Simulating the Whole Picture with distributed Mixed LVC

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ABSTRACT

Bold Quest (BQ) is a Joint Staff J6 coalition capability demonstration and assessment event focused on improving joint fires interoperability in a coalition environment. It provides a rich operational environment for assessing new training and simulation technologies, integrated with live command and control (C2) systems.

BQ 22 built on the successes of the last several years' work to create interoperable Live, Virtual, and Constructive (LVC) environments, breaking new ground in multi-domain integration between simulated and live forces. The Ft. Stewart Mission Training Complex (MTC), 15 Air Support Operations Squadron (ASOS), Colmar Urban Training Center, and DOD experimental vessel, Stiletto, all served as execution locations. The Royal Netherlands Army provided a live instrumentation system (Tactical Engagement Simulation System (TESS)), worn by live units on the ground. TESS allowed virtual and constructive participants to see, react to, and engage live players. The 57 Operations Group provided immersive Advanced Training and Tactics for Combat Kills (iATTACK), which pushed simulated video to a live video downlink. Simulated units exchanged Link 16 messages with live participants, through a J6 Joint Assessments Division (JAD) software application that translated Joint Range Extension Applications Protocol C (JREAP-C) and the Distributed Interactive Simulation (DIS) Link 16 protocols (DOD, 2008).

As a "capstone event" highlighting these mixed LVC capabilities, 165 ASOS executed a live Precision Strike Team (PST) scenario, using all these integrating capabilities. The live PST JTAC team at Colmar communicated via HF voice and Link 16 with a small C2 cell at the Fort Stewart MTC. That C2 cell communicated via DIS radio with the virtual MQ-9 crew at Hurlburt and the 132 Combat Training Squadron at Des Moines, IA, who played the role of Ground Force Commander.

This paper describes the lessons learned in conducting mixed LVC events, proposes some long-term implications of distributed mission training, and outlines future ways to improve coalition force interoperability and readiness.

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INTRODUCTION

There is a rhythm to being a participant in an international interoperability exercise – plug in, get assigned network addresses, direct your data to where other systems can find it, and execute interations in support of training objectives. If you are lucky, you can integrate behind the scenes without the weight of interfacing with a test or a training objective being put at risk.

There is a standing assumption by many in the training audience that their requests can just be dialed up. That, for example, all the interactions of a distributed aircraft simulator with their JTAC Simulator in the context of a coalition ISR Scenario will simply *work*. The completion of the integration work behind the scenes is often taken for granted, and the system owners seldom have the chance to learn and stretch their experiences into the realm of the possible. This makes the opportunities for interoperability and demonstration work performed in a safe place to fail even more critical. One of these test and exploration events is Bold Quest (BQ) -- a Joint Staff J6 coalition capability demonstration and assessment event focused on improving joint fires interoperability in a coalition environment (Gross, Hobson, & Bouwens, 2016). It provides a rich operational environment for assessing new training and simulation technologies, integrated with live command and control (C2) systems.

THE CHALLENGE

The Bold Quest Live/Virtual Environment was created to provide a venue where Nations, Services, and Programs can demonstrate and assess ways to create more capable and interoperable simulation environments to build and maintain coalition joint fires proficiency. This includes three goals:

- Demonstrate and assess ways to build individual and collective joint fires skills in a coalition environment.
- Identify tools, processes, and new technologies to improve distributed simulation capabilities and close interoperability gaps.
- Provide stakeholders a collaborative environment to support sustained improvement.

Conducted at the Fort Stewart MTC, adjacent sites and ranges in coastal Georgia and distributed sites across the U.S., Bold Quest 22 (BQ22) was an excellent venue for experiments in mixed LVC environment integration. As in previous years, BQ participants established a distributed simulation environment spanning multiple networks that supported participating Nation and Service objectives.

The primary networks supporting BQ22 included the Bold Quest Mission Network (BQMN) and the Bold Quest - Unclassified (BQ-U) network. Both use the NATO Federated Mission Network (FMN) / Mission Partner Environment (MPE) architecture and principles. These two networks were the central means of connectivity for all partners during BQ22. Additionally, U.S. units connected from U.S. specific training networks, including the Joint Staff J7's Joint Training Enterprise Network (JTEN), USSOCOM's Special Operations Force (SOF) Training and Exercise Network (STEN) and the Air National Guard's Air Reserve Component Network X (ARCNet-X).

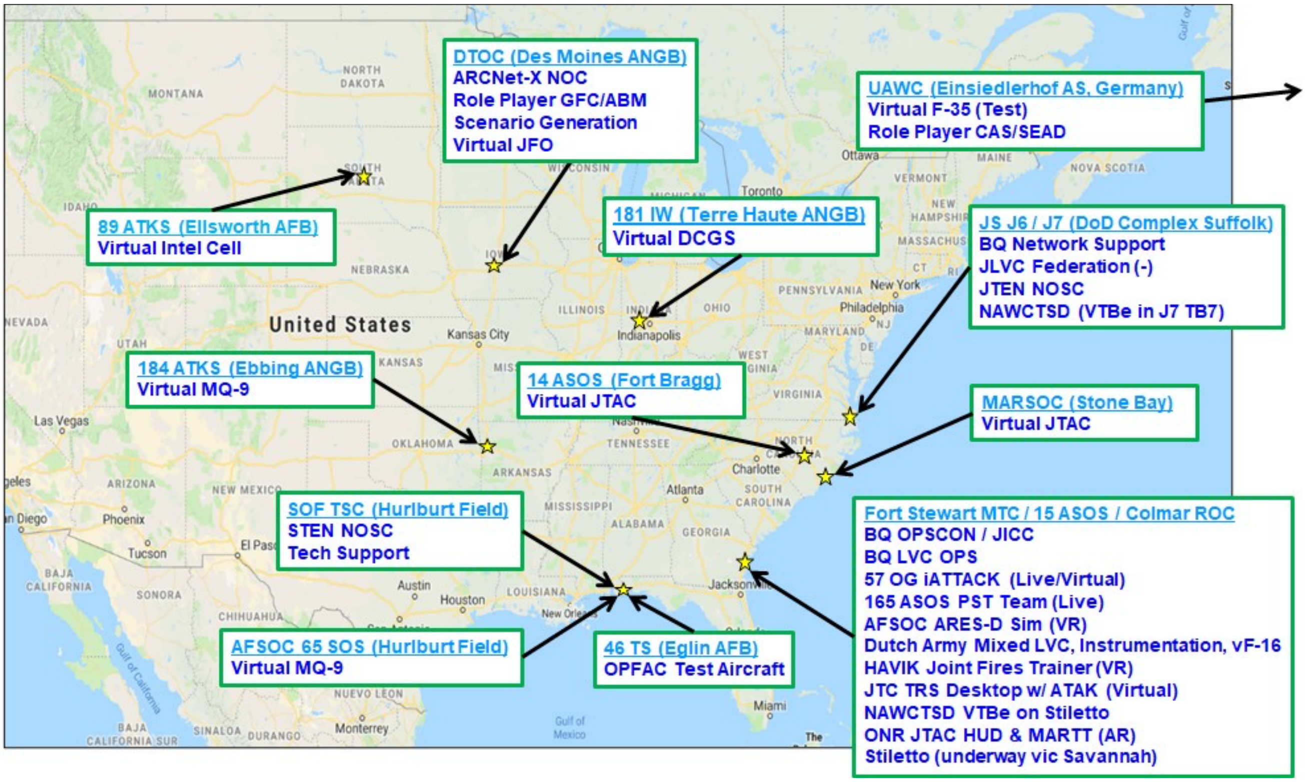

Figure 1: BQ 22 Participating Sites

In the Fort Stewart area, LVC operations were conducted at the MTC, 15th Air Support Operations Squadron (15 ASOS), Colmar Urban Training Center (UTC) and on board the DoD experimental vessel, Stiletto. Taking advantage of the live ranges and capabilities at Fort Stewart, BQ22 focused on mixed LVC operations to improve interoperability and the integration of simulated and live forces.

EXECUTING LVC

Multiple critical capabilities have been identified over the years as necessary for creating Live, Virtual and Constructive (LVC) environments (Seavey, Reitz, Hanne, 2019). Some of these lay in the importance of providing a task-realistic, cognitively correct training environment to prevent mistakes being experienced first in a real-life situation (Scales, 2013); other critical capabilities are more focused on the technology that enables an inter-woven LVC environment. The critical LVC integrating capabilities demonstrated by government organizations during BQ22 included:

- **Instrumentation:** The Royal Netherlands Army provided a live instrumentation system (Tactical Engagement Simulation System (TESS)). Live units on the ground (USMC platoon and Joint Terminal Attack Controllers (JTACs)) wore TESS to support LVC integration. TESS allowed the virtual and constructive participants to see, react to and engage live players.

- **Communications:** Joint Staff J6 Joint Assessments Division (JAD) provided the ability to bridge live and simulated radio traffic using the ASTi Voisus system. This capability allowed live JTACs on the range to communicate via voice with a virtual MQ-9 crew at Hurlburt Field, FL.

- **Sensor Stimulation:** The 57 Operations Group provided the immersive Advanced Training and Tactics for Combat Kills (iATTACK) system that, among other capabilities, provided the ability to push simulated video from the network to a live video downlink that live players at Colmar could view on handheld devices. The iATTACK system participated in all three baseline scenarios (F2T, SCAR/AI, Urban Assault) and a live Coalition Intelligence, Surveillance and Reconnaissance (CISR) event. The system provided a taskable, simulated MQ-9B platform, remote full motion video (FMV) onto the BQ-U network, and Live RF target-sensor video to all local joint exercise participants training at the Colmar UTC.

- **Tactical Messages:** The 46th Test Squadron personnel in the Combined Interface Control Center (CICC) provided the ability for simulated units to send and receive Link 16 messages with live participants. JAD also provided software to translate two-way between Joint Range Extension Applications Protocol C (JREAP-C) and the Distributed Interactive Simulation (DIS) Link 16 protocols (DOD, 2008).

Table 1. Critical integrating capabilities contributed by BQ Participants

Sponsor		Location	Instrumentation	Communications	Sensor Stimulation	Tactical Messaging
Royal Netherlands Army	• TESS & Mobile Combat Training Center (MCTC) • Virtual Mission Combat Simulator (MCS) • Steel Beasts Pro • Virtual Battlespace 4 (VBS4)	On Site	X	X	X	X
UAWC	F-35 Effects-Based Simulator (EBS) Role Player Pilots for F-16C & A-10C	Distributed			X	X
46th Test Squadron	Operational Facility (OPFAC) test aircraft and Tactical Data Links (TDL)	Distributed & On Site				X
NAWCTSD & Joint Staff J7	Virtual Tactical Bridge – Enhanced	Distributed			X	X
AFAMS	MACE	On Site			X	
57th Operations Group	iATTACK	On Site	X		X	
181st Intelligence Wing (181 IW)	Processing, Exploitation and Dissemination (PED) crews	Distributed			X	
65th Special Operations Squadron (65 SOS)	MALET Stand-Alone Trainer (MSAT)	Distributed				X
184 ATKS / 188 Wing	MALET Stand-Alone Trainer (MSAT)	Distributed			X	X
132nd Combat Training Squadron (132 CTS) / Distributed Training Operations Center (DTOC)	MACE	Distributed		X		
89th Attack Squadron (89 ATKS)	Intel support systems	Distributed		X		X

Supporting these participants were distributed capabilities, white cells, role players, and other critical participants. The 132 CTS (DTOC) developed, generated and supported the three baseline scenarios for BQ22:

1. *Find, Fix, Track (F2T)*
2. *Strike Coordination and Reconnaissance (SCAR) / Air Interdiction (AI)*
3. *Assault on an Urban Area*

DTOC 132 CTS collaboratively designed the scenarios to provide increasingly demanding scenarios that supported the desired learning objectives of the participants involved. Through the scenarios, the successful integration of joint and coalition LVC capabilities into a synthetic training environment led to 84 personnel trained on 750 quantifiable tasks, allowing participants to meet qualification and currency requirements while demonstrated new and emerging technologies. The F2T missions resulted in identifying objectives for the SCAR and AI missions. The SCAR and AI mission results opened the way for the assault and defense missions to execute.

184 ATKS / 188 Wing supported BQ22 with its simulated Mission Control Element (MCE) flown by live aircrews operating a virtual MQ-9. As its first foray into Bold Quest, 184 ATKS participated in distributed missions with the 65 SOS virtual MQ-9, UAWC's virtual F-16, virtual JTACs from MARSOC and 132 CTS, the iATTACK virtual MQ-9, 165 ASOS PST live at Colmar, NLD Army F-16 and AH-64. All systems were able to connect in a common synthetic environment. Throughout the event, the crew (Pilot, Sensor Operator and Mission Intelligence Coordinator) participated in a complex CAS and CSAR scenario.

During the CSAR scenario, the crew was able to respond and assumed On Scene Commander (OSC) duties. System communications were effective allowing for execution of a quality CSAR scenario. More involvement on a follow-on mission with the Arkansas Distributed Ground System (DGS) occurred during the second day's scenarios, which provided quality training for both group's personnel. Arkansas DGS was able to make realistic, real-world mission products from the virtual feed. This capability could be used to advance virtual exercises/operations from day to day, versus repeating the same scenario each day.

The Royal Netherlands Army, supported in part by Saab, brought the Tactical Engagement Simulation System (TESS) range instrumentation system to equip a contingent of U.S. Marines. The kit includes a small arms laser transmitter that attaches to a rifle barrel to detect muzzle flash and recoil and a sensor vest with GPS to track location and movement of the trainee. The vest also includes laser detectors to detect weapons "hits" and audible status indicator of near miss, hit, kill, or wound status. The detector vest sensors communicate via RF to a centralized antenna erected at Colmar training village for data collection. The antenna feeds the Mobile Combat Training Center (MCTC) that captures and displays the data and converts it into Distributed Interactive Simulation (DIS) protocol for use within the virtual environment. This information facilitates the integration of live ground force training within the larger LVC environment. SteelBeast Pro and Virtual Battle Space 4 (VBS4) systems generated additional simulated forces, to include constructive Dutch armored vehicles and infantry. This combination of LVC training elements, often called *blended* training, enables data collection, analysis, and after-action review.

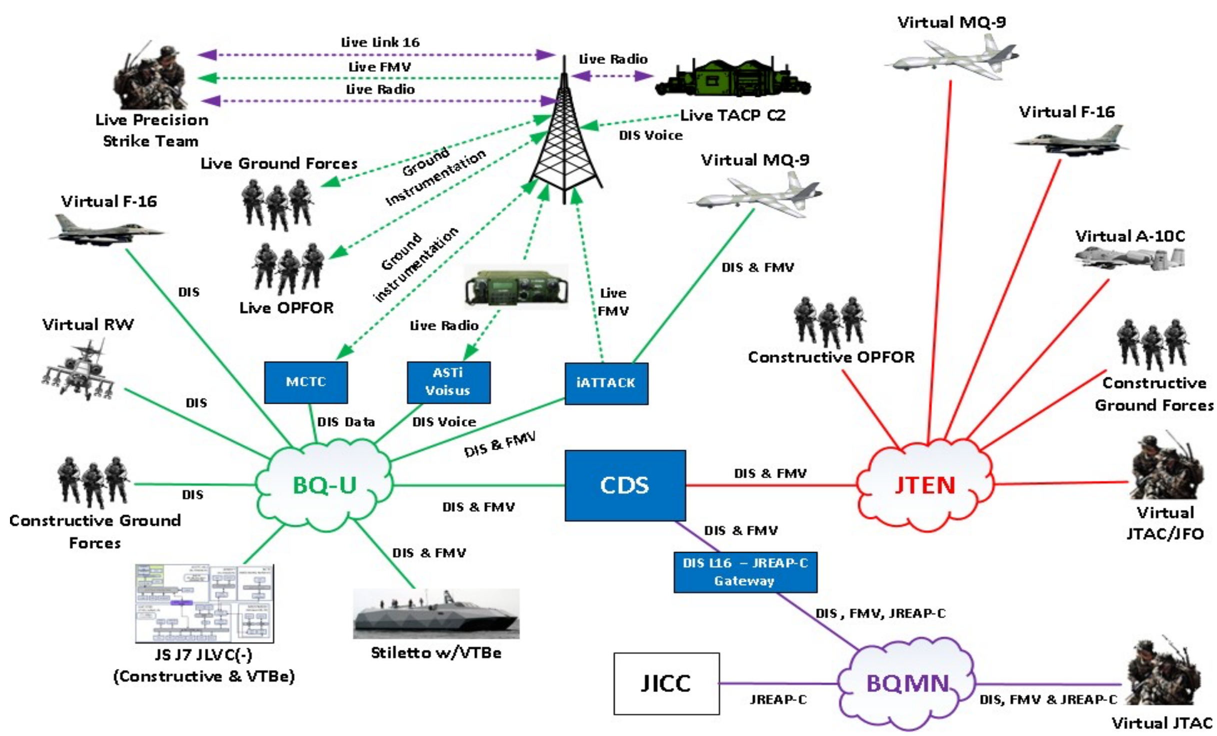

Figure 2 Overarching Data Flow Diagram

The Royal Netherlands Army successfully instrumented live USMC ground forces using the TESS instrumentation kit. The MCTC system, located at the Fort Stewart MTC, received instrumentation tracks from dismounted units via a remote antenna at Colmar range. The connection between the MCTC antenna base station and the MCTC

Exercise Control station (EXCON) was realized over the BQ-U network. MCTC rebroadcast the position data as DIS entities on BQ-U. SB Pro generated Dutch Leopard Tank entities and additional infantry. VBS4 generated simulated Dutch infantry, AH-64 Apaches and Leopard 2A6 tanks within the synthetic environment. Additionally, a Dutch pilot flew the Mission Combat Simulator (MCS), a desktop virtual flight sim, in its Dutch F-16 Fighting Falcon or Dutch AH-64 Apache configurations depending on the scenario need. Each system was able to connect and interact with other simulated units on the Bold Quest Mission Network. Of particular importance to the Dutch efforts in BQ22, the USAF's JTC TRS team supported multiple objectives by integrating with the various Dutch systems for small but valuable off-line experiments.

LVC Culminating Event

As a "capstone event" highlighting these mixed LVC capabilities, 165 ASOS executed a live Precision Strike Team (PST) scenario at Colmar, using all these integrating capabilities. The PST is a relatively new concept for the Tactical Air Control Party (TACP) community, developed by the Air Force Special Warfare community and endorsed by the USAF Deputy Chief of Staff for Operations. The primary role of the TACP and JTAC today is to support Army ground maneuver forces. In the future, however, according to the PST concept, the TACP and JTAC will focus on the air fight as well, to "ensure air-minded ground maneuver elements are postured and available to leverage the full joint all-domain capabilities of the Joint Force to meet the requirements of the Air Component."

In developing their concept for the PST demonstration, 165 ASOS stated the following desired learning objectives (DLO):

1) Plan and Conduct Reconnaissance ISO Dynamic Tasking
2) Develop TTPs for PACE from PST to TACP C2 and MQ-9
3) Receive Mission Type Order Tasking from TACP C2
4) Pass Targeting Data from PST to TACP C2
5) Update Target Data to MQ-9 ISO SCAR
6) Coordinate TOT for HIMARS and MQ-9 Engagement

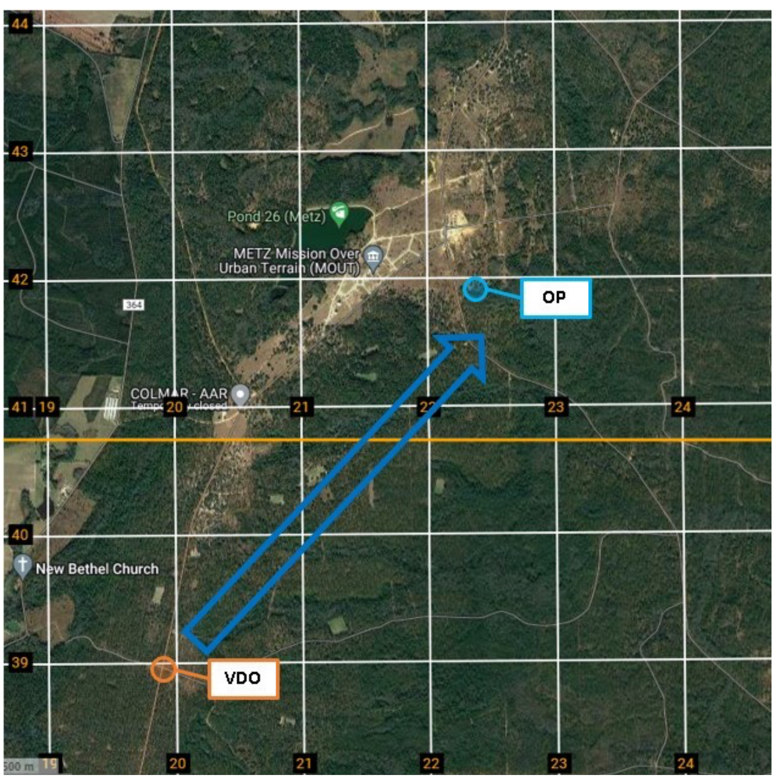

Figure 3: PST Dismounted Infiltration to Colmar OP

To the greatest extent possible, this event in the field would be stimulated from local and distributed constructive and simulated participants. The live PST JTAC team at Colmar communicated via HF voice and Link 16 with a small command and control (C2) cell at the Fort Stewart MTC. That C2 cell communicated via DIS radio with the virtual MQ-9 crew at Hurlburt and the 132 Combat Training Squadron (formerly DTOC) at Des Moines, IA who played the role of Ground Force Commander (GFC). The live PST team successfully controlled USAFE/ AFAFRICA Warfare Center (UAWC) virtual aircraft via Link 16, conducted voice Close Air Support (CAS) missions with the virtual MQ-9 and called for constructive HIMARS fires via the GFC.

According to the 165 ASOS Concept of Operations (CONOPS), the PST was to be located at Colmar UTC on the Fort Stewart range, while the TACP C2 Cell controlling the PST would be located at the Fort Stewart MTC. Initially the CONOPS called for the PST team to infiltrate on the evening of 15 June, provide SITREPs overnight, and conduct reconnaissance and strike support operations during daylight on 16 June. However, due to lack of a qualified Officer in Charge (OIC)/Range Safety Officer (RSO) at night at Colmar, the PST conducted a dismounted movement during early daylight hours on 16 June from the general area of the Colmar Range Operations Center (ROC) to an OP to the south of Metz as depicted in Figure 3.

To bridge the gap between live and synthetic assets, the LVC team used several unique systems and capabilities to meet the following requirements:

1) Blend ground truth positional data on units, both live and synthetic, operating at Colmar. To bridge the gap between live and simulated units, NLD provided its TESS system to instrument the live USMC ground maneuver force conducting training missions at Colmar. TESS provided laser-based force-on-force training, using the standardized NATO UCATT Laser Engagement Interface Standard (U-LEIS), with Position Location Information (PLI) reporting, battle tracking and data collection to support After-Action Reviews (AARs) for live- training events (Cruiming, 2018). Through the MCTC sub-system, PLI data and weapons effects from the live domain are translated into the simulation environment, so, as but one example, the live USMC platoon was visible to participants in simulators, such as the virtual MQ-9 aircrew. In the context of the PST scenario, the USMC platoon represented OPFOR, so virtual systems could track and engage the OPFOR. However, due to other gaps in the ability to conduct seamless LVC training, there was no way for the live units to see the simulated weapons effects.

2) Bridge voice communications between the live and synthetic units. To make it more difficult for the scenario OPFOR to locate their OP, the PST decided to use HF voice radios to communicate with the TACP C2 cell at the MTC. From there, the TACP C2 cell used a DIS radio to relay reports from the PST to the virtual participants. This radio configuration matched the TTPs for current PST CONOPS and provided the capability for virtual ISR and shooter support to meet air component objectives.

3) Ensure tactical data link interoperability between live and virtual assets. JS J6 JAD supported the connectivity using a Multilink Interface Gateway (MIG) that received multicast DIS Signal PDUs, containing J-series formatted Simulation Interoperability Standards Organization (SISO)-J payload messages, and converted the DIS PDUs to J2.0 Indirect PPLIs. The MIG interfaced with the Combined CICC via a single JREAP C TCP interface and the CICC forwarded the aircraft into the Mission Network. Connecting the PST to the BQ22 Multi-TADIL network was successful. Link 16 connectivity between PST and virtual shooters was a primary objective for this demonstration.

4) Enable two-way ISR sensor data flow between virtual ISR platforms and support cells and the live PST. As discussed above, iATTACK provided a mobile virtual MQ-9 simulator flown by a contract pilot. The iATTACK trainer could send streaming FMV on the BQ networks, which flowed through the CDS, to all other networks. It could also push that FMV feed out from their antenna mast via RF downlink in C band or L band frequencies so users could view it with the appropriate handheld devices. Additionally, as discussed in the next section below, the LVC team was much more tightly integrated with the CISR team in BQ22. Despite the goodness that resulted from this, there are still many steps remaining to make this integration more productive for both threads.

The live PST was able to call for fires from the virtual MQ-9 and a constructive HIMARS via the TACP C2 Cell. 65 SOS and 132 CTS, respectively, provided fires in support of the PST. Additionally, the PST cell was able to connect via handheld Link 16 from Colmar UTC via the Canadian RICC at Colmar ROC to the CICC at Fort Stewart MTC and on to UAWC virtual fixed wing air flying in support in Germany.

Other Capabilities Tested

The Joint Live, Virtual and Constructive (JLVC) Federation managed and operated by Joint Staff J7 is a capable and mature federation of joint and Service simulation capabilities. As part of ongoing JLVC improvement efforts, JS J7 also used BQ22 to integrate live and virtual platforms from the Bold Quest environment into the larger JLVC constructive environment. Integrating live, virtual, and constructive entities poses multiple challenges for exercise managers. Virtual simulators generally do not support the message loads the constructive simulations can and live instrumentation systems usually have requirements for unique player IDs. In addition, it is generally challenging to design large exercises so both the live and virtual training audience receive similar quality training.

BQ22 also witnessed the first connection of BQ LVC data to a surface vessel, the DoD experimental unit Stiletto, underway in the coastal waters of Georgia. Stiletto hosted a NAWCTSD experiment designed to test data compression algorithms over SATCOM to support long-term Navy "LVC at sea" initiatives. Joint Staff J7 in Suffolk, VA served as the shore-based component of this network. The JS J7 Test Bay 7 received DIS and FMV traffic from the Bold Quest simulation environment via the BQ unclassified network, compressed it using various algorithms and sent it via SATCOM to the experimental vessel Stiletto underway off the Georgia coast. This test was a critical milestone in optimizing data delivery over SATCOM to support "LVC at sea" efforts.

FIVE RECOMMENDATIONS

BQ22 highlighted a number of key areas for further work to improve overall LVC capabilities, both within and outside of the Bold Quest community.

1. <u>Partner Nation Representation</u>. LVC has been unsuccessful in drawing multiple partner nation participants. Primary reasons are the policy and cybersecurity difficulties in connecting national networks with mission networks. Additionally, BQ has no integrated capability with NATO architectures.

   <u>Recommendation</u>:
   a. Work to overcome barriers for many nations to participate. Facilitate a "crawl, walk, run" approach to partner nation interoperability that provides a realistic pacing strategy to full integration.
   b. Continue to coordinate with the NATO Modeling and Simulation Group (NMSG) to integrate the Bold Quest LVC environment with NATO's Distributed Synthetic Training (DST) architecture.

2. <u>Link 16</u>. BQ22 witnessed a higher level of Link 16 use between simulators as well as virtual assets and live platforms. The CICC and JAD both provided outstanding support to this effort, especially to the initial integration of the F-35 EBS. Additional work to refine the methods and to exchange and translate data will bring a higher level of realism in TDL use in LVC events.

   <u>Recommendation</u>: Integrate additional TADL/Link 16-capable simulators, to include Joint Fires C2 cells (e.g., ASOC, JAGIC) during future BQ events to augment limited live capabilities on site.

3. <u>Simulated DACAS</u>. Effective DACAS training requires high fidelity and available DACAS capabilities in simulators. BQ22 hosted the first implementation of an ATAK device in JTC TRS, a new capability that will lead to improved proficiency and performance in DACAS.

   <u>Recommendation</u>: Continue to support demonstration of simulated DACAS capabilities, in both stand-alone simulator and mixed LVC environments.

4. <u>Adversary Threats</u>. Preparing warfighters to face current adversaries requires better representation of current threats. Many simulations and simulators still use a standard Cold War model of adversary threats and do not model the weapons, systems and personnel from nations like China, Iran and North Korea. Similarly, non-kinetic threats, such as adversary Electromagnetic Warfare (EW), navigation warfare (e.g., GPS denial) and cyber are generally not available to support joint and coalition training.

   <u>Recommendation</u>: Work with Program Offices and M&S community to expand representation and fidelity of current adversary threats in tactical simulators.

5. <u>JADC2</u>. Development and fielding of JADC2 capabilities will change the way joint and coalition forces operate and provide new capabilities to sense, make sense and act at all levels and phases of war, across all domains with mission partners to deliver an information advantage. JADC2 technology advances will require commensurate changes in doctrine and the way warfighters conduct C2. Accordingly, JADC2 will require changes in the way

we educate and train warfighters. To this end, training and exercises supported by simulation and simulators must be able to support the C2 aspects of operations during crisis and conflict with peer competitors.

Recommendation: Work with nations and Services to demonstrate and assess simulated C2 systems to support Bold Quest. The purpose of the USAF's Joint Theater Air Ground Simulation System (JTAGSS) is to train Air Support Operations Center (ASOC) personnel; from this position, it appears to the best opportunity to begin this effort.

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REFERENCES

Cruiming, B.A. (2018). The Strategic role of UCATT standards to NATO's enhanced Forward Presence mission. Proceedings of I/ITSEC 2018. Orlando, FL.

Gross, A., Hobson, B., & Bouwens, C. (2016, May). Reducing acquisition risk through integrated systems of systems engineering. In Modeling and Simulation for Defense Systems and Applications XI (Vol. 9848, pp. 24-39). SPIE.

Joint Chiefs of Staff. (2021). CJCSI 6265.01A, COALITION CAPABILITY DEMONSTRATION AND ASSESSMENT (BOLD QUEST) GOVERNANCE AND MANAGEMENT, 14 May 2021.

US Department of Defense. (2008). MIL-STD-6016D, Tactical Data Link (TADIL) J Message Standard, 12 December 2008

Scales, B. (2013). Virtual immersion training: bloodless battles for small-unit readiness. The Magazine of the Association of the United States Army, 24-27.

Seavey, K., Reitz, E. A., Hanne, C. F. (2019). Digitally-Aided Close Air Support Capabilities in Simulation: Lessons Learned from a France-US Effort. Proceedings of I/ITSEC 2019. Orlando, FL.