CACCTUS: Linking the Live, Virtual, and Constructive Environments

Conference Paper · November 2004

CITATIONS
0

READS
368

1 author:

Bob Armstrong
Eastern Virginia Medical School
12 PUBLICATIONS **309** CITATIONS

SEE PROFILE

CACCTUS: Linking the Live, Virtual, and Constructive Environments

Lieutenant Colonel Robert K. Armstrong
Deputy, Technology Division, TECOM
Quantico, VA
robert.armstrong@usmc.mil

Dr. Michael Page Bailey, PhD
Director, Technology Division, TECOM
Quantico, VA
michael.bailey@usmc.mil

Lieutenant Colonel Gregory R. Caldwell
Liaison Officer, Technology Division, TECOM
Orlando, FL
gregory.caldwell@navy.mil

Nancy Harmon
Project Officer, CACCTUS, PM Training Systems
Orlando, FL
nancy.harmon@navy.mil

ABSTRACT

The Marine Corps' Combined Arms Command and Control Training Upgrade System (CACCTUS) is a transformational program that will add significant enhancements to the all aspects of Marine Air Ground Task Force (MAGTF) training. CACCTUS will enable comprehensive Marine Corps staff, unit, and individual training across the Live, Virtual, and Constructive (LVC) training realms through the incorporation of all appropriate Command, Control, Communication, Computers, and Intelligence (C4I) architectures and equipment. Further, CACCTUS will facilitate multi-echelon as well as distributed training opportunities, thereby increasing the breadth and scope of future training events. Also, CACCTUS will incorporate links to and from the live training environment, to include robust capture and display of events for detailed after action review. This paper describes the capabilities that CACCTUS will bring to the Marine Corps and how it will further Marine Corps Training Transformation.

ABOUT THE AUTHORS

Lieutenant Colonel Robert K. Armstrong is currently the Deputy Director, Training and Education Technology Division, Training and Education Command, Marine Corps Combat Development Command, Quantico, Virginia. He received his BS in Engineering from the United States Naval Academy in 1985, is a graduate of the Amphibious Warfare School in Quantico, Virginia, and has earned an MS in Computer Science from the Naval Postgraduate School, Monterey California, in 1997. Lieutenant Colonel Armstrong has served in the capacity of Artillery Officer with the 1st Marine Division in Korea, Somalia, and Kuwait.

Dr. Michael Page Bailey was born in Baltimore, Maryland on May 19, 1961. He graduated from the University of North Carolina at Chapel Hill with a PhD in Operations Research in 1988, and became an Assistant Professor of Operations Research at the Naval Postgraduate School in Monterey, California. He was promoted to Associate Professor in 1993 and tenured in 1994. In 1995, he sabbaticaled at the Office of the Chief of Naval Operations, Assessments Division, OPNAV-N81, as a visiting scholar. There he served as operations analyst in support of the Quadrennial Defense Review until 1997, whereupon he joined the Marine Corps as Principal Analyst, Modeling and Simulation. In December 1999, he joined the Marine Corps' Training and Education Command as Technical Director. In December 2000, the Marine Corps formed the Training and Education Technology Division, with Dr. Bailey as its head.

Lieutenant Colonel Gregory R. Caldwell is currently assigned as to Training and Education Technology Division, Training and Education Command, Marine Corps Combat Development Command, Quantico, Virginia as the Liaison Officer to Program Manager for Training Systems. He received his BBA in Accounting from Texas A&M University in 1984, is a graduate of the Amphibious Warfare School in Quantico, Virginia, and has earned an MS in Acquisition and Contract Management from the Naval Postgraduate School, Monterey California, in 1995.

Nancy Harmon is currently assigned as the Project Officer for the Combined Arms Command and Control Training Upgrade System (CACCTUS). She works for the Program Manager, Training Systems, Marine Corps Systems Command in Orlando, Florida. She joined the Government in 1973 and enjoyed her career as a Project Manager since 1991.

CACCTUS: Linking the Live, Virtual, and Constructive Environments

Lieutenant Colonel Robert K. Armstrong
Deputy, Technology Division, TECOM
Quantico, VA
robert.armstrong@usmc.mil

Dr. Michael Page Bailey, PhD
Director, Technology Division, TECOM
Quantico, VA
michael.bailey@usmc.mil

Lieutenant Colonel Gregory R. Caldwell
Liaison Officer, Technology Division, TECOM
Orlando, FL
gregory.caldwell@navy.mil

Nancy Harmon
Project Officer, CACCTUS, PM Training Systems
Orlando, FL
nancy.harmon@navy.mil

Marine Corps training, writ large, is not broken. Not in the least. Our training systems, however are not keeping pace with the systems and ideology that are resident in highly networked, digitized, operational environments. Marine units, like the rest of the Joint world, increasingly rely upon digital command, control, communications, computers, and intelligence (C4I) systems at both high and low echelons of command; however, we find it increasingly difficult to realistically train our forces while making maximum use of these systems. Further, cost – in both time and money – makes it difficult to create a training event that facilitates effective, realistic training for more than a single echelon of command or element of the Marine Air-Ground Task Force (MAGTF). The Marine Corps' solution to these problems is a transformational program called the Combined Arms Command and Control Training Upgrade System, henceforth referred to as CACCTUS. CACCTUS has been enjoying a successful development phase (since 2001) that includes limited prototypical installation at the Marine Corps Air Ground Combat Center (MCAGCC) in Twentynine Palms, California. This paper will first orient the reader to MAGTF Training, our current training shortfalls, the solution set that CACCTUS provides, and an example training event.

OVERVIEW OF MAGTF TRAINING

The Training Continuum

In order to understand the necessity of CACCTUS, one must first understand how we train in the Marine Corps, and then understand current training shortcomings. First, there is a Training Continuum (Figure 1) into which all USMC training must fit. The placement in the continuum of *Unit Training* is not random; unit training is reliant upon the strength of common skills, progression training, and professional military training. Unit training is what creates highly effective fighting forces, referred to as Marine Air Ground Task Forces (MAGTF)[1].

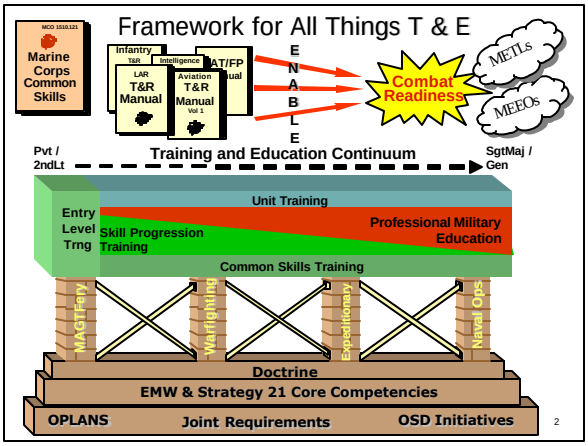

Figure 1. The USMC Training Continuum

Individual Training

Individual training is directly related to Marine Corps Training and Readiness (T&R) standards. T&R standards map directly to Military Occupational Specialty (MOS) codes, and are utilized to design and direct entry level and early skill progression training. Continued training for individuals occurs through progressive combinations of various schools and events. The Marine Corps requires follow-on professional military training, and offers advanced skills training at schools, as well as online via distance learning. There is also individual skills training that takes place via virtual simulation. These types of training have been common to the aviation elements of the MAGTF for quite some time, but are now making

[1] Marines organize for combat as MAGTFs in order to provide significant flexibility to a commander, since unit size, composition, and strength can be changed – even on the fly – to meet the needs of the threat or environment. A MAGTF is a self-sustaining amalgam of Marine ground, air, and combat service support elements, led by a single commander.

their way into the other elements of the MAGTF – particularly members of ground maneuver forces.

Staff Training
The Marine Corps trains MAGTF staffs with both simulation-based training and live training. Due to the costs incurred when creating a large-scale live training event, however, the majority of staff training incorporates simulation. Marine Expeditionary Force (MEF) staffs are routinely trained during constructive simulation-based training events put on by our own MAGTF Staff Training Program.

Unit Training
The Marine Corps trains units predominantly in the live environment, to include live-fire training. Unit staffs sometimes utilize simulation-based training, but the majority of their training is coupled with live unit training.

Live and Live Fire Training
The prize possession of the Marine Corps is our ability to conduct live and live-fire training events. These collective training events provide Marines and Marine Commanders with the opportunity to exercise certain critical elements of the MAGTF. The most rigorous live-fire training occurs during training for mobile assault. Marine ground forces maneuver to advantage over the enemy, firing direct fire weapons to isolate and kill. Artillery fires, coordinated with the efforts of the maneuvering ground forces; rain down upon the embattled enemy, while coordinated and complementary aviation-delivered fires further decimate his high value targets. These events happen in four dimensions (3D + time) and are very dynamic and deadly. The enemy in the example provided here is never live, but because of the efforts of the Tactical Training and Exercise Control Group (TTECG), the enemy situation is portrayed to the training force in a controlled constructive fashion.

TRAINING SHORTFALLS

While the Marine Corps has been winning battles for many years under the training construct briefly outlined above, there is room for improvement. While we make extensive use of digital C4I systems, we do not take full advantage of opportunities to train using the full complement of systems and interfaces. Because we do not possess any automated after action review (AAR) collection capability for live or simulated training, we rely heavily on observer-controller subjective evaluation – not only of individual/team performance, but also of collective/unit performance. Only recently have we been able to portray accurate model behavior in concert with accurate depiction of the battlefield, which is necessary for successful human-simulation interaction. Most importantly, however is the fact that we have not been able to stress/test multiple echelons of commands and their staffs due to the high cost of exercising 100% of a MAGTF in the live environment. The cost is not just monetary; all units involved in such an extensive training event must have time in their training and operational schedules prepare and, in some cases, deploy. Additionally, the Marine Corps does not possess a single stateside training area that can handle the footprint of a Marine Expeditionary Force.

Criteria for the Use of Simulation

The Marine Corps looks to solve training deficiencies with simulation. The following four criteria are considered when deciding how to augment live training:

- Consider simulation in order to expand the scale of the exercise by expanding the force structure, making the OPFOR more interactive, expanding the geography of the exercise, expanding the variety of the weapons used by both sides, adding missing MAGTF players or MAGTF interoperability tasks, or adding Naval of Joint players.
- Consider simulation in order to increase training value by compressing the scenario timeline (creating higher stress and allowing more repetitions), adding after-action review capability, enhancing observability and measurability of performance.
- Consider simulation in order to make an event possible by making it economical. The Marine Expeditionary Force Exercise (MEFEX), is a great example of this. MEFEX is a training event for the extended staff of a Marine Expeditionary Force, the Marine Corps' largest standing maneuver element including a complete Division, Wing, and Force Service Support Group.
- Consider simulation in order to make events possible in more locations, such as shipboard, OCONUS, or when a previously available live training range vanishes for political expediency or environmental conservation.

CACCTUS Essential Elements

CACCTUS is intended to improve and/or enhance MAGTF training as it is performed today. The list below denotes the essential elements that the system must include to provide significant improvement over the current training construct.

- Train to Standards
- Entity-Level Simulation
- Valid Models
- Controllable Battle Damage Assessment, Attrition
- Valid Semi-Autonomous Model Behavior
- After Action Review
- Accurate Display of Authentic Terrain
- Self-Authoring Scenario Generation
- Logistics Modeling
- Detection of Unsafe Conditions
- Digital and Analog Communications
- Reconfigurable Communication System
- Links to other bases/stations
- 3D Photorealistic Display of Terrain, Models
- Depiction of Trajectories
- Detection, Display of Danger Areas
- Enforcement of Time Management
- Accurate Weather, Light Conditions
- Sensor Modeling
- Depiction of Control Measures
- Support for Mission Rehearsal

At the macro level, CACCTUS is intended to provide the following improved capabilities:

- Link simulation-based or simulation-enhanced training events between training sites or bases/stations.
- Provide a realistic and accurate depiction of the battlefield.
- Facilitate the unlimited use of C4I systems in order to mimic the (Joint and Service) capabilities found during real-world operations.
- Link live forces with virtual and constructive forces in order to maximize the return on the MAGTF training investment.
- Facilitate robust after action review (AAR) for a comprehensive training event.

THE MAJOR ELEMENTS OF CACCTUS

CACCTUS, as an "installed" system, will be located throughout the Marine Corps at our major training locations: Camp Pendleton, California, with I Marine Expeditionary Force (MEF); Camp Lejeune, North Carolina, with II MEF; Okinawa, Japan, with III MEF; Hawaii, with Commander, Marine Forces Pacific; Quantico, Virginia, with the Marine Corps University; and Twentynine Palms, California, with the MAGTF Training Command. Common to each of these locations is the presence of a Combined Arms Staff Trainer, or CAST. CACCTUS will subsume each CAST facility as it is installed throughout the Marine Corps. Major elements of CACCTUS are shown in Figure 2.

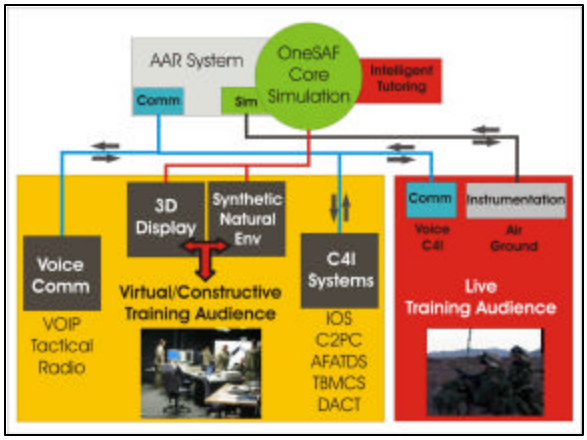

Figure 2. CACCTUS Elements

The Combined Arms Staff Trainer

In order to fully appreciate some of the training tasks and the training environment that CACCTUS will replace, it is important to understand the incumbent system. A CAST is an outdated facility that is used to support many different types of training. It will support limited training of a battalion staff and their ground companies and supporting arms. It is most often used to train Forward Observers and Forward Air Controllers in the art of combined arms. The heart of each CAST is the terrain board. In the center of the CAST lies a large, scaled version of some portion of land. At the Delta Training Area in Twentynine Palms, for instance, there are two sets of terrain boards: the 978 square-mile training area of the Marine Corps Air-Ground Combat Center (aka Twentynine Palms), and parts of the east coast of Korea. These terrain boards provide a view of the ground for the training Marines. Not-to-scale models are used to represent general location of friendly and enemy forces. Each CAST has the ability to depict enemy and friendly fires onto the terrain board. A ceiling-mounted green and red laser system receives an aim point from a DOS-based program. Effects of fires are interpreted by controllers/facilitators. There is no 3-D depiction of aircraft, besides the representative but inaccurate use of a plane on the end of a stick. While it makes the teaching point of the aircraft moving towards the target from the appropriate inbound point, it does not make the teaching point well -- or elegantly. Lastly, each CAST today has an integrated voice communications system that serves as the radio architecture between the Fire Support Team (FiST) and the higher command. It is this voice only communication system that is used to

stimulate the battalion and regimental headquarters to action. This communication system is fixed and will not flex to meet the requirements of a MAGTF's tailored communication plan.

As previously stated, CACCTUS will subsume the CAST and it's current configuration. Accordingly, CACCTUS will replace some aspects of the current CAST, and add other new systems and capabilities. The remainder of this paper provides explanations of the key capabilities that make up the system.

COMMUNICATIONS CAPABILITY

The need for a flexible, responsive communications architecture is evident from the earlier explanation; however, what is not as evident is the need to ensure that the communications architecture and infrastructure in CACCTUS be able to handle the analog and digital signals and systems that are used in the Marine Corps. CACCTUS provides this architecture/infrastructure through an IP-based solution. All voice and digital communications pass over the native data network in the system. Such commonality ensures that voice communications can be digitally recorded and time stamped for inclusion in the AAR. Further, it ensures that some digital C4I signals can be extracted and employed to support the AAR as well.

Tactical communications are inherently flexible. CACCTUS communications flexibility is achieved through the IP structure. A master station establishes and controls the communications architecture so it reflects exactly what the training audience needs. Further, the physical limitations of radio are taken into account by the master station and the simulation. Units that should not be able to talk to each other because of physical separation will not be able to talk – unless they have planned retransmission capability in the communications plan. Again, this ensures realistic training.

The Marine Corps has more than one type of radio in use, so this system duplicates not only the capabilities but also the physical interfaces of the radios. This is not done with physical mock-ups, but with virtual mock-ups. Each communications station includes a simple touch-screen LCD, upon which is displayed the faceplate of a particular radio. The user can select the appropriate frequency or net name on the display itself. Handsets and headsets are authentic.

A major element of the communication system are the C4I devices and the physical links between those systems. We mentioned previously that we have to be able to extract key data from the C4I systems for inclusion in the AAR. The solution to this problem is not complete; however, the solutions we are pursuing include log file manipulation, extracting appropriate C4I relevant data from the simulation, and C4I data packet sniffing. The network infrastructure over which this data will ride is consistent with the IP voice network mentioned previously. It will mimic the capability we have in the operational environment. Access to circuits will be controlled by both the network master control station and the access controls resident in the C4I platforms. Controllers will assess/monitor activity on these digital systems both by direct and indirect observation.

The communications capability is easily the lifeblood of a CACCTUS training event; however, the brain of the CACCTUS event is the simulation system, in which all live or simulated physical warfighting activities will be represented.

SIMULATION SYSTEM

The Marine Corps has chosen the U. S. Army's One Semi Autonomous Forces (OneSAF) line of entity-level constructive simulation products as our simulation engine. This decision was made after a careful comparison of available SAFs, wherein version control led the team to select OneSAF. Currently, the Marine Corps is working with the Program Manager for OneSAF on the development of Marine-specific models, behaviors, and task organization – all which must be accurately depicted in order for CACCTUS to be of any use at all.

The simulation system serves to represent the ground truth in CACCTUS. Commanders and their staffs are directing the battles from their combat operation centers, gleaning situational awareness from both voice feeds and C4I and text messaging digital feeds from the fighting forces. In CACCTUS, the fighting forces are fighting their battles in simulation. The need to purposefully control and reflect entity-level activities caused us to choose a Semi-Autonomous Force simulation engine.

As an example, consider the activities of the FiST involved in a well-timed, highly coordinated attack of targets with multiple weapon systems and varied ordnance. The direction of events in time and space by the FiST, the coordinated actions of the friendly forces, and the action/reaction of the enemy maneuver forces are the triad of activities that must be accounted for in a Marine combined arms engagement. Without entity-level representation of movement, maneuver, target

acquisition, ordnance trajectory, fires, and effects of fires, the activities of the FiST cannot be held accountable for their performance.

SYNTHETIC NATURAL ENVIRONMENT AND STEALTH VIEWER

Closely related to the simulation system is the synthetic natural environment (SNE). The training audience gains their "eyes-on view" of the SNE through the stealth viewer. The stealth viewer is a graphical depiction, in 3-D, of what is happening in the simulation. While battles can be fought in OneSAF directly on a OneSAF terminal, the interface is inappropriate for certain levels of interaction – most notably, the training of those whose duty it is to directly engage the enemy on the ground. OneSAF was never designed to present a 3-D view of ongoing sim-based activities; hence our requirement for a geographically correct representation of the environment on which the engagement/battle is being fought.

There are a multitude of systems that can present an adequate synthetic natural environment. CACCTUS is using a PC-based system called SOFViz, which was developed by Special Operations Command (SOCOM) for the display of 3D terrain to special ops forces prior to their arrival in an area of operations. This software is government-owned; more importantly, it provides a highly engaging, accurate rendition of the SNE.

INTELLIGENT TUTOR

The intelligent tutor system (ITS) is another vital part of CACCTUS. It is what makes CACCTUS more than a technically advanced version of the current CAST. Recognizing that a typical question-and-answer test schema would not meet the comprehensive needs of the training audience, we chose to implement a scenario-based intelligent tutoring system. The system will allow the training audience to practice solving realistic problems in a realistically complex environment while receiving extensive coaching and feedback. The system includes authoring tools to allow the trainer to focus on particular skill sets. It also includes performance assessment and adaptive instructional feedback.

Intelligent tutoring will be used to facilitate a variety of learning. For example, an artillery forward observer will use CACCTUS to brush up on his individual call-for-fire skills. These skills include target identification, target location, munitions selection, correction from initial round fired in adjustment, and battle damage assessment. As the forward observer uses these skills to prosecute the target, the intelligent tutoring system can be accessed for feedback. Potential feedback may include suggestions to make more bold adjustments to the target position, or reminders as to the correct method to identify a Soviet-era tactical vehicle. Further, follow up tutoring can occur, wherein the forward observer would have to talk through his procedures with a facilitator who is assisted by feedback provided via the same intelligent tutoring system.

Teams can be tutored, too. Teams skills such as plan execution, adherence to standard operating procedures, and timeliness can be collected. Appropriate feedback would include a breakdown of what did happen against what should have happened, identification of friction points, and suggested areas where improvement is needed.

The Intelligent Evaluation System (IES) is another vital part of CACCTUS; the concept has been derived from the Intelligent Tutoring System (ITS) proof-of-concept demonstration. The IES will allow the AAR system to capture and correlate the specific simulation event, voice communications and C4I text messages associated with the training event and feed this information to the after action intelligent review component (After Action Intelligent Review System). The system will provide evaluation and feedback as an optional feature of the tool.

LIVE, VIRTUAL, AND CONSTRUCTIVE LINKS

Links between the building-housed CACCTUS system and the live environment is a challenge that we are attacking from many different directions. While it is beyond the scope of this paper to discuss the physical devices that will be used to collect instrumented data from the live training environment, suffice it to say that we intend to be able to collect a combination of entity and unit positional information for both ground and aviation assets, and to generate track data for these entities/units that can be injected into a near real-time in simulation system. Figure 3 denotes our intent. The depth to which we collect entity-level track data is driven by the objectives of the training event. The determination of precisely what level of coverage we require will come from further analysis of the training objectives. The Marine Corps will utilize its' instrumentation system in both the live and live-fire training environment.

OneSAF will serve as a collection point for the assimilation of all the live, virtual, and constructive

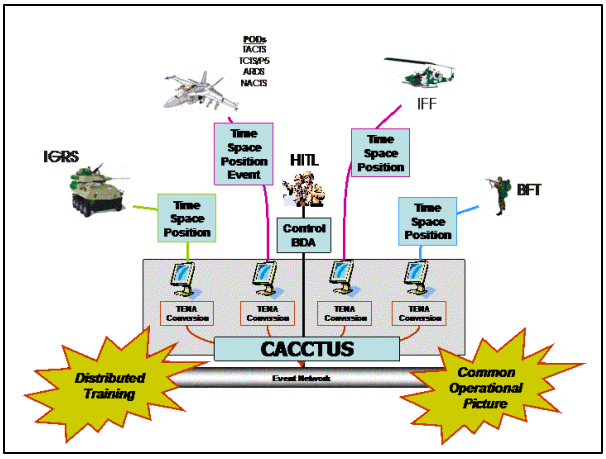

Figure 3. Live Feeds

data that will exist on the established training network. Live feeds will be pushed from the live training ranges to the nearest CACCTUS, converted to Test and Training Enabling Architecture (TENA) compliant format, and injected into the common operational picture or after action review system. Where live feeds go depends upon the desire to collect perceived truth or ground truth. In a non-instrumented tactical environment, ground truth is never truly known; therefore, it is irresponsible to provide ground truth to a unit in a training environment. Virtual and constructive feeds are easier to assimilate due to their inherently digital origins; however, conversion of data will be necessary in order to incorporate all simulation-provided data into the overarching common operational picture and eventual after action review.

AFTER ACTION REVIEW

Last, but not least, is CACCTUS' After Action Review (AAR) system, called the After Action Intelligent Review System (AAIRS). Training without evaluation/accountability is ineffective training. Casual observation (by the training event participants) results in anecdotal, informal, and individualized evaluation/feedback that has limited use by the individual and almost no use by the unit as a whole. The formalized, systematic collection of data pertaining to specific functional areas is required to present thoughtful feedback to the unit as a whole.

The AAIRS is reliant upon the entirety of the system, to include trainers/observers/controllers, for data. Battlefield maneuver, fires, and aviation – essentially everything that can occur physically on the battlefield, but which is performed in simulation – are captured, time-tagged, and available for complete playback during the AAR. Figure 4 is an example AAR visualization. The same is true for instrumented live feeds that are collected from the training areas. Further, the "playback clock" can be advanced in order to speed up review. Also, the AAIRS allows a facilitator to jump forward or backwards in time to highlight events. The result of this capability is the accurate play back of the training event, indexed by time.

The performance-driven factor for much of what occurs during a training event is communication; therefore, CACCTUS AAIRS includes captured and time-tagged voice communications that occur throughout the training event. Time tagging allows for the synchronous replay of communications leading up to and during a noteworthy AAR event. Another important aspect of the AAIRS is the synthesis of a takeaway product that the training unit can use however they see fit. The result is an AAR capability that reduces the problems inherent in subjective evaluation, improves the use of objective references to simulation ground truth, and helps a commander to better train his or her unit.

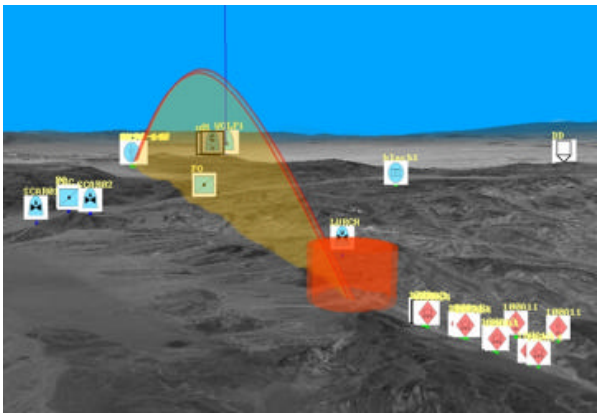

Figure 4. CACCTUS AAR Visualization

A CACCTUS TRAINING EVENT

A CACCTUS-enabled training event might go thusly:

A Marine Expeditionary Brigade (MEB) desires to hold a mission rehearsal/training event. Apart from the overall training goals of the event, the MEB trainers must determine the following training/planning factors: location of the event, the makeup of the opposing forces, the task organization of the friendly forces, the command structure, the communications architecture

and associated systems to be exercised, the need for distributed training, the need to link with live training forces, the extent of logistics play in the context of the problem, the true footprint of the training audience, and the general scheme of maneuver/concept of operations for both friendly and enemy. These factors must be applied to CACCTUS to construct the training event. This MEB decides that it wants to link its Camp Pendleton Headquarters with a live Regimental Headquarters that is training a single Battalion on the ranges of Twentynine Palms, California. Figure 5 depicts the command structure and linkages within CACCTUS that will be energized to make this event occur.

TRANSFORMING TRAINING

CACCTUS and the JNTC

Interestingly enough, CACCTUS has existed as a name and capability (consistent with what is currently being built) since 2000. With a focus from the beginning on exploiting the live, virtual, and constructive environments, it will easily fit into the Joint National Training Capability (JNTC).

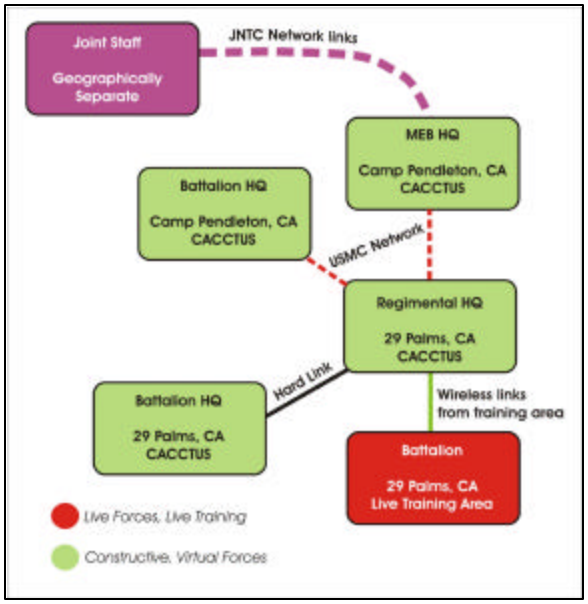

Figure 5. A CACCTUS Training Event

Transformational Aspects of CACCTUS

The transformational aspects of CACCTUS are centered not in the technology, but in how we are using technology to improve our training. At the beginning of this paper, we noted that Marine Corps training is not broken – it merely needs to be updated, enhanced, and improved. CACCTUS is that mechanism for improvement and change.

With CACCTUS, we will be able to regularly train and interact in a distributed fashion within our own service. Equally important, CACCTUS will be another means to participate in the JNTC at more diverse Marine Corps locations, thereby meeting our Joint training requirement. The ability to meld live training with virtual and constructive simulation-based training is not trivial; in fact, it introduces not only technical but also operational challenges that are not far removed from the challenges of the asynchronous battlefield. When correctly applied, this solution makes Marine Corps and Joint training events possible that would not have been possible previously. The AAR system, coupled with the Communications system, offers the first real opportunity for consistent, regular assessment of a Marine Corps training event. The ability to link the C4I systems of a CACCTUS training unit with the C4I systems of a live training force is also groundbreaking; further, the inject of this perceived truth data into the AAR is a quantum leap forward for the Marine Corps. Lastly, the reliance upon a robust entity-level constructive simulation, OneSAF, ensures that the Marine Corps can exercise every aspect of the MAGTF – ground maneuver, aviation support, and combat service support – during the execution of a training event. The result is a transformational change in the way that we plan for, execute, and evaluate Marine Corps MAGTF training.

FUTURE DEVELOPMENT

CACCTUS development and install is currently occurring at Twentynine Palms, California. The current status includes an infrastructure upgrade, installation of the communications system, prototypical installation of the 3-D visualization system, and preparation for installation of the OneSAF Objective System software. The communications system is functional, as is the rudimentary functionality of the synthetic natural environment. Ongoing developmental areas include the intelligent tutoring system, digital C4I data collection, general user interface evaluation and improvement, and links to the live training environment. CACCTUS is closely coupled with the Marine Corps' ongoing efforts to modernize our live training ranges as well. These two efforts are leveraging key technologies to the betterment of the Marine Corps.

REFERENCES

Ong, James and Ramachandran, Sowmya, (2003) Intelligent Tutoring Systems: Using AI to Improve Training Performance and ROI, *Stottler Henke, http://www.shai.com*

Unk., (2003) Intelligent Tutoring Systems Technologies for Military Training, *Stottler Henke, http://www.shai.com*