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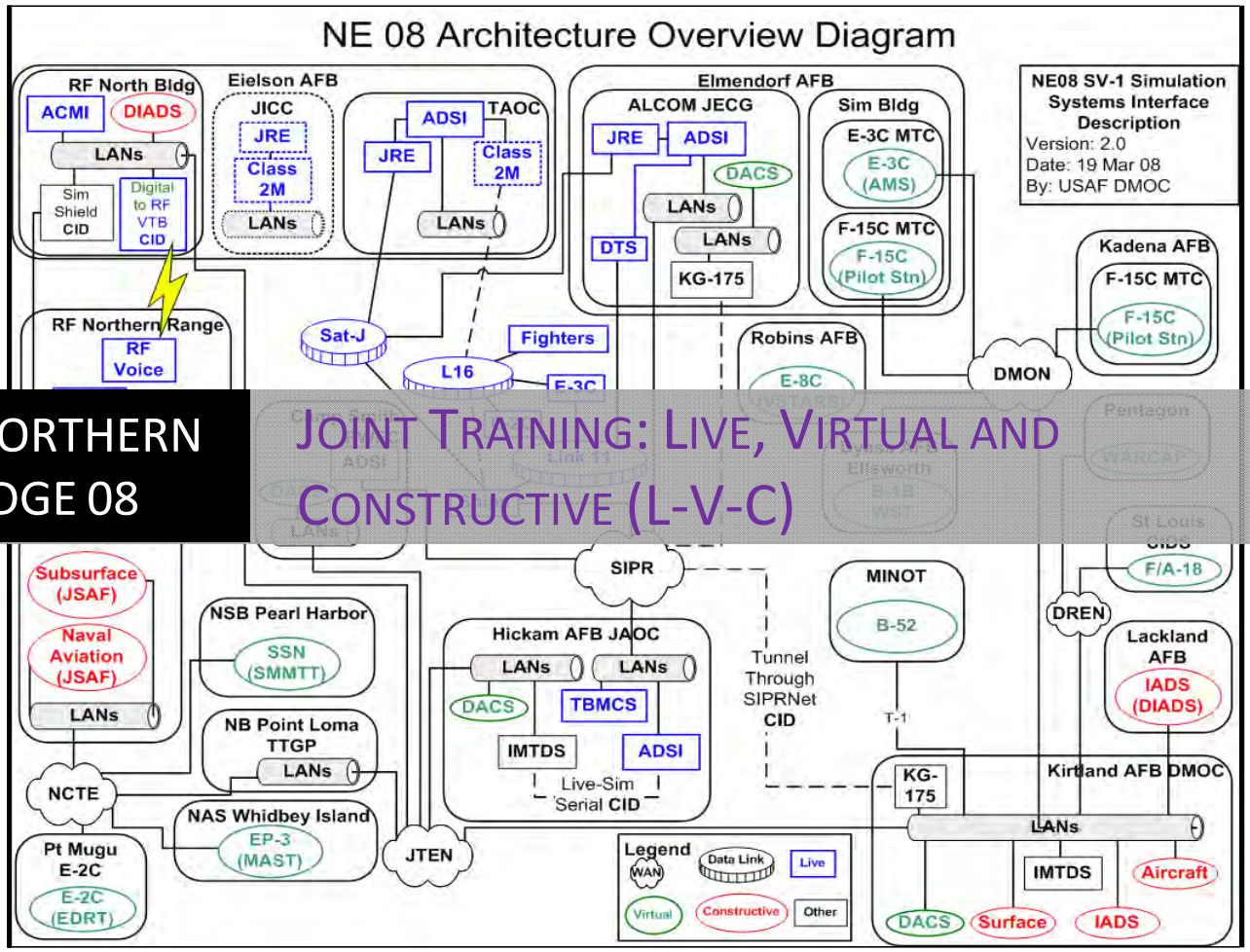

NORTHERN EDGE 08

JOINT TRAINING: LIVE, VIRTUAL AND CONSTRUCTIVE (L-V-C)

Session: Distributive Live-Virtual-Constructive And T&E

Mr. Phil Harvey, Mr. Steven Hatter, Maj Michael Davis

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Joint Training: Live, Virtual, and Constructive (L-V-C)

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Distributive Live-Virtual-Constructive and T&E

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ABSTRACT – Mr. Phil Harvey, Mr. Steven Hatter, Maj Michael Davis Revision 4, 29 Jul 08

EXERCISE NORTHERN EDGE 08 (NE08) was conducted 5-16 May 08 with special emphasis on Live-Virtual-Constructive (L-V-C) operations leveraging instrumented training airspace associated with the Pacific Alaska Range Complex (PARC). NE08 was a United States Pacific Command (USPACOM) sponsored, Alaskan Command (ALCOM) executed, Joint Chiefs of Staff (JCS) tactical field training exercise focused on a critical USPACOM war plan. The Air Force Distributed Mission Operations Center (DMOC) served as exercise L-V-C planning Co-Chair along with ALCOM J7, and provided joint L-V-C technical and operational leadership during the joint exercise life cycle (JELC) planning, and direct technical and exercise control support during exercise execution. DMOC partnered with ALCOM, the Navy's Tactical Training Group Pacific (TTGP), Pt Loma, CA, and Joint Forces Command Joint Warfighting

Center (JWFC), Suffolk, VA, to achieve the largest tactically focused joint L-V-C network ever built.

DMOC was specifically responsible for obtaining approvals on all L-V-C architecture Controlled Interface Device (CID) activity, to include use of the JFCOM Joint Training and Experimentation Network (JTEN). Approved architecture enabled the employment of both live instrumented and constructive targets in the PARC live training space and a digital-to-live Radio Frequency (RF) Virtual Tactical Bridge (VTB) by which virtual E-8C crews controlled live fighters against these targets. This demonstration of joint military crew interaction between live and virtual Command and Control (C2), Intelligence, Surveillance, and Reconnaissance (ISR), and live and virtual Air Interdiction fighter platforms models the vision of Training Transformation's (T2) Joint National Training Capability (JNTC). It also demonstrates significant joint evolution of L-V-C in terms of war plan mission rehearsals.

Of the two USPACOM sponsored Joint Test and Evaluation activities included in NE08, one was determined to be best supported by live only. The other, Joint Command and Control of Net Enabled Weapons (JC2NEW), was better supported by joint V-C Modeling and Simulation as part of the overall L-V-C architecture. JC2NEW was supported in both the PARC overland north ranges and Gulf Of Alaska (GOA), and was the driving factor behind creating a V-C only airspace west of Eielson AFB similar to the live fly areas east of Eielson AFB. This new V-C area supported F/A-18C deployment of Standoff Land Attack Missile -Expanded Response (SLAM-ER) weapons requiring a scenario similar to the overall live environment, and was supported by a virtual E-2C and constructive P-3 inputs. The L-V-C scenario also provided additional support to JC2NEW for both overland and over water Tactical Tomahawk (TACTOM) employment.

While this paper primarily addresses L-V-C as applied to training, the reader should note that there are significant applications for L-V-C as applied to testing and experimentation as well. The current DOD modeling and simulation (M&S) management framework emphasizes six M&S acquisition thrust areas: Analysis, Experimentation, Acquisition, Test, Planning, and Training, cross-cut by multiple leadership and oversight forums at the service and DOD levels. This framework presents a prime opportunity to leverage advances in L-V-C for training to meet testing requirements. In fact, the emphasis on mission-based, system-of-systems thinking, where common modeling and simulation scenarios and tools are used throughout the life cycle of a system, begs for cross-cutting application of training and testing L-V-C, where applicable. Of course, test and evaluation activities may not always fit well within training-focused L-V-C events due to the potential for competing requirements be they objectives- or fidelity-based. Additionally, T&E requirements aren’t always standardized among major commands, and there appears to be a lack of continuity among test squadrons, major commands, and services regarding testing of similar issues. This paper will address possible ways to improve T&E interaction with the L-V-C community.

1. Introduction

1.1 In The Beginning

What is Joint Live, Virtual, Constructive (Joint L-V-C) training? Where did the concept originate from? What policy and technology advances has made Joint L-V-C possible? Is Joint L-V-C viable and worthy of continued Department of Defense capital investment in the 21st Century?

The L-V-C concept is an upward spiral of constantly emerging national capability the military services are building, and Joint L-V-C has its roots in the not too distant past. For the Air Force, it began as a ten-year long Joint Test and Evaluation (JT&E) program called the Identification Friend, Foe, or Neutral (IFFN) Joint Test Force (JTF) conducted from 1979 to 1989 at Kirtland AFB, NM. The IFFN JTF project pioneered a new concept in joint testing by means of connecting from the main joint simulation facility at Kirtland AFB to a distributed site geographically separated by some 300 miles at Ft Bliss, TX. This joint test was conceived, built, and conducted before the days of the current adaptation of internet technology to Air Force distributed simulation, and was innovative in that the testing brought Army and Air Force Virtual and Constructive Service operating systems together in a first-ever joint test. This demonstration became the seed bed of future joint internet Protocol Data Unit (PDU) based distributed simulation.

1.2 Distributed Interactive Simulation Is Born

In the spring of 1990, the IFFN JTF facility was handed over to the United States Air Force (USAF) and became the Air Force's Theater Air Command and Control Simulation Facility (TACCSF). From 1990 until 1995, TACCSF continued involvement with myriad Joint Test and Evaluation (JT&E) programs based on the technology developed in the IFFN JTF days. However, in 1995 internet based PDU distributed interactive simulation (DIS) was introduced to TACCSF, which marked the beginning of an Air Force policy commitment to exclusive use of the DIS protocol, first in a JT&E application and later expanding into a joint training role as well. DIS has proved a catalyst to explosive growth in both Joint L-V-C policy and in technology advances to better enable Joint L-V-C.

When one considers that only thirteen years ago USAF basic distributed simulation was in infant stages at the TACCSF facility, it is amazing to survey the huge growth and sustainment of what has emerged as a powerful joint training and testing capability—Joint L-V-C. In the summer of 1998, TACCSF conducted its last large scale JT&E supported by DIS in the old facility at Kirtland AFB, NM. It was called the Joint Combat Search and Rescue (JCSAR) event and proved highly successful.

From the summer of 1998 until the summer of 2000 momentum built rapidly and many changes were implemented. The USAF Air Combat Command (ACC) planned for a network to stand up a distributed mission training capability (DMT) and TACCSF was promised a new facility on Kirtland AFB. TACCSF continued to be a leader in distributed simulation, and much of the expertise gained in previous operations was shared gladly in an effort to bring about an Air Force training transformation referred to as DMT.

1.3 Distributed Mission Operations Comes Of Age

In the summer of 2000, TACCSF moved into the new facility at Kirtland AFB and immediately conducted its first test for ACC called the Airborne Battlefield Command, Control, and Communications (ABCCC) Divestiture Test. Although this test was conducted totally in-house at the new TACCSF facility with no distributed participants, it was a totally DIS-based test. The requirements for the test brought back to life concepts of White Force play in training events that had been discarded earlier by TACCSF. The test also introduced a ground environment capability at TACCSF by bringing in new DIS simulation systems such as the E-8C Virtual Joint STARS (VSTARS), the Joint Conflict and Tactical Simulation (JCATS) ground environment generation tool, and use of the Air Force Synthetic Environment for Reconnaissance and Surveillance (AFSERS) unmanned aerial vehicle (UAV) Predator capability in a merged air/ground operationally and tactically integrated DIS battlespace. This newly added dimension of simulation began yet another TACCSF transformation. Now a truly multi-dimensional joint distributed simulation battlespace was possible that was quickly leveraged in the first TACCSF sponsored training exercise known as DESERT PIVOT and thus Distributed Mission Operations (DMO) was formally born. The Air Force's DMT network name was also eventually changed to the Distributed Mission Operations Network (DMON). In 2001, TACCSF's DESERT PIVOT exercise won the both the Air Force's and Department of Defense's Best Modeling and Simulation Training Program award. Since that time the USAF DMOC has won either a Department of Defense or United States Air Force Best Modeling and Simulation Training Program award almost every year since.

1.4 Virtual Exercises Take Flight

The summer of 2003 saw the transformation of DESERT PIVOT into the current VIRTUAL FLAG series of Virtual-Constructive exercises, and eventually the facility name was changed from TACCSF to the Air Force Distributed Mission Operations Center (AF DMOC). The small TACCSF detachment became the 705th Exercise Control Squadron (EXS) and later the 705th Combat Training Squadron (CTS), and was aligned under the 505th Distributed Warfare Group and the 505th Command and Control Wing, Hurlburt AFB, FL. Subsequent alignment of the Group and Wing under the USAF Warfare Center, Nellis AFB, NV brought increased awareness, focus, funding, growth, and increased capability until eventually the AF DMOC transformed the

fledgling service-centric orientation of the Virtual-Constructive battlespace into an unparalleled multi-dimensional joint training and JT&E battlespace facility unequalled in the world. Today the AF DMOC operates a joint Virtual-Constructive battlespace leveraging the networks of the AF DMON, Joint Force's Command's (JFCOM) Joint Training and Experimentation Network (JTEN), and the USN Navy Continuous Training Environment (NCTE), as well as additional useful networks and protocols such as High Level Architecture (HLA) and Test, Training and Enabling Architecture (TENA) in a multi-faceted capability that supports the Secretary of Defense's Joint National Training Capability (JNTC). Figure 1-1 shows a typical joint L-V-C battlespace available for high value joint training. In addition, the DMOC is preparing for increased coalition training audience participation as Cross Domain and multi-level network security concerns are overcome.

1.5 DMO Is A Valuable Joint Service Asset

Is Joint L-V-C viable and worthy of continued Department of defense capital investment in the 21st Century? Senior decision-makers from the Office of the Secretary of Defense to the Joint Staff and across the Services seem to think so. In DoD's current resource constrained reality, Joint L-V-C simply gets significant joint training "bang for the buck!" From a JT&E beginning until now, the "grass roots" "lean-forward", "can-do" mentality and work ethic of the AF DMOC in distributed simulation has influenced L-V-C growth across the joint spectrum ahead of any imagined schedule, and is the premier Air Force joint distributed battlespace facility today. From the early days of the IFFN JTF, TACCSF, and now the USAF DMOC, this organization has provided unsurpassed leadership, technological know-how, and dogged determination to transform stove-piped simulation systems into an extremely sophisticated world-class Joint National Training Capability (JNTC) training environment in the absence of any formal system acquisition process. Similarly, all of the Services have been working hard to stand up their own L-V-C capabilities. NORTHERN EDGE 2008 proved a nexus for these many lines of effort and success.

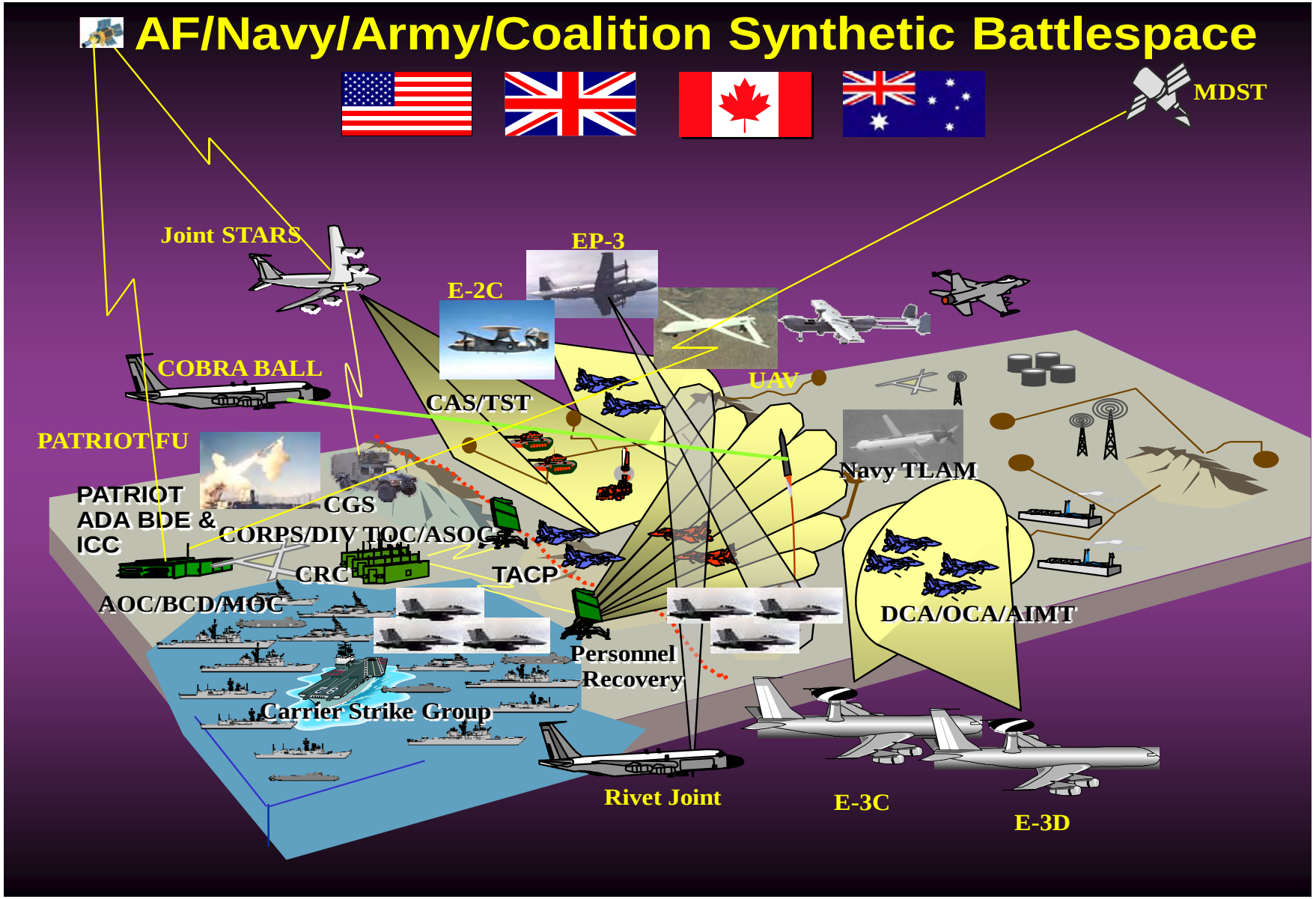

Figure 1-1Joint/Coalition Synthetic L-V-C Battlespace

2 NORTHERN EDGE History

2.1 Gold Fever In Alaska

In the spring of 2005, ALCOM J7 planning personnel visited the USAF DMOC to explore the possibility of adding V-C to the live fly exercise tactically focused air and maritime centric Exercise NORTHERN EDGE 06 (NE06). A DMOC planner was invited to attend the Concept Development Conference (CDC) and immediately the potential for a jointly executed time and geographically separated battlespace was envisioned and captured on paper in the form of an Operational View (OV-1) and Systems View (SV-1). ALCOM's leap of faith began the upward spiral of improving exercise V-C play while aggressively seeking to integrate live with the Virtual-Constructive in the NORTHERN EDGE series of exercises. Figure 2-1 shows the first NE06 Systems View, which in and of itself was innovative in that it was the first use of a merged L-V-C TADIL-J data link picture in this JCS funded USPACOM live fly exercise executed by ALCOM in the Pacific Alaska Range complex (PARC).

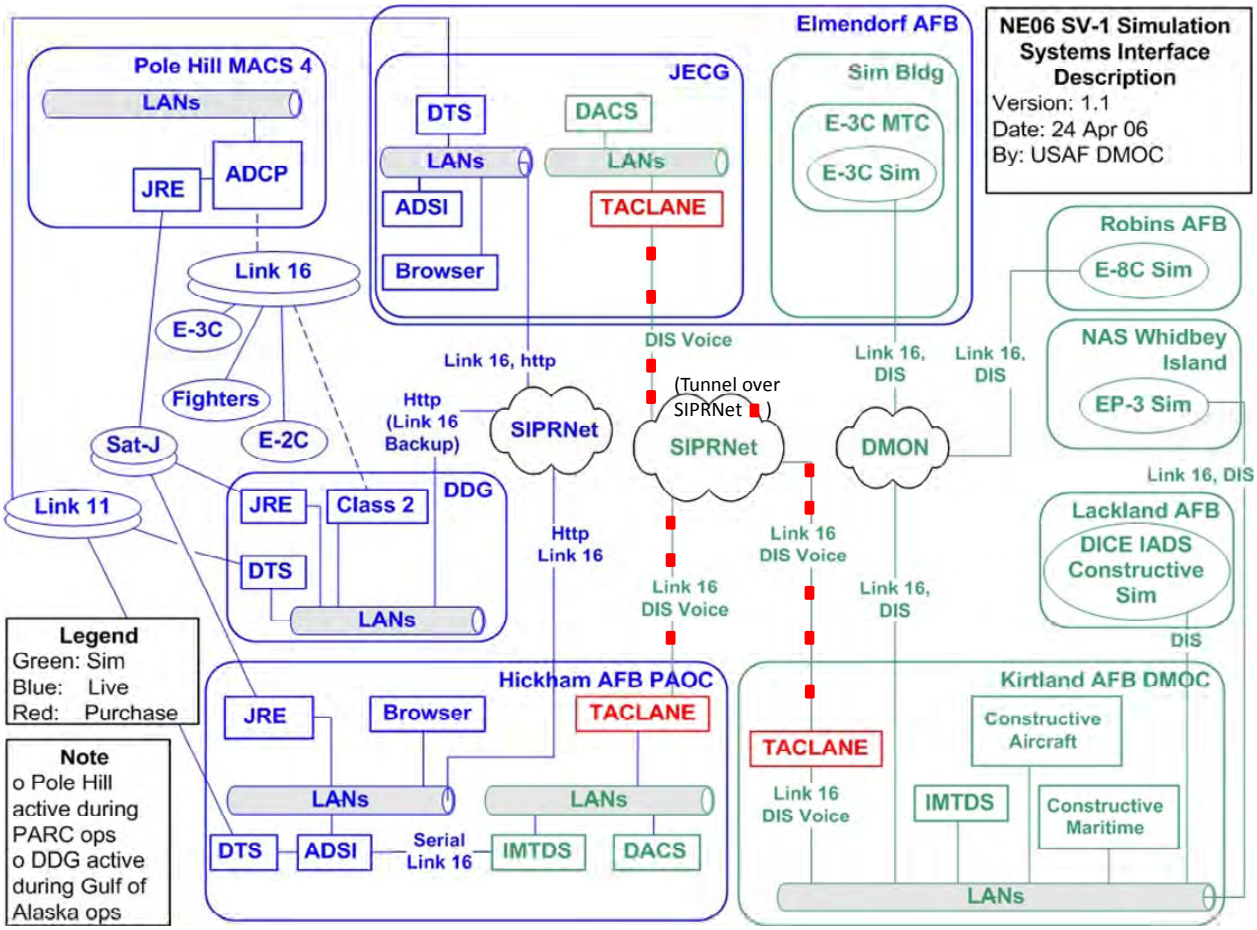

Figure 2-1 NE06 Systems View-1 (UNCLASSIFIED)

2.2 Instrumentation On The Nellis Range

To fully understand joint L-V-C tactical battlespace execution it is necessary to step back a few years and review some of the basic building blocks that have helped us realize the success of NE08. It takes time and money to grow a capability, and the reliable, tactically-focused battlespace operated today was made possible by several smaller steps taken years before by the USAF DMOC and other services. Indeed, in late 2001 some of the earliest L-V-C live range interoperability steps were taken to support a Time Sensitive Targeting exercise funded by ACC, and supported by TACCSF at the time. It was executed on the Nevada Test & Training Range (NTTR), Nellis AFB, NV), more commonly known as the Nellis Red Flag range. This project was known as the Command and Control Battle Lab (C2B) Surveillance, Management, and Reconnaissance Tasking System (CSMARTS) project. It was managed by the Air Force C2 Battle Lab at Hurlburt AFB, FL and was the first time instrumented vehicles on the NTTR were converted to DIS and transmitted over a T-1 connection to the TACCSF facility. TACCSF introduced several simulation systems to interface with this input, to include the AFSERS UAV Predator, the E-8C VSTARS, JCATS, the Extended Air Defense Simulation (EADSIM) system, the DMOC RC-135S Cobra Ball virtual system, and virtual TADIL-J. A virtual TADIL-J picture from TACCSF was forwarded by the Nellis Combined Air Operations Center (CAOC) Joint Interface Control Officer (JICO) from the Air Defense System Integrator (ADSI) to live fighters on the NTTR. The only thing lacking was the ability to have the virtual E-8C VSTARS crew at TACCSF be able to perform Air Interdiction fighter "talk-on" against the instrumented target locations as the Red Flag Range Control facility did not have enough spare radios installed on the Nellis Range to support this and no formal approvals have been sought after to approve this step toward live to V-C integration. After the 2001 event an almost identical repeat of this operation was planned and operated by Nellis CAOC, Red Flag and USAF DMOC in the spring of 2005 during the JFCOM led Joint Red Flag exercise. After each day's VIRTUAL FLAG V-C portion of the exercise, and in support of Red Flag live operations at the Nellis CAOC, the live vehicle instrumented picture (converted to DIS) was forwarded to the E-8C VSTARS crew at Robins AFB, GA. The 116th Air Control Wing (ACW) Joint STARS crew received partial training from this effort using a surveillance team only, as there was again no possibility of supporting a full virtual JSTARS crew with Air Battle Managers (ABMs) involved in providing procedural control to talk live fighters onto targets (live vehicles) moving on the Nellis Range.

2.3 Experience Gained With The Navy

In the fall of 2005, the AF DMOC conducted a joint exercise with the USN Tactical Training Group Atlantic (TTGL). The Navy exercise was called OPERATION BRIMSTONE and was a Fleet Synthetic Training-Joint (FST-J) event operating with approximately 12 ships in port at Norfolk Naval Base, VA connected to the USN NCTE virtual local area network (LAN). The Navy conducted pre-deployment spin up training for a Carrier Strike Group, a Surface Strike

Group, and an Expeditionary Strike Group. The Air Force conducted a full VIRTUAL FLAG (VF) exercise in parallel with distributed players connected to the DMON and other tactical network connections. During this first-ever joint service, large scale V-C exercise (with some real world hardware in the loop), the Army (PATRIOT, Ft Bliss, TX), Navy (ships at Norfolk), and Air Force VF planners and technicians gained very valuable insights into large scale V-C joint battlespace operations. A variety of networks and simulation protocols (DIS/HLA) were brought together and merged into a working joint battlespace depiction. There were many valuable lessons learned and many technical issues solved as a result. Additionally, AF planners learned much about the Navy's use of secure voice from digital radios to live secure radio frequencies. The lessons learned from this successfully merged joint service exercise planted yet more of the seeds that account for many of the successes of NE08, especially in the area of voice communications. Use of tactically bridged communications from digital to live radio frequency (RF) was a specific seed that eventually grew into a capability in NE08 that allowed for true virtual to live aircrew interoperability. All of these L-V-C building block experiences were valuable lessons learned and applied to the current state of the art in L-V-C as seen in NE08 and current preparations for NE09.

2.4 NE06 L-V-C Is On The Edge

ALCOM's vision to broaden their live fly experiences from NE04 enabled the accomplishment of L-V-C in NE06. Specifically, a new concept learned in the early days of forwarding TADIL-J to live aircraft for the CSMARTS TST L-V-C event came to fruition during NE06 in that the USAF DMOC coordinated with the then DISN Security Accreditation Working Group (DSAWG) to merge the L-V-C TADIL-J picture at the Pacific Air Operations Center (PAOC), Hickam AFB, HI, which is now the 613th AOC. The reason DSAWG approval was necessary was because of the live requirement to pass all TADIL-J over both SAT-J and Satellite SIPRNet TCP/IP as a backup path. Since the PAOC live ADSI common operational picture (COP) viewport was connected to SIPRNet, a controlled interface (CI) situation occurred requiring an approved CID. AF DMOC solved the CI issue by means of an RS232 serial cable installed between the AF DMOC provided Improved Multi-link Translator Display System (IMTDS) and the PAOC ADSI. Since both machines were collocated within the controlled secret inner confines of the PAOC, risk assessment was deemed low. Even though the live and DMO network enclaves were both secret, and the connection was to be made in the secret PAOC facility, DSAWG's concern was that someone from the DMO secret enclave could tunnel over this connection to access actual SIPRNet on the PAOC side. To preclude this, AF DMOC and PAOC were required to shut down all extraneous processes on the IMTDS and ADSI such as TELNET, FTP, RLOGIN, etc., so that only pure TADIL-J messages were passed between the IMTDS and ADSI. This CI solution satisfied the DSAWG requirements and NE06 successfully executed a merged L-V-C TADIL-J COP for the first time. The result of this common sense CI approach allowed the PAOC Combat Operations Division exercise participants a merged L-V-C

picture for a much broader view of the L-V-C fight taking place across the entire PARC complex some 2200-2800 miles to the north over water and over land ranges. Figure 2-2 shows the GOA operating area for NE06. Additionally, the AF DMOC supported live fighters by injecting a TADIL-J presentation to mark the red forces Integrated Air Defense System (IADS) along the Yukon River because no Red Flag Alaska Unmanned Threat Emulators (UMTEs) were available in those locations.

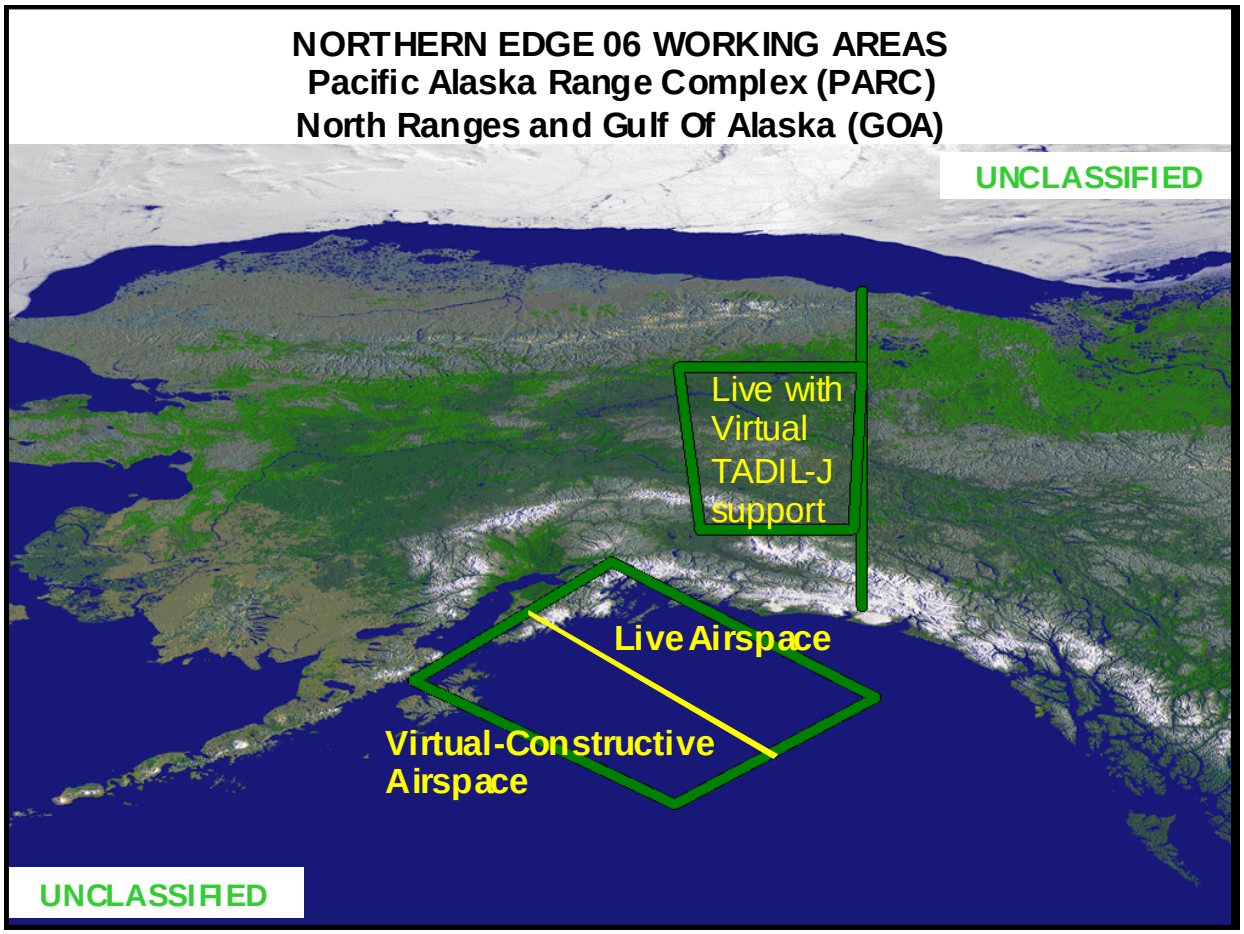

Figure 2-2 NE06 GOA Operating Area (UNCLASSIFIED)

The overall NE06 network architecture also allowed the PAOC exercise participants a path for full voice communications to both live and virtual C2ISR aircraft by use of digital radios for V-C assets and live radios for live assets, but there was no merge of live and virtual radios during NE06. While live assets were operating in the PARC ranges, virtual C2ISR crews were operating from their home bases in Elmendorf AFB, AK and CONUS bases (Whidbey Island, WA and Robins AFB, GA) with their virtual displays focused on the PARC area in Alaska. The merged L-V-C TADIL-J COP also provided the Joint Exercise Control Group (JECG) the same COP at Elmendorf AFB resulting in the comment from the then ALCOM commander Lt Gen Douglas M. Fraser, “I have better situational awareness of the NE06 fight in the JECG than I do

of the Alaska NORAD Region picture." Both Lt Gen Fraser and Admiral Timothy J. Keating, USPACOM Commander, were elated about the successful outcome of the NE06 exercise as it had established a better foundation upon which to develop Tactics, Techniques, and Procedures (TTP's) in USPACOM's largest tactical field training exercise focused on a mission set of its largest Joint Task Force. The introduction of L-V-C was conducted safely and played a significant role in helping to focus on development of joint TTP's, improved functional component products, and improved war planning in general.

2.5 ALCOM Commander Issues L-V-C Marching Orders For NE08

After the success of NE06, Admiral Gary Roughead, then the Commander of the Pacific Fleet (PACFLT) indicated a desire to apply the NE06 L-V-C solution to exercise VALIANT SHIELD 07 (VS07), but the AF DMOC could not fit that event into the already bulging DMOC exercise schedule. So in January 2007, while observing the VS 07 Main Planning Conference to see if L-V-C could be applied to the Navy led live fly theater of operations in the Guam airspaces at a future date, both ALCOM and DMOC planners laid out plans for NORTHERN EDGE 08. The guidance was straight forward from Lt Gen Fraser…"Make NE08 a joint L-V-C exercise, and increase the Live to Virtual interaction." Immediately a Concept of Operations (CONOPS) was envisioned and an Operations View-1 was quickly scribbled on a "blank sheet of paper." By the end of the VS07 MPC, a vision for the future was delivered to ALCOM and thus NE08 L-V-C was born.

3 NORTHERN EDGE 08 Joint Service L-V-C Exercise

3.1 Battlespace and Network Challenges

Direction was clear…"Make it joint and increase L-V interaction." Based on that guidance USAF DMOC, NWDC, and TTGP set out to build a joint service network designed to push the envelope in several directions. We pushed to not only add more tactical simulation systems, but also in the use of cross domain solutions, controlled interfaces, dissimilar battlespace protocol integration, and voice communication initiatives. Figure 3-1 provides an overview of the entire NE08 network, and to the trained eye many of the network challenges are evident. What may not be so evident are the network approval processes, security considerations, CI issues, and battlespace protocol differences. All of these will be discussed, and as of this writing yet more approval process changes have been implemented at higher headquarters that will require another layer of coordination for approval of the NE09 network. Each issue will be explained in detail in this section.

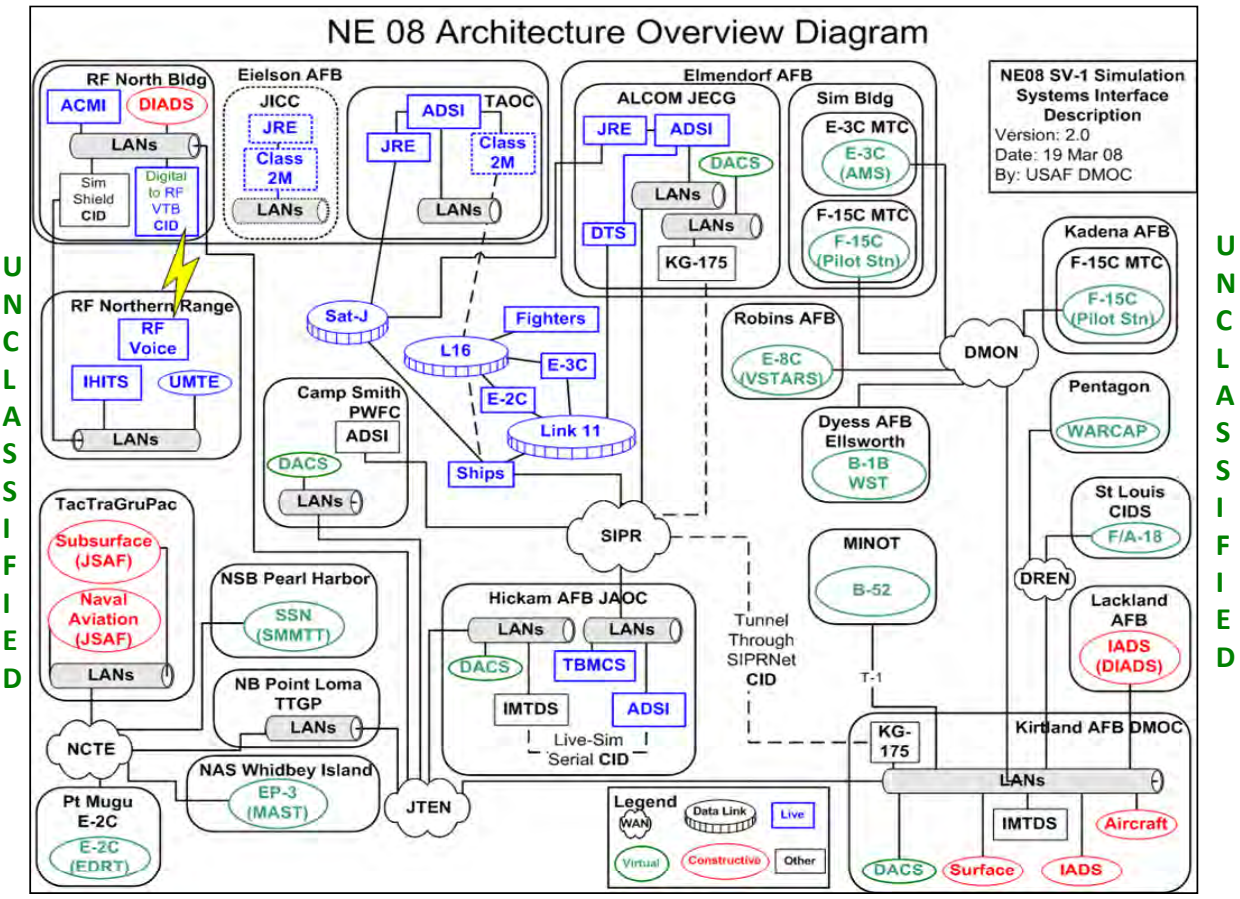

Figure 3-1 NE08 Systems View-1 (UNCLASSIFIED)

3.2 Support For NE08 Execution

First, it is necessary to understand that several agencies were involved in bringing about NE08. ALCOM is the executive agent for USPACOM and responsible to the USPACOM Joint Task Force (JTF) Commander for creating the joint training environment that meets his tactical level interoperability training objectives. Within ALCOM the J7 Directorate is responsible for exercise design and funding for what is typically a two week, large scale, force on force joint training event. At the service level, both the USAF DMOC and the Navy Warfare Development Command (NWDC), Newport, RI, provided operational and technical expertise for the joint L-V-C battlespace. Likewise, offices of Commander, Third Fleet (C3F) and TTGP (both in the San Diego, CA area) were involved, especially TTGP from a technical aspect bringing about terminal connectivity for Navy assets. Pacific Air Forces (PACAF) staff offices were also involved with NE08 in that some of the range and exercise control initiatives being worked for Red Flag-Alaska were already in work at the beginning of Joint Exercise Life Cycle (JELC) planning for NE08. Key to building an L-V-C plan for NE08 was early cognizance and recognition of potential capabilities upon which the NE08 battlespace could be built by leveraging off of the

PACAF initiatives. This resulted in AF DMOC interaction with the 353rd Combat Training Squadron (CTS) at Eielson AFB as they were engrossed in the process of obtaining persistent JTEN connectivity by means of the Sim Shield Guard. Together PACAF HQ and the 353rd CTS are developing significant capabilities and infrastructure for Red Flag Alaska to interface activities on the PARC ranges to the outside DMO world by means of JTEN and DMON connectivity. All Red Flag-Alaska range data output to the JTEN is in the form of TENA.

Building upon these key PACAF initiatives provided enablers for overall L-V-C battlespace operations in the PARC for NE08 and beyond. Security accreditation and approvals were accomplished by individual service standing network battlespace accreditations, but also for the NE08 event AF DMOC coordinated all CI activity with the DSAWG and the Secretary of the Air Force (SAF) offices. Likewise, PACAF IA personnel were involved locally for PACAF approval to operate the L-V-C TADIL-J CI merged battlespace picture at the 613th AOC, Hickam AFB. Likewise PACAF also contributed funding toward extra F-15C Mission Training Center (MTC) hard drives to participate in NE08, and the AF DMOC purchased equipment for operation of a digital-to-Radio Frequency (RF) Virtual Tactical Bridge (VTB). ALCOM provided funding for a needed virtual F-15C MTC Gulf of Alaska map extension. Lastly, the overarching security requirements of the exercise (SECRET US Only) dictated that an Inter Service Agreement (ISA) was established between AF DMOC, NWDC, JFCOM, and ALCOM for the purpose of ensuring data control and clean up procedures in the event of a data spill. Overall approval of the NE08 architecture would not have been possible without this ISA.

3.3 New Virtual Participants And Capabilities

Most of the virtual systems within the AF DMO battlespace were well established in exercise participation either on the DMON or other established USAF networks. However, new participation of the Kadena AB, Japan-based F-15C MTC required new hard drives for the simulator and a map extension in the GOA. In preparation for NE09, The Boeing Corporation has expanded the map database even more based on lessons learned in NE08. All of these additions generally require a long lead time to fund or coordinate, and thus the year long time required for the joint exercise life cycle to progress from the CDC, to the Initial Planning Conference (IPC), through the Main Planning Conference (MPC), and finally into the Final Planning Conference (FPC) is also time required to coordinate all the requirements of the L-V-C efforts.

Navy participation in NE08 added some new virtual simulator capabilities such as the virtual E-2C Deployable Readiness Trainer (EDRT) at Pt Mugu, CA, and the Submarine Manned Mission Tactical Trainer (SMMTT) at Pearl Harbor, HI. Scenario planning was expanded to include activity to challenge all of these new assets. Specifically, the virtual E-2C Hawkeye crew operated in support of the Joint Command and Control of Net Enabled Weapons (JC2NEW) JT&E. Coordination for JC2NEW began early at the USAF DMOC in that JC2NEW also participated in the USAF DMOC's VF08-1 to conduct Risk Reduction-1 in preparation for

their first Field Test-1 in NE08. Specific preparation for JC2NEW required the integration of the virtual F-18C simulator systems at Boeing's Center for Integrated Defense Simulation (CIDS), St Louis, MO facility.

3.4 Support for JC2NEW JT&E

Of the two USPACOM sponsored Joint Test and Evaluation activities included in NE08, one was determined to be best supported by live only. The other, Joint Command and Control of Net Enabled Weapons (JC2NEW), was better supported by joint V-C Modeling and Simulation as part of the overall L-V-C architecture. JC2NEW was supported in both the PARC overland north ranges and Gulf Of Alaska (GOA), and was the driving factor behind creating a V-C only airspace west of Eielson AFB similar to the live fly areas east of Eielson AFB. This new V-C area supported F/A-18C deployment of Standoff Land Attack Missile -Expanded Response (SLAM-ER) weapons requiring a scenario similar to the overall live environment, and was supported by a virtual E-2C and constructive P-3 inputs. The L-V-C scenario also provided additional support to JC2NEW for both overland and over water Tactical Tomahawk (TACTOM) employment.

JC2NEW chose to focus their activities in the L-V-C design of NE08, and in order to accommodate their scenario requirements, the USAF DMOC modified the GOA scenario significantly and created new V-C airspace in the PARC north range area west of Eielson AFB, AK. Figures 3-2 and 3-3 show the layout of both the PARC North Ranges and PARC GOA L-V-C lanes. The construction of the new lanes overland west of Eielson required some innovative scenario design on the part of AF DMOC JCATS personnel in that early on they ordered a low resolution map for the area, then carefully removed the Digital Terrain Elevation Data (DTED) to create a sea level maritime environment to support JC2NEW and the rest of the L-V-C activity. No problems were experienced from CIDS St Louis F-18C’s engaging targets in this area. Two E-8C crews supported the PARC North Range area from both Robins AFB, GA and from the AF DMOC. How this enhanced live operations will be discussed in section 3.5 of this paper in greater detail.

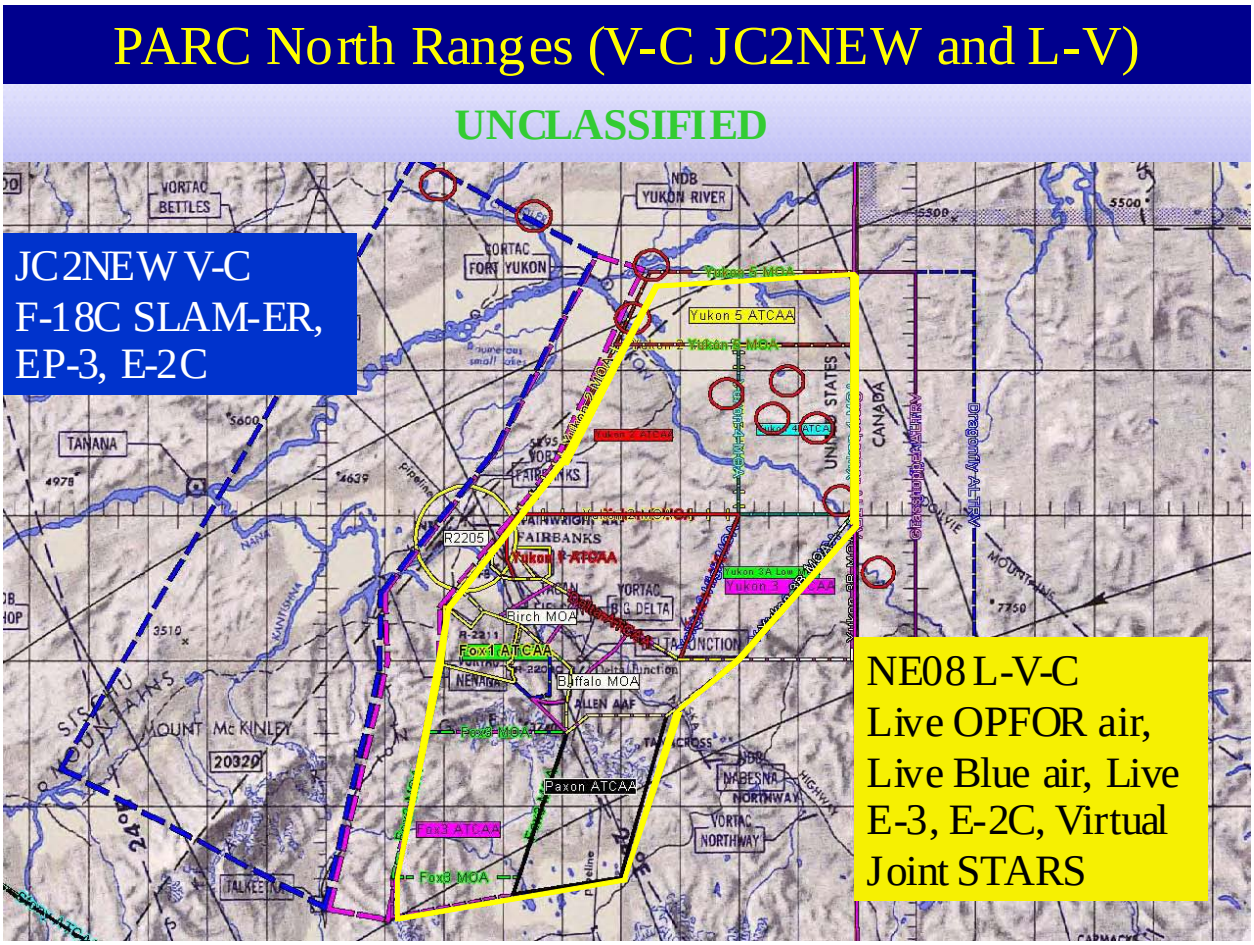

Figure 3-2 NE08 L-V-C PARC North Range Areas (UNCLASSIFIED)

The addition of the V-C only lane west of Eielson AFB and live play areas to the east created a whole new dimension for L-V-C operations overland in the PARC North Ranges. Safety of flight for live aircraft was not hindered as all V-C participants orbited outside of the live areas, and a buffer was created between the two areas to act as a safety cushion and also a corridor for live aircraft to transit to and from the live area as needed. The merged TADIL-J picture was clean with both live and virtual C2ISR crews maintaining very strict TADIL-J link discipline. This deconfliction methodology was also used in the PARC GOA training areas.

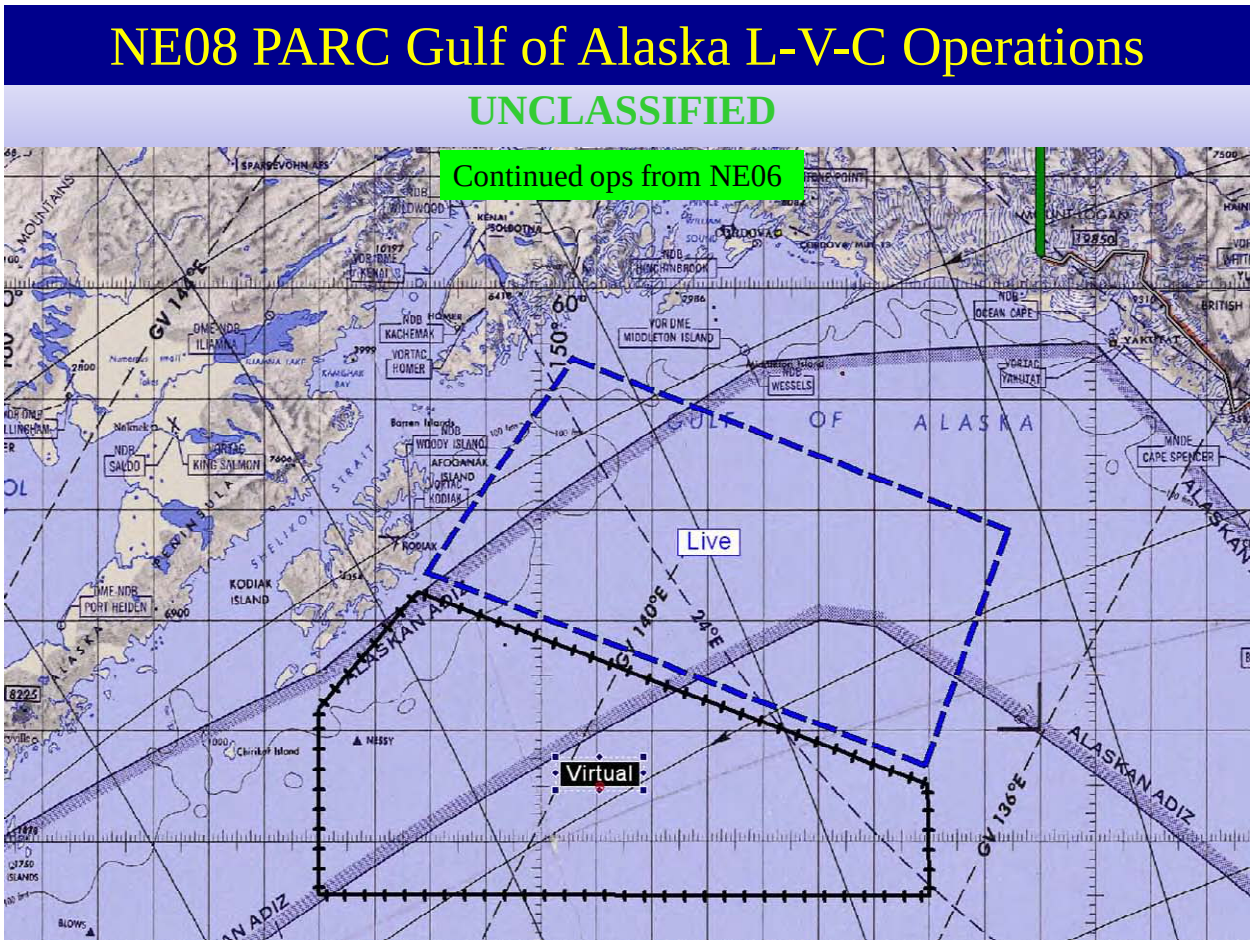

Figure 3-3 NE08 L-V-C PARC GOA Range Areas (UNCLASSIFIED)

PARC GOA operations were conducted similarly in that aircraft from Elmendorf AFB, AK were planned to flow straight south into the live areas depicted in the northern part of the GOA Range, and the V-C participants operated in the south with forces flowing from a simulated base east of Elmendorf AFB and a simulated US Navy Carrier Strike Group. While NE08 GOA L-V-C operations were planned to continue very much the same as in NE06, bad weather precluded live aircraft and ship play in the GOA. Hence, joint live air operations were continued in the PARC North Ranges. AF DMOC supported live aircraft in the PARC north ranges by injecting an IADS TADIL-J picture in the North Range airspace, while simultaneously operating V-C operations in the GOA. Continued V-C operations in the PARC L-V-C North Range airspace had not been planned beyond the first three days of the exercise since it was expected that the weather would allow planned operations in the GOA. In spite of these changes to the plan, L-V-C operations continued unhampered with superb, joint interoperability focused training accomplished by all. A totally merged L-V-C TADIL-J COP was displayed for both working areas as one display at the 613th AOC and the Elmendorf JECG. The first three days of side-by side L-V-C operations in the PARC North Ranges requires further explanation, and plans for

NE09 call for flexibility to conduct the L-V-C exercise in either airspace as weather conditions dictate.

3.5 NE08 PARC North Range L-V-C Initiatives

Creating a totally merged L-V-C airspace in the PARC north Range area was initially conceived as direct support for JC2NEW alone, but it quickly became apparent that there was so much more that could be done in this cleverly designed and operationally lucrative solution for the NE08 training audience. While PACAF and the 353rd CTS continued working toward the Certification Test and Evaluation (CT&E) process for their Sim Shield Guard to allow persistent connectivity to the JTEN at Eielson AFB Red Flag-Alaska Range Control facility, AF DMOC saw another opportunity to implement some initiatives based on ideas learned much earlier. With the addition of the Eielson JTEN connection, this meant that instrumented vehicles and digital-to-live RF voice communications were possible. Upon introducing these ideas at the IPC and Technical Interchange Meeting (TIM) held at the AF DMOC in the fall of 2007, ALCOM, PACAF, and the 353rd CTS quickly embraced the concept and gave the green light for AF DMOC to pursue the solutions. This required long term close cooperation between all three organizations as plans were quickly drawn up to implement these very important additions. The goal was to create the environment COMALCOM had called for to allow increased L-V interoperability and support for the live training mission, while also enhancing training for all virtual C2ISR crews. The plan called for AF DMOC to convert the TENA format output of the Sim Shield Guard at Eielson Red Flag-Alaska Range Control to the DIS protocol to be able to virtually track the live instrumented vehicles on the North Range road structure. The instrumented vehicle data was transmitted to the Red Flag-Alaska Range Control facility via the existing Army Initial-Home Instrumented Training System (I-HITS) tower network operated by US Army Alaska range operations at Fort Wainwright, AK. The system in now just called the HITS system and one can think of it as a ground version of the Air Combat Maneuvering Instrumentation (ACMI) system. The 353rd CTS covered the cost of instrumenting these vehicles and covered them with brightly colored tarps. They were operated on road segments covered by the I-HITS system to be translated to DIS by the USAF DMOC and then broadcasted on the battlespace network for any virtual C2ISR with a surface radar capability to track. However, primary responsibility for tracking these live instrumented vehicles fell to the virtual E-8C VSTARS crew participating from Robins AFB, GA, with secondary assistance from the virtual E-8C VSTARS crew operating from the USAF DMOC.

With the Robins virtual E-8C orbiting in the V-C lanes to the west and the AF DMOC virtual E-8C orbiting to the east of the live airspace there was continued virtual radar coverage of the live area. The shared virtual radar responsibility also allowed for the USAF DMOC to populate the live lanes with preplanned constructive vehicle ground movement, designed to maneuver toward locations that were easily recognizable by live aircraft visually. Between the live vehicles converted to DIS and the constructive vehicles created in JCATS, a large surface movement picture was created for live aircraft support, all of which was tracked by two

VSTARS using TADIL-J J3.5 ground tracks for sustained accurate tracking on all of the live and constructive vehicles. TADIL-J was automatically received by live fighters operating in the live areas of the PARC North Ranges due to the CI for TADIL-J described earlier at the 613th AOC at Hickam AFB, HI. But unlike some of the shortfalls experienced in earlier applications of instrumented vehicle tracking on live ranges, one thing further was required…the ability for the virtual crew to talk to the live aircraft. USAF DMOC called upon their Navy brethren in Orlando, FL, for the solution, and the Naval Air Warfare Center Training Systems Division (NAWCTSD) Concept Development and Integration Laboratory (CDIL) Virtual Tactical Bridge (VTB) Technology folks came through in a most enthusiastic way. The VTB is a Marine Digital Voice (MDV) based application, and was undergoing certification testing as of the NE08 implementation. The NAWCTSD CDIL team conducted a site survey at the 353rd CTS Red Flag Alaska Range Control Facility in the spring of 2008 and made good recommendations for implementing a VTB solution. USAF DMOC worked with the Red Flag-Alaska planners to get approval to use two radios for two live operational frequencies. Figure 3-4 shows the proposed VTB implementation at the Red Flag- Alaska Range Control facility as well as the Sim Shield Guard.

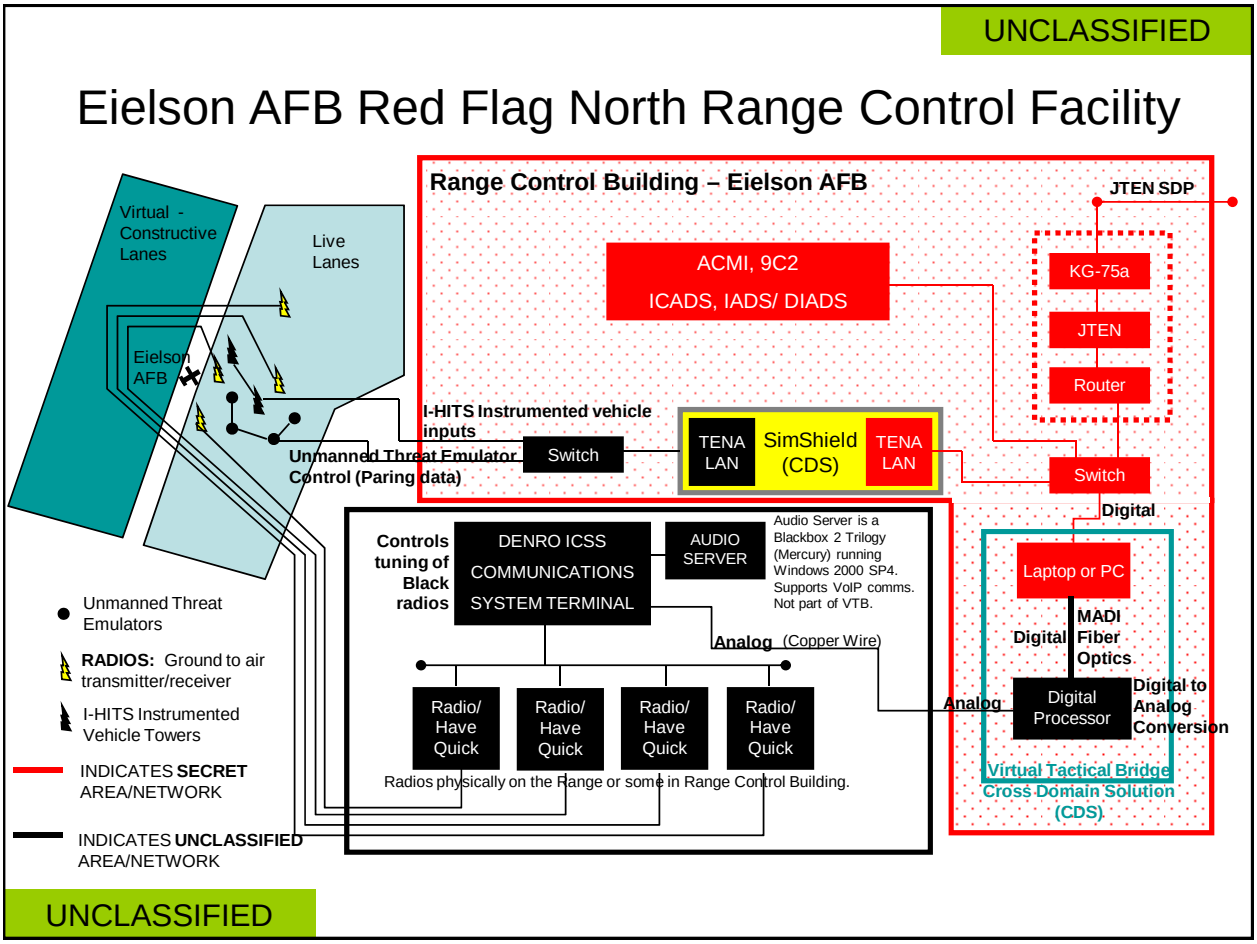

Figure 3-4 VTB and Sim Shield Guard Installation (UNCLASSIFIED)

The USAF DMOC then purchased the hardware for the VTB and shipped it to the NAWCTSD CDIL laboratory in Orlando, FL, for initial configuration. It was then shipped to Eielson AFB, AK accompanied by an engineer from NAWCTSD CDIL for final installation and set up. The VTB worked flawlessly!

Additionally, the USAF DMOC was responsible for getting approval for use of the VTB as a CID to satisfy DSAWG requirements. Use of the VTB in this sort of a situation was also a goal for NAWCTSD as the Navy had also desired to implement this kind of a solution, so this initial step was mutually beneficial for both Services. Obtaining approval for the CI required the same DSAWG process as for all of the other CI issues, but again a case was built to present this to the DSAWG as a CI for which no guard was required. This was also the way AF DMOC approached DSAWG for the CI approval for merging the L-V-C TADIL-J picture. By first satisfying all requirements for a totally US SECRET battlespace, and by installing equipment in totally US SECRET facilities the foundation was laid for achieving DSAWG approval on all CI's. A case was made for the CI solution in that although the DMO networks are SECRET, voice communications are the responsibility of virtual crewmembers and were therefore considered unclassified, given appropriate adherence to operations security dictated in the exercise special instructions. Also, the case for the CI was made in that it was very low risk that anyone on the live side of the voice communications solution could gain access back into the classified network via the unclassified voice communication system. Two frequencies were operated from digital-to-live such that both the virtual E-2C Hawkeye crew and the virtual E-8C Joint STARS crew could talk to the live E-3C Airborne Warning and Control System (AWACS) aircraft flying in the live portion of the PARC North Ranges. Additionally the virtual E-8C Joint STARS crew could also talk to live fighter surface strike aircraft also operating in the live portion of the PARC North Ranges. Together with the digital-to-live voice communications, the L-V-C TADIL-J picture, and with surface vehicle locations visible on the ground for strike aircraft, a truly merged L-V-C training environment existed and overall great training was accomplished for the first time in this manner on a live range with such a widely geographically and time zone separated L-V-C training audience.

3.6 Expansion of PARC North Range Capabilities Into The GOA

Operating a VTB in the GOA presents challenges as there are limited facilities and networks currently located near or in the GOA that will allow for a digital-to-live RF voice capability, but it is currently being explored as there are some options. Instrumentation of the GOA with live surface movers and emitters is an on-going goal of ALCOM. Forward momentum from NE06 to NE08 might have been realized had it not been for the weather problems associated with an unfortunately timed weather system in the GOA during NE 08 execution, but this is being re-attacked for NE09. On the other hand, an L-V-C TADIL-J merge has always been possible by means of live Navy ships operating in the GOA operating a data link architecture similar to the PARC North Ranges where ground Marine Corps units have supported live TADIL-J.

3.7 NE08 Battlespace Protocol Differences

In all, there were three different simulation protocols used in the NE08 joint battlespace as follows: DIS, HLA, and TENA. DIS is primarily used by the Air Force, while the Navy uses both DIS and HLA. The Navy NCTE architecture uses existing Gateway technology to convert from DIS to HLA. The AF DMOC converted TENA to DIS, but some other network issues created problems for that solution. However, the TENA to DIS solution has since been resolved and implementation of that will be of no concern for NE09 with several solutions now possible. Translation between protocols has matured enough so that a joint service L-V-C battlespace combined with live range operations is now totally possible.

4 JT&E, T&E and Experimentation

4.1 Support In General

L-V-C enhancements and direct support to JT&E, T&E, and experimentation are possible certainly within the NORTHERN EDGE series of exercises and perhaps other tactical interoperability focused exercises provided such support has application to the event particular training objectives and audiences. In the case of NE08, a large portion of the joint L-V-C battlespace was created or modified to support JC2NEW, and this occurred not only in L-V-C NE08 but also in the AF DMOC V-C VIRTUAL FLAG exercise as a Risk Reduction leading up to NE08. Looking ahead toward NE09 there is a potential experimentation requirement being looked at for possible inclusion in the L-V-C battlespace mix that may or may not have total network interoperability by the time NE09 executes, but may be useful to the virtual crews to implement the procedures from this experimentation during actual event execution. There needs to be a balance between how much this activity interacts with current day capabilities and future capabilities since much of the TTP development and crew training centers around existing capabilities. Provided the JT&E, T&E, or experimentation does not “hijack” focus and resources in an out of balance fashion, there is certainly room for supporting these kinds of unique testing requirements and hence, they are generally encouraged by higher HQ since many of these initiatives stem from real world problems that need solutions.

As stated in the Abstract, L-V-C training events provide opportunities to support test. This leverage is best illustrated through systems evaluation for mission suitability within OT&E and TTP development during JT&Es. Leveraging training events and tools for test directly supports DOD’s emerging acquisition thrust area concept (Figure 4-1), encouraging the use of common data, tools, and services to conceive, design, develop, test, and train new capabilities.

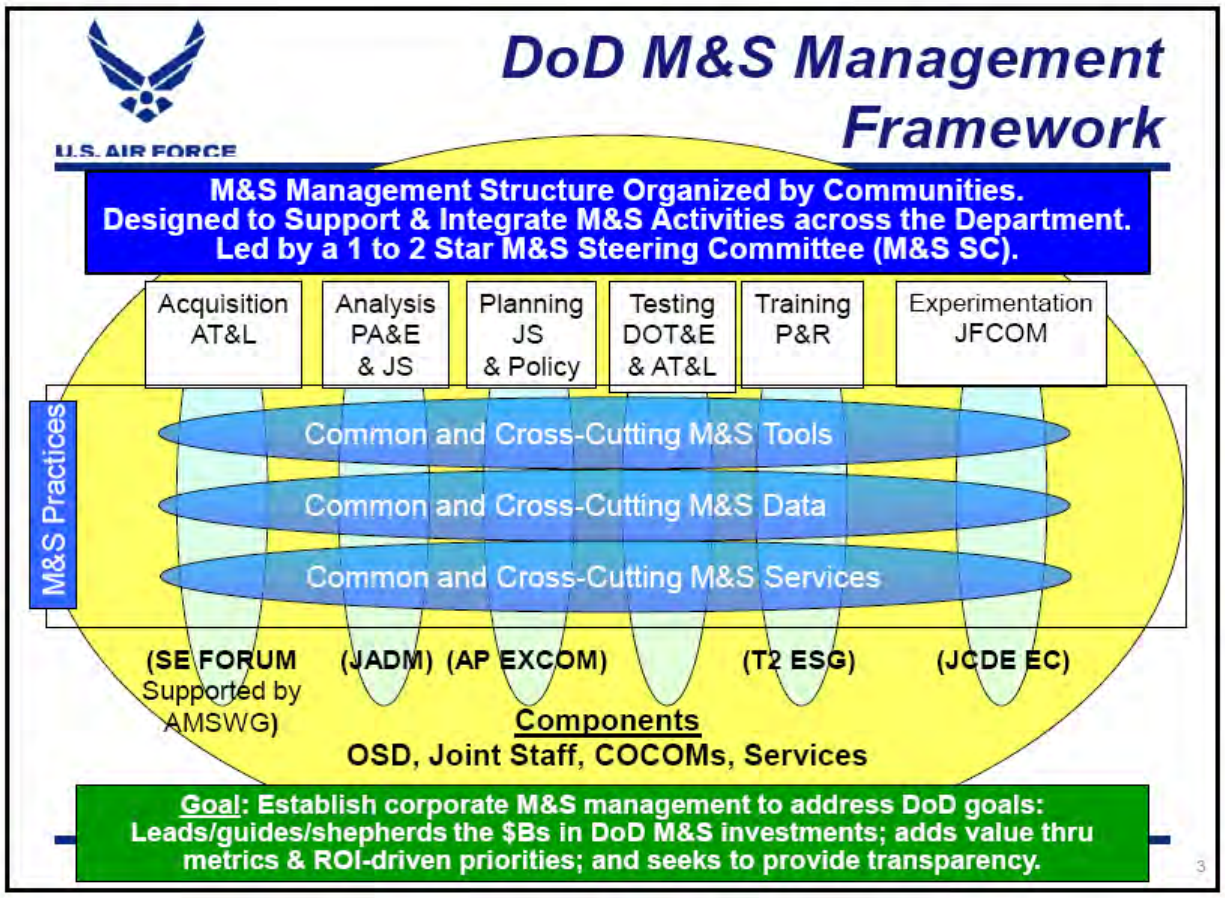

Figure 4-1 DoD M&S Management Framework (UNCLASSIFIED)

4.2 Specific Observations Regarding T&E

Every opportunity to smartly balance training and test requirements should be pursued, so that both communities' objectives are met without undue compromise. Within the L-V-C (and M&S) world, that means using as many common data, tools, and services as possible. However, there are significant challenges facing this ideal.

First, there are competing objectives for model fidelity. Within the training community, one finds models that must be real-time (or faster) for execution. Due to the sheer mathematical complexity of processing, these training models tend to be effects-focused, i.e. does the model adequately mimic real-world experiences for the training audience? Training audiences are not focused on monitoring and collecting detailed flight characteristics such as flutter, which may be modeled at less-than-real-time to ensure complete analysis. They are, however, interested in the model giving the appearance of proper flyout, tracking, and engagement.

Secondly, data availability is directly proportional to model fidelity. For example, in a training environment, only the DIS PDU packet (or similar simulation protocol such as HLA or TENA) goes out across the network and can be collected. There are no modeled waveforms or

instrumentation packets sending streams of data back to collection points for post-test analysis. Likewise, the dearth of data produced by test has the potential for significant bandwidth use, which may impact training events with hundreds or thousands of systems participating at once.

Given these limitations, one may ask exactly how we might utilize the M&S portions of L-V-C to meet training objectives. As detailed throughout, it comes down to objectives. A test event during OT&E or a JT&E could certainly explore TTP development using the extremely robust threat and network environment possible in an L-V-C training exercise. The JC2NEW portion of NORTHERN EDGE '08 is a perfect example of such a test. JC2NEW was not looking to collect flight data on the TACTOM and SLAM-ER; they instead sought to test novel employment techniques in an operational environment.

One should not look at the success of JC2NEW in NORTHERN EDGE '08 as the only example of a test and training L-V-C merge. The possibilities are boundless to integrate emerging cyber, information operations, and space simulation capabilities with live training events on ranges such at the Nellis Test and Training Range (NTTR) and the National Training Center (NTC), in order to evaluate employment effects on modeled enemy networks and systems. Additionally, the testing of new aircraft instrumentation pods, such as the P5, during live training events prompted the DMOC to work with the Joint Mission Environment Test Capability (JMETC) to develop the Maritime Synthetic Research (MSR) TENA-DIS gateway solution. This gateway enabled P5-pod equipped test aircraft at the NTC to feed directly into the DMOC synthetic battlespace, paving the way for future live test events to integrate with larger virtual and constructive training exercises. .

Looking to the future with a firm grasp on model and data fidelity limitations, one can visualize fully networked, DIS, HLA, and TENA-compatible live, virtual, and constructive test and training ranges, with each containing high-fidelity modeled threat systems and necessary data collection and transmission networks. On one range, a JT&E is evaluating new TTP against a known enemy super threat, with live, instrumented systems-under-test fully immersed in a V-C threat environment. At the same time, another live range is carrying out large force maneuvers, supported by live aircraft and V-C UAVs. Simultaneously, a VIRTUAL FLAG is underway, bringing in air, land, sea, and space forces within a major V-C combat operation event. What ties these apparently separate events together? The live JT&E is flying over the same IADS as the VIRTUAL FLAG players. The VIRTUAL FLAG virtual E-8C has full visibility over not just the virtual-constructive fight, but also the live ground training, and is able to accurately track the instrumented enemy ground forces and provide ISR to the all ground forces, live and constructive, in both VIRTUAL FLAG and the maneuver exercise. A virtual JTAC integrates with all three events, effectively improving the JT&E TTP while getting effective training from interaction between himself, the VIRTUAL FLAG participants, and the maneuver forces. All the while, the three events are integrated across TENA, DIS, and HLA networks, merging themselves into a system of systems, communicating seamlessly across environments, and meeting their individual and collective objectives.

Such a future is within reach given creative thought, smart technology investment, and time. It will require the training and test communities to seek out common interoperability solutions, allowing joint forces to test out their systems outside of stovepipes and within a greater net. This vision would satisfy the construct of the DOD acquisition thrust areas, and move both test and training toward a collaborative, intelligent, future. The T&E and training worlds must focus on finding ways to cross the bridge between stove-piped range issues, providing small stepping stones that could lead to achieving similar goals and objectives by pooling resources and saving dollars in an ever more constrained resource environment. In the greater training and T&E communities, a need exists to find ways to better coordinate and consolidate training and testing to achieve the goals and objectives of all live ranges and their interaction with the existing joint L-V-C battlespace.

5. Conclusion

Over the past ten years of continued L-V-C distributed simulation growth, many of the ideas, trials and errors, and money spent came to fruition in the NE08 exercise conducted from 5-16 May 08. As a result, over 5000 live and virtual participants received extremely valuable training and furthered development of critical joint interoperability TTP's in a very important JTF joint operations area. ALCOM, AF DMOC, and NWDC planners are already "leaning forward" toward achieving a similar design for NE09 to once again address important real world issues and to carry these solutions forward to more of USPACOM's series of live- tactically focused exercises such as the Navy led VALIANT SHIELD.

The results of NE08 clearly demonstrated even greater potential for upward spiraling growth toward achieving a totally integrated L-V-C Joint National Training Capability just as former Secretary of Defense Donald Rumsfeld envisioned. Support for JT&E, T&E, and experimentation is quite possible within the confines of joint L-V-C battlespace when and where these effort are in concert with established joint training goals and objectives and not perceived to be competing with pressing training audience objectives. Finally, there is an ever pressing need to achieve synergy in combining and pooling T&E programs in efforts to streamline and better expend limited resources. The result will be affordable solutions achieved faster for the warfighter—America's most precious resource.

6. Biographies

Mr Philip J. Harvey is a Project Officer for Scientific Research Corporation (SRC) at the United States Air Force Distributed Mission Operations Center at Kirtland Air Force Base in Albuquerque, New Mexico. He is a retired Air Force Officer with over 20 years of C2ISR experience and almost fifteen years of experience in JT&E and L-V-C growth as an IFFN JTF, TACCSF, and AF DMOC Project Officer. Phil is a combat veteran of Desert Storm and Operation Southern Watch. He was a USAF Air Battle Manager with experience as a NORAD ground Air Defense Controller. He was an Air Weapons Controller and Mission Crew

Commander in the NATO and US E-3 AWACS, has experience with the Joint STARS aircraft. He led many of the early DESERT PIVOT and VIRTUAL FLAG exercise development projects, the first USAF/USN VF/FST-J exercise, and all AF DMOC NORTHERN EDGE exercise development to date. He led the AF DMOC's development of the first Multi-National Information Sharing (MNIS) connectivity and exercise with the United Kingdom and is the MNIS team lead for the AF DMOC's first Coalition VIRTUAL FLAG by further developing the AF DMOC MNIS Guard capability. He is Team Lead of the Advanced Projects section within SRC at the AF DMOC.

Mr Steven D. Hatter is the Alaskan Command Joint Training and Ranges Administrator with the Alaskan Command Joint Staff located at Elmendorf AFB, AK. He recently retired from the US Air Force as a Colonel after 26 years of service where as a fighter pilot he flew the F-4 Phantom and the F-15E Strike Eagle. Over his career, Steve served in various key command positions to include fighter squadron command and leadership at the group command level. He also served in key staff positions at the Pentagon and most recently at Alaskan Command as the Director of Operations, and later as the first-ever Director of Training and Exercises pursuant to a staff reorganization in 2004. He served as the Exercise Director for numerous joint training events in Alaska to include NORTHERN EDGE 2004, 2005, and 2006. Steve is a combat veteran of Desert Storm, Operation Southern Watch, and Operation Enduring Freedom. He is a graduate of Vanderbilt University with Masters degrees from Troy University and the Naval War College. He is currently pursuing an additional Masters degree in Project Management at the University of Alaska, Anchorage.

Major Michael N. Davis is the Assistant Director of Operations – Technical, for the United States Air Force Distributed Mission Operations Center (705th Combat Training Squadron) at Kirtland AFB NM. Major Davis is an engineer, with assignments in aircraft maintenance, battle damage repair, non-destructive inspection for corrosion research, officer basic training, deployed embedded training with the Afghan National Army, and modeling and simulation system planning, research, development and engineering at the DMOC. He has served as Military Assistant to the Commander for Aeronautical Systems Center and also at the Director of Operations for the 36th Student Squadron at Maxwell AFB AL. Maj Davis maintains oversight of all simulation development and engineering programs at the DMOC, with a combined budget of over $27 million. He is also the L-V-C training integration lead for the United States Air Force Warfare Center. Major Davis is a 1997 graduate from The Ohio State University, with a Bachelor of Science in Metallurgical Engineering. He will complete his Masters degree in Military Operational Science through Air University in April 2009, and has been selected to attend the Air Force Institute of Technology's Master of Systems Engineering Intermediate Developmental Education Program in May of 2009.