also limit the maneuverability of aircraft and inhibit the full execution of some threat maneuvers. Command and control such as the E-3 and tanker assets are particularly affected by the artificialities imposed upon warfighters during large force exercises.⁴

Distributed mission operations may be the key to solving these dilemmas. Distributed mission operations is generally defined as an event in which multiple war fighters operating in geographically separated simulators are brought together by a distributed missions network.⁵ Within this network, the war fighter can train in a complex environment, challenging both individual skill sets and the ability to integrate with one another. Today's technology offers a menu of distributed mission operations capabilities. Distributed mission operations can limit integration to single weapon systems or include dissimilar weapons systems to rehearse more complex mission sets. In addition to networking geographically separated simulators of both similar and dissimilar varieties, distributed mission operations can integrate constructive entities, bringing assets unavailable via simulator to the operational battle space to present a more realistic training scenario.⁶

Finally, distributed mission operations has the capability to introduce live assets into the battle space. This concept is referred to as live-virtual-constructive (LVC) operations. LVC is generally defined as the integration of actual military assets operated by live crews, simulators driven by a human operator (referred to as virtuals), and computer generated entities (referred to

as constructives). This particular capability is in its infancy, but holds promise to meet future training needs.

Considering the challenges of training today's U.S. war fighter, in what ways can distributed mission operations provide a joint integrated training environment that allows war fighters to fully exercise, in the most practical way possible, the military tactics that they must be capable of implementing in an actual contested and degraded environment? The distributed mission environment is a potential avenue to ensure high fidelity training for the joint war fighter in a CDO environment that is not limited by safety of flight considerations, while simultaneously reducing TDY rates and training budgets for the Armed Services.

The distributed mission operations training concept has been proven in multiple distributed mission events over the past decade. Today, distributed mission operations can facilitate the rehearsal of theater wide operations, integrating all the anticipated units involved in the mission set, either live, virtually or constructively. The significant improvement of the capabilities within the distributed mission operations environment now enabled the provision of realistic training to the war fighter across a range of military operations and geographic locations. In addition, today's network architecture enables virtual entities from around the globe to coordinate and operate together in the same simulated location without physically departing their home station.⁷

It is a simple matter of ensuring the live, virtual, and constructive entities share the same network for a training event. As simulator and distributed mission operations technology continues to improve, distributed mission operations environments will likely provide increasing amounts of high fidelity joint war fighter training that was once only possible in live training environments. Furthermore, distributed mission operations will be able to provide that training

in environments encumbered by CDO while war fighters complete their training from their home bases. Although the advantages of distributed mission operations are convincing, many war fighters exhibit concerns that simulator training is not as effective as live training. Thus, it is important to note that distributed mission operations is not a replacement for all live training, but rather a cost-effective supplement.

In order to analyze the realistic application of distributed mission operations to meet the U.S. war fighter's needs, the scenario planning framework will be employed to examine the current state and future potential of training in a distributed mission operation environment. This paper will address whether or not distributed mission operations can ensure high fidelity joint war fighter training in a CDO environment without compromising the safety of the warfighter. Additionally, this paper will explore whether or not distributed mission operations has the capacity to reduce the monetary costs associated with training the war fighter. The investigation will begin with a thorough analysis of the historical development, current status, and future projections of distributed mission operations capabilities through the exploration of previously published studies. The effectiveness of training in a distributed mission operations environment will also be studied through the examination of previously documented experiments, as well as data collected during recent distributed mission operations events. Then, utilizing the scenario development framework, this paper will explore future possibilities for training in the distributed mission operations environment and identify driving factors for change. Among these driving factors of change, this paper will investigate the budgetary concerns related to training the war fighter and distributed mission operations's potential to reduce that budget while improving the war fighter's quality of life.

Through the assessment of the aforementioned data sets, this paper will determine

whether or not the distributed mission operations environment is a viable solution to meet today's training challenges including the opportunity to train in a CDO environment without safety of flight concerns, as well as the potential fiscal savings reduced training budgets could provide.⁸ Additionally, this paper will outline the limitations that are currently present within distributed mission operations. Finally, several key recommendations will be made that will enable distributed mission operations training to be a worthwhile investment for the war fighter of today and tomorrow.

Background

Simulators were originally only utilized as part task trainers, allowing aviators to practice their checklists and validate their emergency procedures. In many cases, there was no motion, no ability to insert weather or inject stresses that originate from outside the aircraft to challenge the aviator. Even in the 21st century, pilot training students are given large diagrams of the cockpits of their trainer aircraft.⁹ Then, they are told to sit in front of them and simulate the motions of starting the engines, taking off, landing, and finally shutting the engine down at the end of their simulated flight. Aviators have been limited to their own imaginations to emulate flight conditions and interactions or influences from players outside their cockpit that present challenges during live-fly situations.

In contrast, today's distributed mission operations "networked environments enable frequent training of higher order individual and team-oriented skills."¹⁰ Technology has changed simulator training for the modern aviator. Today an aircrew can experience a full motion flight impacted by weather, engine malfunctions, and threats. A crew can also challenge their skills by flying formation with another simulator and interacting with command and control entities flying

in geographically separated location. In fact, today's simulators are so effective that many aviators earn their basic aircraft qualification before their first flight in the airplane.¹¹

Computer memory was once a significant limitation of the simulators used for training war fighters. Not only were crews asked to train in limited motion environments, but the geography and graphics were far from realistic.¹² In fact, so limited were the gains of simulator training, part task trainers which employed no motion or visual cues were often utilized to save on costs. This type of training provided zero interoperability between platforms, Services or the tactical and operational levels of war.

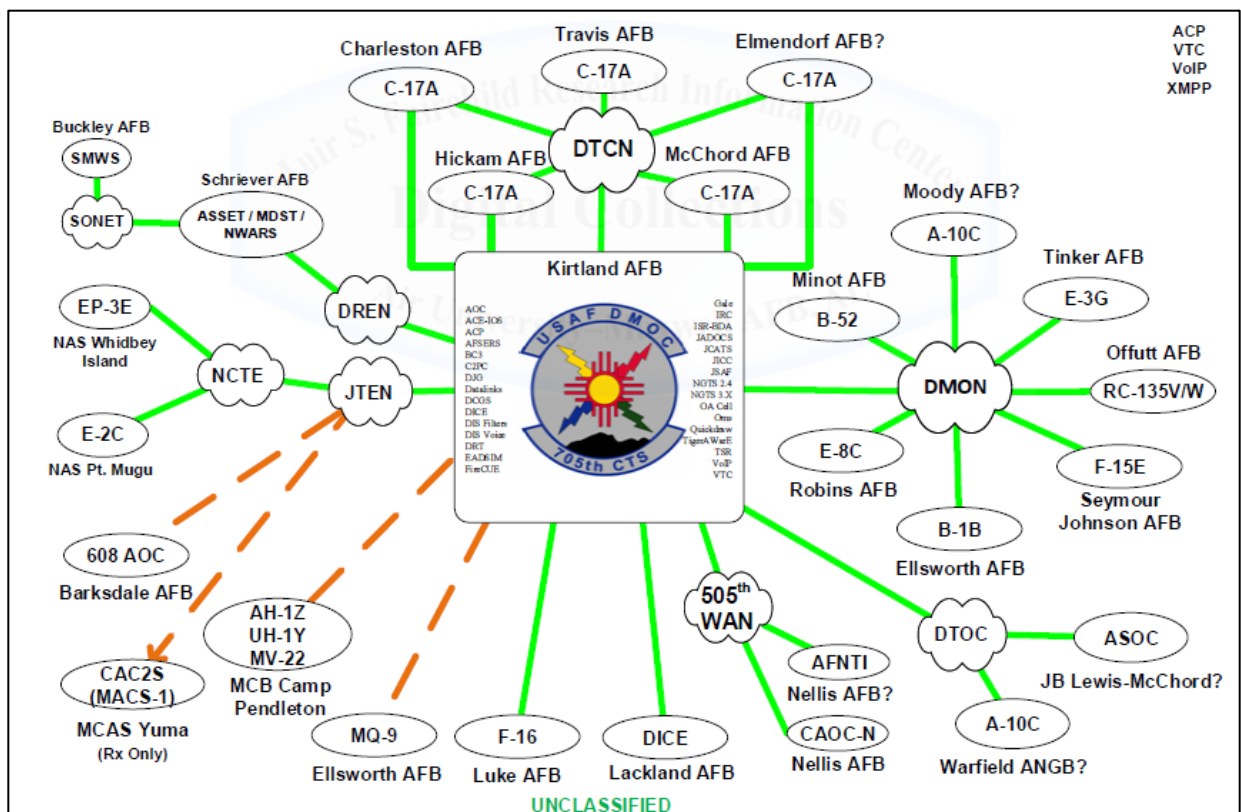


Figure 1¹³

Today the distributed mission network can link lives assets, high-fidelity weapons system virtuals, and constructive entities together to operate in an integrated real time scenario.

Distributed Mission Operations occur when multiple virtual assets including, but not limited to two F-16s from Luke Air Force Base (AFB), AZ, a four-ship of F-15Es from Seymour-Johnson AFB, SC, an E-3 simulator from Tinker AFB, OK, and a simulated Marine Tactical Air Operation Center located in Yuma, AZ link together on the same network as depicted in Figure 1. As you can see in Figure 1, the assets do not all begin on the same network. Instead, they are brought together through a central node or hub which, in this instance, is the Distributed Mission Operations Center (DMOC) at Kirtland AFB. Regardless, the network conductivity of today enables the operators of each simulator to talk to one another, direct actions and execute missions as a joint integrated force to defeat enemy forces in the simulated environment.

While the purpose of this paper is not focused on network architecture to support distributed mission operations, to better explain the development of distributed mission operations, a short discussion of networks is warranted and will be limited to the networks displayed in Figure 1. Although it is important to note that these networks are not all inclusive of distributed mission operations capabilities and that the network capabilities and connections consistently change, this diagram illustrates an example of what connectivity can be achieved. In this particular illustration, you can see the connection of the Distributed Mission Operations Network (DMON), the Joint Training and Experimentation Network (JTEN), the Defense Research Engineering Network (DREN), the Distributed Training Center Network (DTCN), and the 505th Wide Area Network. Managed by different corporations in support of particular Department of Defense initiatives, each of these networks can be linked together to support the training requirements of the war fighter.¹⁴

Furthermore, today's technology has enabled the effective infusion of constructive entities into the distributed mission operations environment. Constructive weapons systems may

represent friendly or adversary forces. Constructive entities may be fully automated or have a human (ie. “man-in-the-loop”) manipulating them to realistically respond to the actions of the other players in the distributed mission operations environment.¹⁵ For example, a command control asset being operated by a live crew may direct a two-ship of constructive fighters to a new location. A “man-in-the-loop” constructive entity can respond to the C2 directive either by radio or chat and then with the physical movement of the constructive entity. The software provides both friendly and enemy computer generated aircraft, ships, ground forces, missiles, and any other military entity needed to augment the virtuals in order to create a battle picture representative of an expected friendly and enemy order of battle. Thus, the capability to link virtuals and constructives means a C2 platform can meet their training objectives in a distributed mission operations environment even if virtual fighters are not present in the training environment. Instead, man-in-the-loop constructive entities can fulfill the role of the missing virtual and provide realistic training for the C2 platform. Ultimately, distributed mission operations links constructives and virtuals together to create a realistic and challenging battle space for the warfighter to train like they fight, regardless of the number of virtuals available. Thus, effective training is no longer limited by the availability of live or even virtual assets in today’s distributed mission operations environment.

As early as 2001, studies were conducted to assess the impacts of distributed mission operations on live training as well as the effectiveness of virtual training. In particular, the Coalition Mission Training Research (CMPTR) Programme conducted a study that examined the development of systems that would mitigate the impact of real-time actions slowed by long distance data links. They were also asked to create tools that would assess whether or not distributed mission operations training was an effective means of training for the warfighter.

This study followed a group of aviators from a virtual exercise called Red Skies to Red Flag, an Air Combat Command live fly exercise conducted on the Nellis AFB range. The aircrew members were skeptical about whether or not the virtual integrated training would be value added. However, interviews after the event indicated that crews that participated in Red Skies gained familiarity with the Nellis live fly range and increased their ability to interact more effectively with other crews. Ultimately preparing them for the subsequent Red Flag event and lending evidence to the theory that distributed mission operations training could meet training objectives. The study showed evidence of the benefit crews experienced by utilizing virtual training environments to prepare for live fly training events.¹⁶

Moreover, successful mission rehearsal via virtual training was demonstrated in 2005. In this instance, an Air National Guard unit cited a specific mission rehearsal they later executed in Operation IRAQI FREEDOM and noted that the highly realistic simulation prepared them well for the actual event.¹⁷ Today, distributed mission operations can facilitate the rehearsal of theater wide operations rather than limiting the rehearsal to a single weapons system. In fact, the mission set forth by the Commander Air Combat Command (COMACC) EXECISE PLAN 88 is “to prepare Combat Air Force (CAF) personnel in the mission execution phase of composite fore operations and OPLAN flyout, in a joint and coalition environment.”¹⁸

During the years that passed between the aforementioned study in 2001 and a directed live-virtual-constructive Northern Edge in 2008, distributed mission operations slowly expanded its capabilities. During that time period, distributed mission operations connected virtuals across the world, tested C2 capabilities, emission limitations and much more. By 2008, Northern Edge was ready to validate the supposition that distributed mission operations training could effectively emulate and train warfighters for potential real world scenarios while allowing the

crews to accomplish that training from geographically separated locations. The exercise was successful and demonstrated that testing could be accomplished in conjunction with warfighter training.

This was significant for several reasons. The ability to accomplish training and testing simultaneously offered obvious impacts to budget savings. It showed that the safety of virtual training afforded operators and engineers the opportunity to test and evaluate new systems and tactics without the risk of life incurred during live fly test and evaluation scenarios, while still accomplishing effective training for the war fighter.¹⁹

Beyond that, Virtual Flag events conducted by the Distributed Mission Operations Center as directed by COMACC EXERCISE PLAN 88 have demonstrated the capability of live assets to successfully interact with virtual assets.²⁰ Additionally, Nellis AFB provided a demonstration to the live, virtual, constructive (LVC) industry that showcased a friendly force of two live F-15s and two live F-18s head-to-head with an enemy force of two live F-16s and 12 additional fighter aircraft introduced to the fight via computer-generated constructive entities. All entities were networked together and the friendly force could see the enemy targets and respond to them just as they would live targets.²¹

Evidence indicates that technology has continued to progress since the success of Northern Edge in 2008. Today aircrew members have the opportunity to train in full motion simulators with multiple destinations while interacting with live troops on the ground. The initial distributed mission operations training was limited to a simulated Nellis range, but today a number of geographic areas around the globe can be simulated with more being added at the request of the war fighter. In fact “the terrain around the simulated bases is so true-to-life, and because things such as local air traffic pattern procedures are specific to particular bases and

ranges, pilots easily slip into the belief that they are somewhere else.”²² The advent of the distributed mission network takes simulator training to the next level, allowing training platforms from multiple locations to integrate. Thus, providing joint training for the tactical and operation level war fighter across the services and achieving the training vision described by General Jumper and Secretary Roche. General John P. Jumper, United States Air Force, Retired and Secretary of the Air Force James G. Roche wrote a memo in 2005 that stated the Air Force “has long recognized the growing dependence of warfighters and decision-makers on information generated and shared across worldwide networks. Successful provision of war fighting integration requires an enterprise approach of total information cycle activities including people, processes, and technology.”²³

Ultimately, today’s technological advancements provide leaders with an avenue to bring their joint forces together in a virtual environment, rehearse specific mission sets or large force operational plans and introduce problem sets that are predicted, but impossible to emulate in live training environments. Air National Guard mission rehearsals, Northern Edge events, Virtual Flag Exercises and Nellis AFB demonstrations have illustrated that the technological growth in the distributed mission operation environment can enable successful preparation of the war fighter for combat operations.

ANALYSIS

The future of distributed mission operations could take a number of turns. Potentially, the LVC construct will be pursued, investing in the integration of live and virtual flying. However, that does not meet the needs of the fifth generation assets that become exposed for collection by our adversaries each time they take flight.²⁴ Additionally, continued large,

integrated live fly events do not meet the need to train effectively in an environment of contested and degraded operations.²⁵ The cost of acquiring new assets to replace our aging fleet indicates that there will not be a one for one swap to replace the aging fleet, thus opportunities for our warfighters to train live will also likely decrease.²⁶ Finally, integrating virtual training to augment live fly events only reduces the cost of training by a fraction in comparison to an increased reliance on virtual training and does not reduce the number of TDY requirements for the war fighter.

In comparison, it is possible that an increased amount of training will be conducted in the virtual environment, slowly transitioning today's less technologically capable simulators to distributed mission operations capable simulators. The advantages of increasing distributed mission operations training are vast. First and foremost, an increased distributed mission operations capability will enable the effective integration of newly acquired assets as the aging fleet is replaced. Second, distributed mission operations can enable higher levels of integration worldwide, to include fifth generation assets, in an environment of contested, degraded operations across the Services. Third, an increased reliance on distributed mission operations potentially also offers the war fighter more opportunities to hone their skills as the inventory of actual assets at home station decreases due to the increased cost of replacing the old fleet and rising commitments to support theater commanders. Fourth, an increased utilization of distributed mission operations also allows the Services to reduce their training budgets by reducing TDY costs to accomplish joint-integrated training, reducing the live capability requirements to emulate adversary aircraft and capabilities, and reducing the overall number of live assets required to maintain a ready force of war fighters. The added benefit, of course, is that the reduced TDY rates can also have a positive impact on war fighter quality of life. Finally,

an increased reliance on distributed mission operations training will likely reduce the safety risks associated with live training events, while enabling higher intensity levels of training.

One of the distinct advantages of an increasing reliance on distributed mission operations training venues is the ability to integrate new assets into large force training events sooner.

Additionally, Northern Edge 2008 demonstrated that distributed mission operations environments do provide a safe environment to effectively test new training, tactics and techniques.²⁷ It is not a large leap to predict a future application of distributed mission operations to test the capabilities of new assets in the joint war fighter environment. The safety of flight concerns associated with fielding new systems or assets is removed in the distributed mission operations environment. The new system can fail to meet the requirements set forth by the contract in the distributed mission operations environment, but there is no risk of life associated, nor is there a financial risk of losing an expensive prototype during testing. Thus, war fighters can simultaneously develop the tactics, techniques and procedures that will enable effective integration and utilization of the new assets while the new system is being tested for its ability to meet performance requirements. While seemingly insignificant, reducing the timeline to integrate a new weapon system into the joint war fighter's toolkit through timely development of tactics, techniques and procedures results in a more rapid employment of a new and improved weapon system.

Furthermore, distributed mission operations offers the war fighter an avenue to continue capitalizing on the effects specific weapons system offer the joint war fighter in a combat environment during the transition from the soon to be decommissioned (legacy) asset to the new acquisition. As plans are developed to retire legacy assets from the fleet, it may not be cost effective to enhance the current simulator technology to enable legacy virtuals to participate in

distributed mission operations. However, the effects that legacy asset bring to the war fighter may be vital to some mission and theater rehearsals. The capacity to integrate live assets under the LVC construct recently demonstrated at Nellis AFB overcomes this particular shortfall.²⁸ Thus, as legacy weapon systems are retired and new ones join the fight, LVC presents an opportunity for warfighters to seamlessly continue training without losing a mission capability in the training scenario.

Additionally, distributed mission operations answers the need to integrate the information collected from intelligence, surveillance, and reconnaissance (ISR) assets, including remotely pilot aircraft and fifth generation fighters into the operational level decisions. The operational level decisions that are made based on the information collected by ISR assets often drives the tactical employment of the war fighter and military assets such as aircraft, ships and tanks. Distributed mission operations can enable supporting communities such as intelligence agencies to effectively integrate into training environments, allowing operators and commanders the opportunity to practice executing their reactions based on real-time ISR data.

This is valuable to ensure the complete integration of military assets in a joint training environment. Simply, the vast amount of intelligence collected by our ISR assets has changed the way we fight.²⁹ The speed in which information can be collected, analyzed, and disseminated for action has proven to be a challenge for our joint forces. For instance, a four-ship of F-22 spanning about 160 miles of the sky can serve as an excellent ISR collection platform, but the data collected is at a classification level so high that dissemination to the people that can action the information is prohibited.³⁰ Until recently, integrating this particular ISR asset into joint training has been limited to due to classification levels and the ability to emulate the collection procedures in a training environment.

However, training and testing in a distributed mission operations environment offers operators and engineers opportunities to overcome the aforementioned security challenges. First, distributed mission operations can provide a closed network for operations, offering engineers different avenues to distribute and disseminate information without the risk of compromising classified information on open networks. Additionally, distributed mission operations can integrate ISR collection platforms such as MQ-9 Reapers and operational level command and control entities such as Air Operations Centers in order to develop new tactics and techniques to improve the speed and breadth in which information can be collected, analyzed and disseminated.

In reference to the integration of fifth generation assets such as F-22s and F-35s, their integration in a distributed mission operations environment supports ISR training objectives initiated at the CJCS level and enables joint war fighters to train with these assets without compromising the technology of our new fighters. Currently, the distributed mission operations network can run at different levels of security classification. While the current baseline is SECRET//NOFORN and presents some integration challenges, the goal by the end of CY2016 “is to move to two enclaves, with one SECRET//NOFORN enclave and one Core Mission Federation enclave for special access program integration.”³¹

The future ability to conduct training at a higher classification level will also propel distributed mission operations training from focusing on unit flying training to expand to the intelligence, cyber and space communities, expanding the integration of war fighter training to multiple aspects of a campaign. As it stands, the 526th Intelligence Squadron provides Air Force Distributed Common Ground System support to the Distributed Mission Operations Center in support of Virtual Flags. Essentially, the unit takes on a supporting role to provide realistic

training for the participants. Members of the intelligence community accomplish this by emulating the data they would collect in real world operational environments for inject into the Virtual Flag exercise to assist other participants in the accomplishment of their training objectives. However, as the integration of ISR into distributed mission operations expands, to include fifth generation fighters, further realism and an increased value of distributed mission operations training will be realized for all participants. This includes the airmen from the intelligence, cyber, and space communities who currently play a supporting role in distributed mission training.³²

Moreover, it is easy to acknowledge that the high cost of frequent joint war fighter training limits the opportunities. Fortunately, distributed mission operation answers the need to provide more training opportunities to war fighters in a fiscally constrained environment. The 2015 Operations and Maintenance Budget estimate projected a \$100.1 million dollar decrease in flight training, which included a projected decrease of \$77.1 million dollars for the annual Flying Hour Program.³³ The cost efficiency alone is a convincing reason to rely on distributed mission operations to meet training requirements for all Services. According to statistics published in 2012, the Air Force forecasted a saving of \$1.7 billion dollars over five years by transitioning flying hours to simulator hours and the Navy estimated that a \$500 million investment in simulators over seven years would result in an annual training budget savings of \$119 million.³⁴ So, in just over four years the Navy forecasted breaking even on their initial investment, while the Air Force forecasts a continual savings. In fact, the overall cost savings associated with live flying versus simulator training is estimated to be between 5-20% according to the National Training and Simulation association.³⁵

Additionally, the cost to replace the aging weapons systems of our nation's Armed Services also plays a factor in the need to seek distributed mission operations training venues. The cost of new aircraft means there will not be a one for one swap to replace the old with new. For example, the Navy plans to replace its current P-3 fleet of 130 airplanes with only 117 new P-8 aircraft. Overall cost savings will be gained with the purchase of a reduced number of aircraft and the reduced maintenance costs to maintain a smaller fleet. However, the amount of training to maintain enough proficient aircrews is not reduced. To offset that particular delta, the Navy will add four more training simulators with the P-8 program than it had with the P-3 program.³⁶ Therefore, it is a reasonable prediction that the future of live training events will be limited by aircraft availability. The ability to integrate virtual assets into large force events via distributed mission operations allows the warfighter to easily overcome that particular limitation.

Furthermore, the number of real world missions and the aging fleets of our services has equated to fewer training opportunities for our war fighters. The actual assets are simply not available for training purposes due to worldwide mission requirements. As a result, war fighters who are not deployed with their assets suffer from limited training opportunities due a lack of assets to train on. Distributed missions operations is a viable option to fill in that gap. Already the Navy has embraced the opportunity of virtual training, performing 18% of their annual F-18 training in the simulator in 2012 with a forecast increase to 32% by 2020.³⁷ The Air Force Special Operations and Air Mobility commands have also embraced the fact that their aircrews cannot remain proficient without utilizing virtual training opportunities. Both commands have set a goal of accomplishing 50 percent of their aircrew training in the simulator.³⁸

In addition to providing increased frequency of training at a lower cost, distributed mission operations training also has the potential to provide more repetition to specific tactical

challenges to today's war fighter.³⁹ For example, the distributed mission operations environment allows trainers to reproduce tough tactical problems in a CDO environment. There are a number of instances that may force the war fighter to operate in a CDO environment. Some of these instances may include the degradation of communication networks to include chat tools, the degradation of data link capabilities limiting the ability to accurately identify friendly assets from enemy assets and the degradation of space assets to deliver timely intelligence information. However, one of the simplest examples is learning to operate in degraded weather conditions such as poor visibility, high winds, or icy conditions. This seemingly simple problem can easily illustrate the value of distributed mission operations to the war fighter.

War fighters are generally limited by actual weather conditions to realistically practice their ability to operate in degraded environmental conditions. However, simulator environments allow instructors to emulate these conditions as often as they are needed to ensure warfighter proficiency.⁴⁰ Many other war fighter skills can benefit from repetitive practice to include, but are not limited to tanker operations among aircrew, emergency procedures, threat responses to adversary threats and command and control tactics.⁴¹

Distributed mission operations offers the war fighter the capability to take this high fidelity, repetitive training one step further. Distributed mission operations can reproduce challenging tactical problems such as degraded weather conditions in an a large force event, forcing the war fighters to overcome the effects and see first hand the impact of how one asset's challenge can impact a large-scale operation. For example, if high winds at the airfield where tankers are located prevent a tanker from departing the airfield, aircraft currently airborne that were depending on that tanker for fuel will be forced to identify alternative refueling options, likely impacting planned missions. In addition, operational level command and control assets

such as an Air Operations Center will be forced to determine what planned assets can still accomplish their missions and identify missions that may have to be delayed until the winds recede at the tanker base. This example illustrates the capability of distributed mission operations to bring both operational level and tactical level training decisions together for war fighter training in CDO environments. Ordinarily, this is a scenario that instructors and students can only talk about. However, distributed mission operations enables the rehearsal of predictable situations that were previously impossible to rehearse and allows warfighters to respond in an integrated environment with the opportunity to evaluate their reactions.

A second example of how distributed mission operations can improve future CDO training venues is highlighted by training restrictions imposed by the Federal Aviation Administration (FAA). To ensure the safety of civilian aircraft, Department of Defense aircrews rarely have the opportunity to train in an actual CDO environment. Most crews simulate that they have lost a particular tool within their cockpit, but as soon as the problem is recognized and discussed, the aircrew resumes normal operation procedures. However, the distributed mission operations environment allows realistic training in response to this problem set. Aircrew can follow the scenario to its logical conclusion or employ their designated tactics without regard for FAA restrictions or artificially limited airspace. Instead, distributed mission operations trainees can react to their potential adversaries realistically, thus better preparing them for future combat.

The aforementioned scenarios directly support the fact that distributed mission operations can meet many of the training tasks set forth by General Dempsey in 2014. In the October 2014, Chairman of Joints Chief (CJCS) of Staff Notice, he emphasized that “the Joint Force is entering a period that requires flexibility and adaptively as we rebalance our strategic posture and force structure. Supporting both Service and joint readiness will be a priority as we address Global

Force Management and balance Combatant Command requirements with our ability to respond to crises.”⁴² In order to accomplish that, the CJCS Notice further identified thirteen high interest training issues (HITIs). Over half of the high interest items identified rely on joint Service integration to achieve desired training objectives. Some of these training items include personnel recovery (PR) tactics and rehearsals, joint logistic rehearsals, the integration of Special Operations Forces (SOF) with conventional forces, the integration of ISR information into operational level decision-making, the application of information operations in a wartime scenario and the rehearsal of joint access in the operational and tactical environment.⁴³

In order to meet the requirements levied by the 2014 CJCS Notice, many of have acknowledged that LVC training via distributed mission operations is the best avenue, including Air Force Deputy Assistant, Dave Walker, in his 2015 address to the House Armed Services Committee.⁴⁴ In his address, he highlighted the ability of LVC to train our war fighters in environments of CDO across a wide range of military specialties, to include command and control, tactical airlift, SOF and ISR communities. Additionally, Captain Dorrans, the Naval Air System Command Naval Aviation Training Systems and Training Ranges Program Manager, noted that LVC training and distributed mission operations facilitates joint operations, supporting the strategic vision for future training. Furthermore, he stated live integration is “increasingly challenging because you need to get so many assets together to train like you fight.”⁴⁵

In addition to the CJCS Notice of 2014, the events of Operation Enduring Freedom and Operation Iraqi Freedom have underscored the importance of the ability of troops to remain flexible as they encounter new types of warfare in varied environments around the globe. In addition, recent operations have emphasized the importance of effectively and efficiently communicating across the services and platforms during real time operations.⁴⁶ General John P.

Jumper, United States Air Force, Retired and Secretary of the Air Force James G. Roche emphasized this point in their 2005 memo.⁴⁷ Essentially, this memo pushed an agenda to bring the various networks together into a single enterprise solution and enhance the Joint Service's capability to train the way they fight.

Most recently, Virtual Flag 16-1 hosted by the Distributed Mission Operations Center at Kirtland AFB in December 2015, incorporated participants from multiple geographic locations and trained approximated 350 warfighters. This exercise showcased the advancements towards utilizing distributed mission operations for large force integration. Of note, less than 50 percent of the war fighters left their home station to participate in the training event.⁴⁸ During FY15, two large scale Air Combat Command exercises (Red Flag and Virtual Flag) executed simultaneously and successfully demonstrated that live, virtual and constructive assets can interact and achieve desired learning objectives; training over 300 airman, marines, seaman and soldiers from four coalition nations and operating from three different countries, some operation from virtual entities in their home countries.⁴⁹

Finally, another important aspect of training in the distributed mission operations environment that has been eluded to through several examples is the reduced safety risk to the warfighter and the subsequent reduction in cost associated with the loss of lives and assets. Although losses do not always occur so closely together, a series of incidents in October 2014 highlights the dangers live training. In the span of less than thirty days, an F-15, two F-16s, and a British built Hawker Hunter crashed resulting in the loss of four aircraft and one life. The other three pilots sustained only minor injuries according to open source reports.⁵⁰ Although lessons would have undoubtedly been learned from each of these training events had they occurred in a distributed mission environment, none would have cost lives or the loss of aircraft.

Thus, it has been clearly demonstrated that war fighters are no longer limited to large live event exercises such as Red Flag, Green Flag, and various bi-lateral or multi-lateral training events to accomplish their desired training objectives and meet the requirements needed to effectively prepare for combat operations. The advancement of technology during the latter 1990s and early 21st century presented distributed mission operations as viable option for warfighters to accomplish training in a join-integrated environment. Since then, the Department of Defense has made significant strides in increasing the capabilities of distributed mission operations as evidenced by the successes of recent events. Unfortunately, there are still several limitations that distributed mission operations faces.

One of the most significant limitations of distributed mission operations is the perception by the war fighter that the training is substandard or not as valuable as the training they can receive on their live assets (airplanes, tanks, ships). However, multiple interviews have indicated that the training is worthwhile and better prepares the war fighter for combat operations. A study conducted in 2011 which assessed the validity of training in a distributed mission operations environment found that the most convincing evidence of the success of distributed mission operations training was that the number of enemy leakers declined through the week of training by over 58%.⁵¹ Additionally, the increased execution of aviator evaluations in the simulator environment lends credibility to the virtual training environment. For example, pilots of some major weapons systems now receive their basic flight evaluations, including instrument and emergency procedure actions in the simulator.⁵²

Historically, simulator training has been used to practice known procedures without any measurement of the results. “This problem plagues all simulator based training, but is particularly pronounced in distributed mission operations because distributed mission operations

may have a live component” since the poorly executed virtual mission often impacts the live fly mission.⁵³ In order to challenge the war fighter, distributed mission operations must identify a method in which to measure and evaluate the performance of the warfighter with a systematic approach to the training. As with most training methodologies, distributed mission operations training has proven most effective when the “instructional system development approach” is applied. This approach teaches the training audience how to use the equipment and gives them time to familiarize themselves with the scenario and training objectives prior to execution of the actual training event.⁵⁴ In those instances, participants gained a great deal from their training. However, the reality is that the consequences of mistakes in a virtual environment are not as grave as those in a live fly environment. Thus, regardless of the intended method of measurement, it will be a continuing challenge to convince operators of the brevity of their roles in a virtual environment.

Beyond the attitude of the war fighter, there are some significant technical limitations to distributed mission operations that have yet to be overcome. One known and well-documented problem is the speed in which data passes through the network. There are instances in which the data does not flow as fast as it might during a live execution event due to the long distance links. While studies have been accomplished to determine methods to overcome this limitation, the challenge still remains.⁵⁵

In addition, another challenging issue that distributed mission operations faces is the fact that there are multiple networks that do not meet the information security requirements to connect to one another. As a result, there are restrictions on the ability to connect simulators from one geographic location to another. As was previously discussed, there are numerous independent networks that support distributed mission operations. Unfortunately, information

awareness and cyber-security protocols sometimes limit the capability to connect the networks. This particular limitation is based on permissions and security risk concerns rather than physical capability to connect the simulators in question.

Conclusion and Recommendations

The nature of warfare and the amount of information available to the war fighter is one driving factor for the call to change how we train in preparation for combat operations. Prior to the events of 9/11, war fighters sometimes trained in joint integrated exercises, but not to the extent they have been asked to interoperate in Afghanistan, Iraq and Africa in recent years. It is predicted that U.S. forces will rarely conduct large-scale operations as independent Services. As a result, continued and increased integration is expected and outlined in the 2010 Strategic Plan for the next generation of training, as is a call to synchronize live and virtual training to train the war fighter.⁵⁶ As this paper has illustrated, physically bringing multiple units and multiple Services together to train is limited by cost, distance and the demand of the live assets for real world missions. As a result, today's generation of war fighters and those of future generations do not have the same number of training opportunities that their predecessors' experienced. Thus, the distributed mission operations concept will likely become more prevalent in future training plans.

Although there are several limitations associated with distributed mission operations training, the benefits clearly outweigh the costs. The benefits of training in a distributed mission operations environment include the ability to train in a contested and degraded environment, increased repetition of challenging skill sets, as well as a reduced safety risk to the war fighter. Not to mention, the future of distributed mission operation will likely enable training at higher

classification levels enabling integration of fifth generation assets and even further integrating war fighters from different specialties such as intelligence, space and cyber operators in regular training venues. Finally, distributed mission operations can effectively reduce the DOD training budget while enabling troops to train like they fight from home bases.

In order to overcome some of the limitations described in this paper, there are several recommendations to be made. It is suggested that the Department of Defense assess the distributed mission operations environment as a whole and seek to govern and expand it as a joint enterprise, rather than a piece meal venture of independent commands. A whole enterprise approach will likely overcome the current limitations of connecting separate networks. Additionally, a DOD enterprise approach would also have the capacity to ensure current simulator upgrades and future simulator purchases are all able to effectively participate in distributed mission operations. In addition, in order to ensure the security of the training networks and the capabilities of the current LVC construct, it is recommended that significant consideration be given to the cyber security requirements. As the capabilities of the distributed mission operations network increase, more vulnerabilities will undoubtedly present themselves.

In conclusion, distributed mission operations presents a networked architecture of simulators and computers from all Services and all Commands, currently enabling operators to interact and train together on a closed network. The architecture of today is still limited and does not include every major weapons system, nor does it afford every simulator location worldwide the opportunity to interact in a distributed mission operations environment. However, the capability is growing and distributed mission operations has already proven to be a valuable addition to training capabilities across the Services. This paper illustrates that distributed

mission operations has the potential to overcome the training challenges and limitations of today's war fighters and better prepare them for future combat operations.

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