THE ARMY AVIATION COLLECTIVE TRAINING SOLUTION: AVCATT-A

Gary R. George P. E.
L-3 Communications Link Training and Simulation
Binghamton, NY 13904

William C. Reese
United States Army Simulation, Training, and Instrumentation Command (STRICOM)
AMSTI-EV
Orlando, FL 32826-3276

William H. Durham
L-3 Communications Link Training and Simulation
Arlington, Texas 76011

Sam Knight
L-3 Communications Link Training and Simulation
Orlando, Fla. 32826-3224

ABSTRACT

The existing suite of training devices for Army aviators is composed of single cockpit, stand-alone devices designed to support training appropriate for an individual aviator or a single crew. These training devices, while completely appropriate for individual aviator and crew training do not possess the networking and interoperability capability necessary to address collective, unit-level training of multiple crews. This inability to provide company/troop level collective training is to be corrected with the development and procurement of AVCATT-A. This paper will provide an overview of the total AVCATT-A training solution to meet stringent Army aviation collective training requirements. The AVCATT-A represents a different approach to both the level of training addressed and the fidelity of the training devices. AVCATT-A is intended to provide company/troop level training for Army aviation reconnaissance, attack, assault and support units via six networked, reconfigurable cockpits interacting with a rich synthetic battlespace housed in a mobile facility. This approach differs radically from that of fixed site, aircraft specific, limited synthetic battlespace, individual aviator or crew level training devices that comprise the existing training suite.

ABOUT THE AUTHORS

Gary R. George, P. E. is a Principal Systems Engineer at L-3 Communications, Link Simulation and Training with over twenty years of experience in simulation and modeling. He was actively involved in the initial simulator networking of Army full-fidelity simulators. He also was an active participant in the development of the first DIS standards. Mr. George is a licensed engineer in the State of New York. Mr. George recently has been a consultant to Air Force Research Lab (AFRL) for computer-generated forces and training environments and holds a B. S. in Mechanical Engineering, an M. S. in both Mechanical and Electrical Engineering from the State University of New York and Syracuse University. He is currently a Ph.D. candidate at the State University of New York performing research on human perceptual modeling for Computer Generated Forces (CGF). He is also working on various areas in the AVCATT-A training environment and has been awarded both the Link Foundation and IITSEC fellowships.

William C. Reese is the lead systems engineer for the United States Army Simulation, Training and Instrumentation Command (STRICOM) on the AVCATT-A program. Mr. Reese received his undergraduate degree in Electrical Engineering at Virginian Polytechnical Instititute and State University. He received a graduate degree in Computer Engineering from the University of Central Florida. Mr. Reese has 20 years of experience in developing military simulation systems. He has worked for the Naval Training Systems Center (NTSC) for 14 years and STRICOM for the past 6 years. He has been the lead Systems Engineer for the Conduct of Fire Trainer (COFT), Abrams Tank Driver Trainer, Close Combat Tactical Trainer (CCTT), and recently AVCATT-A.

William H. Durham is the L-3 Communications Link Simulation and Training Program Manager on the AVCATT-A program. Mr. Durham has spent the last nineteen years in the flight simulation industry with various derivatives of Link Flight Simulation. The past fourteen years have been as a program manager on the AH-1S Cobra, UH-60 Blackhawk, AH-64 Apache to include the DESERT STAARS program, MH-60K/MH-47E Special Operations Aviation Combat Mission Simulator (SOACMS), F-16 Universal Training Device (UTD), F-18 LRIP/TOFT, and currently as the AVCATT-A Program Manager. His first five years in the industry were spent in field engineering on the B-52/KC-135 program and the UNFO Undergraduate Naval Flight Officer program. Mr. Durham enlisted in the U.S. Navy in 1973 and was honorably discharged in 1980 after completing his enlistment. Mr. Durham holds a B.S. in Marketing from The University of West Florida as well as an M.S. in Management from Troy State University.

Samuel N. Knight is a Manager of Engineering Programs for the Orlando component of the Link Simulation and Training Division of L-3 Communications. He has over 29 years of modeling and simulation experience including Army, Air Force, Navy and foreign programs. His primary areas of expertise include Advanced Distributed Simulation (ADS), High Level Architecture (HLA), Distributed Interactive Simulation (DIS), tactical systems and simulations, tactical mission environments and semi-automated forces, visual and sensor simulation, team training, mission rehearsal requirements and supporting technologies, embedded training, systems integration techniques, testing and the use of simulators for systems and tactics evaluations. He is a committee member for the Simulation Interoperability Standards Organization (SISO) and is the President of SISO Inc. He was previously a Steering Committee member and Chairman of the Emissions Subgroup for the ARPA/STRICOM/UCF Working Group for the Interoperability of Defense Simulations. Mr. Knight has published works in the areas of tactical simulation, simulator networking, simulator fidelity, and mission rehearsal.

THE ARMY AVIATION COLLECTIVE TRAINING SOLUTION: AVCATT-A

Gary R. George P. E.
L-3 Communications Link Training and Simulation
Binghamton, NY 13904

William C. Reese
United States Army Simulation, Training, and Instrumentation Command (STRICOM)
AMSTI-EV
Orlando, FL 32826-3276

William H. Durham
L-3 Communications Link Training and Simulation
Arlington, Texas 76011

Sam Knight
L-3 Communications Link Training and Simulation
Orlando, Fla. 32826-3224

INTRODUCTION TO COMBINED ARMS TRAINING

In the late 1980s, the Defense Advanced Research Projects Agency (DARPA) pioneered distributed simulation technology with the SIMNET program (Aluisi (1991), Hapgood (1997), Pope (1991), Thorpe (1987), Herman (1987)). In association with the U.S. Army, SIMNET led large numbers of manned Abrams and Bradley fighting vehicles to networks. This large scale collective training system employed local and long haul networks which connected not only combat vehicle simulators but also all their command and control (C2), logistics, administration and other combat support and services. SIMNET also employed aircraft modules that were part of the distributed simulation system including an A-10 close air support (CAS) and generic rotary-wing manned simulator.

SIMNET provided what became known as the “60%” solution. The SIMNET concept was to develop quickly, be satisfied with good enough for collective training and keep development and recurring costs low. Although SIMNET provided cartoon style imagery and lower fidelity interaction with the terrain it did provide the ability to network soldiers in manned simulators together in collective training exercises. This concept provided the guiding principle of selective fidelity training devices. From the flight simulation world this was a paradigm shift away from the standard flight simulators of the day. Before SIMNET and the vision of collective training, most Army rotary-wing simulators were high fidelity crew training devices such as those that are part of the Army’s Synthetic Flight Training System (SFTS) (George et.al. (1987), George et.al. (1988), Stark et.al. (1989)). These aircrew training devices continue to provide excellent air crew training today. In the late 80’s the Army was also interested in networking these full fidelity devices together to show that high fidelity collective training using existing Army simulators was possible. (George et.al. (1989), Monette et.al. (1989)) However, to provide large scale collective training, a significant number of simulators are required with a highly interactive synthetic battlespace representing Blue Forces (BLUFOR) and Opposing Forces (OPFOR). This requires that the unit cost of these simulators had to be dramatically lower than typical full flight simulators having high costs associated with full simulation (as opposed to selective fidelity) and large motion bases and that not every aircraft switch and control be fully simulated. It also requires the application of systematic reuse of existing simulation products, standardized interfaces to promote interoperability, understanding the selective simulation concept and use of Commercial-Off-the-Shelf (COTS) products to the highest extent possible. These are the principles that are in use by the Government/contractor team to develop AVCATT-A the Army’s aviation collective training solution of this millennium.

AVCATT-A FOR COLLECTIVE AVIATION TRAINING

The AVCATT-A is an evolving dynamic, alternative instructional training system to provide the ability to rehearse and collectively train, through networked simulation, reconfigurable cockpits, and mobile simulators in a unit-collective and combined arms simulated battlefield environment. AVCATT-A is a critical element of the Combined Arms Training Strategy (CATS) and supports institutional, organizational, and sustainment training for both Active Component (AC) (AH-64A Apache, AH-64D Longbow Apache, RAH-66 Comanche (contract option), OH-58D Kiowa Warrior, UH-60A/L Blackhawk, and CH-47D Chinook aircraft), and Reserve Component (RC) aviation units worldwide.

Simulated collective and combined arms exercises will provide commanders with an affordable capability to hone and sustain acceptable individual performance levels required to support unit collective training and rehearsals, and combined arms wartime mission performance requirements. AVCATT-A will be Distributive Interactive Simulation (DIS)/Higher Level Architecture (HLA) compliant, compatible, and interoperable with other Combined Arms Tactical Trainers (CATT) (i.e., Close Combat Tactical Trainer (CCTT), Engineer CATT (ENCATT), Air Defense CATT (ADCATT), and Fire Support CATT (FSCATT)). The interoperable CCTT/AVCATT-A systems will define the Army's Synthetic Environment Core (SE Core) (Marshall (1998)). AVCATT-A will also be Joint Architecture-Army (JTA-A) compliant. AVCATT-A will provide a realistic, high intensity, task loaded combat environment, composed of attack, reconnaissance, lift aircraft platforms, Semi Automated Forces (SAF) workstations, Aviation Mission Planning System (AMPS), Role Player (RP) workstations, After Action Review (AAR) capability, and Battle Management Controller (BMC) workstations. AVCATT-A will provide training capability at the company/troop level for Army aviation mission units via six networked, reconfigurable cockpits housed in a mobile facility.

THE AVCATT-A SOLUTION

The existing Army aviation simulation training capability does not fully support the aviation Combined Arms Training Strategy (CATS) and vision. Current training devices and the environments in which they are employed do not provide the realism, intensity, and integration required to prepare Army aviation to operate effectively on the joint/combined arms battlefield. As previously noted, existing simulation is limited primarily to individual/air crew trainers, which often do not reflect the latest aircraft configuration, are not mobile and are not designed for interoperability in large scale collective/combined arms exercises. While these trainers do possess high definition visual databases, interactive Computer Generated Forces (CGF), and are capable of task loading an individual crew, the visual databases are geo-typical and the CGF do not include the friendly and opposition force densities (George et.al. (2000)) to support company/troop level collective training. Attempts to supplement existing collective training with full field exercises has always been employed. However, field training exercises are increasingly constrained by high cost, environmental and safety restrictions, limited maneuver areas and ranges, and inadequate threat/target representations. Existing simulations are not capable of realistically simulating the joint/combined arms battlefield, providing effective joint task force/combined arms training, or supporting mission rehearsal in a joint/combined arms environment.

The AVCATT-A system will solve many of these shortcomings. The AVCATT-A system provides a much needed aviation collective training capability. AVCATT-A is a dynamic, alternative instructional concept to train and rehearse, through distributed simulation, in a collective and combined arms synthetic battlespace environment. AVCATT-A can provide training for twelve aviators in a collective training environment. Collective and combined arms simulation exercises provide commanders with an affordable capability to train supporting individual tasks required to conduct unit collective training and rehearsals, the unit's Mission Essential Task List (METL), and combined arms wartime mission performance requirements. AVCATT-A will be a highly mobile training system that can be transported by truck and trailer to remote sites both in and outside the Continental United States (CONUS). The AVCATT-A system will be interoperable with other simulation systems through local area network (LAN) and wide area network (WAN) utilizing broadcast and multicast modes. Through interoperability and networking with CCTT as well as other CATT elements, the AVCATT-A system will provide aviation the opportunity to conduct realistic collective and combined arms training and mission rehearsals with other Army Battlefield Operating System (BOS) training systems. The transportability supports the highly mobile National Guard training program. Additionally, a Software Engineering Environment (SEE) consisting of computational equipment and software tools necessary to support the equipment over its life cycle will be provided at a fixed Army site.

In order to define the selective fidelity solution for the AVCATT-A system a number of studies were conducted. The AVCATT-A Fidelity Analysis presents the results of a selective task and fidelity analysis, and a summary and comparison for the AH-64A Apache, AH-64D Longbow, OH-58D Kiowa Warrior, UH-60 Blackhawk, CH-47D Chinook and Comanche (contract option) helicopters. These analyses identify the dependency relationships between the crew (pilot and copilot/gunner) tasks and the respective cockpit controls, displays switches and devices. With these fidelity analyses, it is possible to identify the displays and controls required to be active in the simulation meeting the required individual/crew tasks as listed in the Aircrew Training Manual (ATM) for the specific aircraft referenced above. The simulation fidelity requirements presented suggest an appropriate fidelity for each control and display element. The Task and Skills Analysis (TSA) and the Selective Fidelity Analysis (SFA) for AVCATT-A individual/crew task training were developed using the ATMs as the primary source document.

To further define AVCATT-A requirements, the AVCATT-D (demonstrator) training system (currently known as Combined Aviation Virtual -Trainer (CAV-T)) in the Army inventory explored capabilities for Army aviation collective training. Lessons learned from this device also provided the basis for the Government specification for the AVCATT-A program. The CAV-T will be used for aviation collective training until the production and deployment of AVCATT-A.

AVCATT-A is a reuse-focused evolutionary integration project. The software implementation utilizes reuse from CCTT, Department of Defense (DoD) SAF systems and numerous legacy programs. The AVCATT-A solution consists of two major portions: (1) the Manned Modules (MM)/Mobile Facilities (MF) and (2) the Training Environment (TE). The MM/MF include the virtual reconfigurable simulators and associated trailers for transport. TE components provide workstations to conduct all phases of the exercise (pre-exercise, preparation, execution, BMC, AAR, CGF, RP and the network).

MANNED MODULES (MM)/ MOBILE FACILITIES (MF)

The MM system (AVCATT-A System Subsystem Design Document (SSDD) Manned Module (2000)) provides the human operator or trainee with the capability to interact with and receive informational responses and sensory cues from the AVCATT-A training system. There are six rotary wing MM per suite that can be reconfigured into any combination of AH-64-A Apache, AH-64-D Longbow, OH-58D Kiowa Warrior, RAH–66 Comanche (contract option), UH-60 A/L Blackhawk, and the CH47D Chinook. This configuration provides a total of 12 aviator seats per suite. The MM is composed of the following components:

- *Hardware Systems* consists of the seats, frame, computer hardware, visual hardware, panels, displays, switches, indicators, controls etc. Also included is the hardware used to generate cockpit indications to the trainee such as auditory, vibration and sensory cues.
- *Computer Systems* consists of reusable legacy code for the MM infrastructure, handlers, network, performance monitoring, maintenance procedures and test software.
- *Visual Systems* consists of the image generator, the Helmet Mounted Display (HMD) and the secondary display for use when the HMD is not available.
- *Aerodynamic Models* are rotary-wing aerodynamic simulations developed by Advanced Rotary Technology (ART) using the FLIGHTLAB development tool and interfaces to other simulated systems, e.g. avionics systems.
- *Simulated Aircraft (A/C) Systems* consists of the primary controls, engines, electrical, fuel, hydraulics and lighting.
- *Simulated Avionics System*s consists of the Fire Control Computers (FCC), controls and displays, communications, cues, navigation, sensors, weapons and Air Survivability Equipment (ASE). Fidelity levels were determined using a fidelity analysis. (AVCATT-A SRD Appendix E (2000)).
- *The Distributed Entity Manager (DEM)* manages the simulated battlefield entities and their attributes significant to the manned modules, e.g. weapon effects from threats.

The AVCATT-A requirement for quick reconfigurable hardware simulation within the MMs requires three unique packaging “schemes”:

- *Instrument Panel Simulations (Overlays):* Instrument panels are simulated utilizing a unique overlay panel for the helicopter type being simulated. These overlay panels accommodate the rear projection of dynamic instruments and imbedded displays. Functional controls such as knobs, switches lamps, etc. are contained in the overlay. Having tactical controls versus touch screens is necessary to keep the system from diverting the aviator’s attention from the mission (i.e., the aviators can quickly adjust the controls in the manner they have been trained). Each MM provides an overlay for each configuration available in the AVCATT-A simulations. Reconfiguration of the instrument panel is accomplished with the removal and replacement of the overlay. Quick disconnect fasteners are provided to simplify this process.
- *Side Shelf and Center Pedestal Controls Simulation (modules):* Center pedestals and side shelves are a modular design providing for a rapid reconfiguration of this hardware. Modules are

rectangular using two sides of the module, each simulating a different A/C configuration. This allows the technician the ability to simply rotate the assembly to the desired configuration and remove its covers. The MM's center-panel area requires the use of four modules to accommodate all of the configurations. Storage for modules not in use can easily be accommodated within the trailer's storage compartments.

- *Flight Controls*: Flight Controls include the applicable sticks and grips required to simulate the controls of the helicopter being simulated (collective, stick etc.). Each of these controls requires an electrical connection to the simulation computers as well as mechanical connections to the applicable control loader. Both of these interfaces are accommodated with simple quick disconnect features which will allow the technician to quickly reconfigure the cockpit. The hardware reconfiguration tasks described above can be performed by a single technician and can be done concurrently with the boot-up of the computer system. It should be noted that change to the control loading hardware is not required. The software employs modeling which provides the proper forces and responses for the aircraft type selected through a generic mechanical linkage within the MMs.

Image Generation

The Silicon Graphics Onyx2 is the image generator (IG) system selected for AVCATT-A. Having been applied on other simulation programs, this IG is a mature product with a powerful image processing system providing Out-the-Window (OTW) and sensor imagery to a wide range of complex simulation requirements. The hardware is modular and extensible, providing functionality for both the high-resolution visual imagery as well as the lower resolution sensor images. Sensor imagery includes radar, Forward Looking Infrared (FLIR), Day Television (DTV), Night Vision Goggles (NVG) and Direct View Optics (DVO). The radar imagery is generated by the Digital Radar Landmass System (DRLMS) which is a separate image processor.

Helmet Mounted Display (HMD)

The HMD system provides the OTW view of the training environment for the aviators in the MM. The HMD is capable of displaying visual scenes, symbology, and night vision images created by the IG. The HMD has a head tracker/rate sensor to precisely monitor the aviator's head position and velocity to allow for the appropriate visual cues to be generated. The helmet optics visor transmits the image to the aviator's eyes with the proper field of view and see through the visor to the cockpit interior.

The MFs (AVCATT-A System Subsystem Design Document (SSDD) Mobile Facility (2000)) provides the operational environment for the AVCATT-A suite. The MF is composed of two custom fabricated trailers designed specifically to house the training system equipment. Modified commercial trailers are used to provide a lower cost solution to military-style International Standards Organization (ISO) containers. The trailers are ruggedized to meet requirements for electromagnetic capability, structural lifting, environment extremes and C-5A and ocean transport functional requirements. The overall configuration consists of two semi-trailers with associated stairs and decking to provide easy ingress/egress (see Figure 1). The trailers are interconnected mechanically by decking. Electrical interfaces between the trailers are provided by protected external connectors that support rapid plug-in of connecting cables.

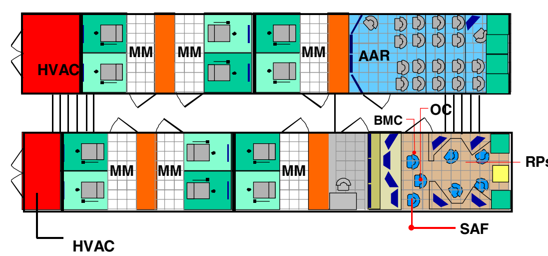

Figure 1. AVCATT-A Mobile Facility Showing AAR, RP, OC, BMC, HVAC and MM

TRAINING ENVIRONMENT (TE)

The TE will provide the human operators in the MM the capability to interact with and receive informational responses and sensory cues from the AVCATT-A training system during and after an exercise (see Figure 2). The AVCATT-A network centric architecture is based on a multiple federate, flexible interface to ensure interoperability with other Higher Level Architecture (HLA) systems and compliance with HLA standards.

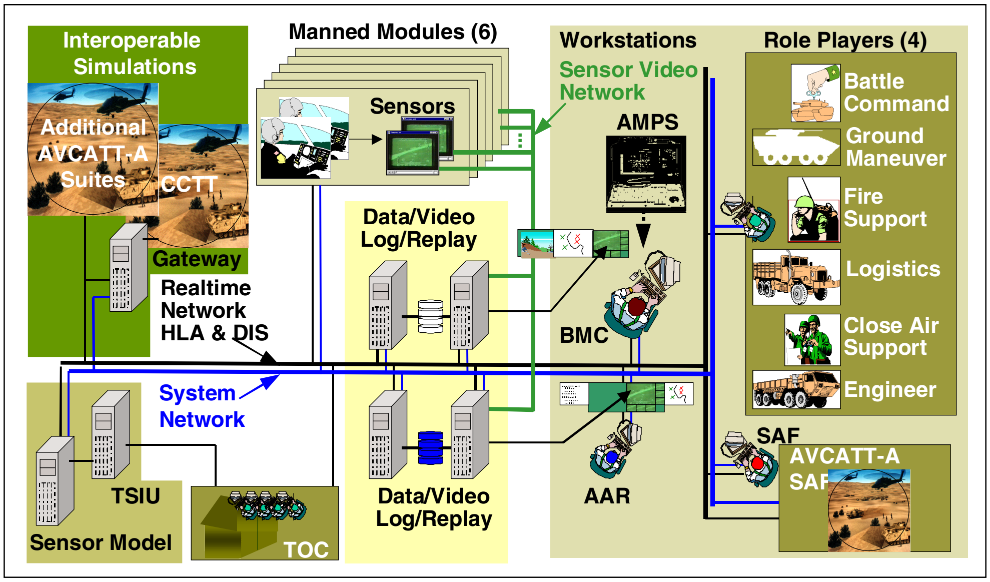

Figure2. Training Environment Network Architecture

The TE consists of the following nine components:

AVCATT-A Semi-Automated Forces (AVCATT-A SAF)

The AVCATT-A SAF component is based on the OneSAF Test Bed (OTB) / Modular Semi-Automated Forces (ModSAF) 5.1 architecture and software. It is a fundamental component of the training environment providing a highly interactive synthetic battlespace for the trainee in the MM. Reuse is from other DoD programs, where applicable, such as Joint Semi-Automated Forces (JSAF). The AVCATT-A SAF component will consist of a ModSAF style front-end SAF Graphical User Interface (GUI) workstation to control and edit the computer generated forces (CGF) entities. The CGF models (physical, behavior and environment) are resident in the ModSAF style "back end" of the CGF system. Additional behavior models and new physical entities will be developed for collective aviation training requirements. This will include OPFOR integrated air defense systems that battle the MM. RPs generally have control of BLUFOR while the SAF operator station controls OPFOR. A key goal is to have AVCATT-A SAF on a road that merges with the Army's OneSAF vision in the future. By using the OTB/ModSAF 5.1 baseline this goal is facilitated.

Role Player (RP) Stations

Since current CGF is not totally autonomous in its actions and behaviors, RPs are sometimes required to augment the AVCATT-A SAF workstation operator. RP workstations will provide the ability to monitor and interact with the simulation exercises. The four Multi-function RP workstations will each be capable of operating as one of the following functional areas: ground maneuver, fire support, CAS, logistics, battle command, and engineer functions. A RP uses data from his ground truth Plan View Displays (PVD) at his workstation to provide training to the trainee in the MM. An example of a role player is the CAS mission. Here the RP controls the F-16 SAF A/C and communicates with the MM for a Joint Air-to-Air Tactics (JAAT) mission. The BMC operator has the capability to perform all RP functions, as will the SAF workstation. Radio and digital communications systems are provided for each of these workstations. In addition, the RP stations are capable of serving as the BMC console in the event of a BMC station failure during an exercise.

Battle Master Controller (BMC)

Mission control capability allowing an operator to initialize, support, control, and monitor all aspects of the AVCATT-A collective training exercises is provided via the BMC Workstation. Functionality includes: initialization, control, recording, and monitoring; view and control of on-going CATT exercises, act as a role player, display stealth and plan views of entire synthetic battlespace, display selected manned module sensor imagery; communicate with manned modules and role players and provide training malfunction/ emergency control. To provide a common user system interface there is a common software load among BMC, RPs, and AAR based on the AVCATT-A SAF GUI. During the exercise, time stamps can be inserted in the recorded data so the BMC can replay portions of the current exercise.

Mission Planning System

Capability is provided to simulate the data transfer functionality of the fielded AMPS and the design basis aircraft. AMPS data may be fed into AVCATT-A at the BMC station. Data such as waypoints, frequencies and weapon configuration can then be downloaded to the MM for initialization. This allows the trainees to plan their missions in advance and not have to manually enter A/C avionics data into the MM just before the start of the exercise.

Tactical Simulation Interface Unit (TSIU) Gateway

The AVCATT-A system utilizes a TSIU to communicate digital tactical message traffic between the AVCATT-A real-time network and the Tactical Operations Center (TOC). The TSIU supports the conversion of TACFIRE and AFAPD message formats between the AVCATT-A SAF and MM simulation formats and the formats required by selected components of the TOCs Command, Control, Communications, Computers and Intelligence (C4I) equipment.

Higher Level Architecture (HLA) Gateway

AVCATT-A is HLA-compliant and uses a gateway to interface with non-HLA systems.

After Action Review (AAR)

The AVCATT-A includes an AAR capability for real-time monitoring and after action debriefing. A total of 20 personnel may be accommodated in the AAR room. Personnel can view either the exercise currently in progress, or any other previously recorded exercise. Review of previous exercises is also possible while the current exercise is underway. The AAR provides a "stealth view" capability that allows the briefer to "fly through" the database without the knowledge of exercise participants, similar to the BMC station. AAR also has the capability to generate a "take home" video tape of the review as well as a series of reports. Reports include killer victim, accuracy of gunnery, accuracy of navigation, timeliness of mission completion, conduct of mission and performance /utilization data.

There are two high-speed data loggers, one for sensor video and a second to record all real-time data from the MM and synthetic battlespace. They can record up to eight hours of data. Two sensors (3 video channels) from each MM can be recorded. Each video channel is recorded in a "Recording Box" that converts the analog video into an MPEG-2 video stream. Six channels of video are available for playback or monitoring in both the BMC and AAR. The BMC and AAR each have separate control over which 6 of the 12 channels are monitored/replayed. The real-time logger records MM, BMC and SAF data such as initial conditions, entity interactions/events, battle damage assessment and radio/intercom communications for later replay and analysis.

Network

The networking component is composed into three major parts:

- Real-time Network
- System Network
- Sensor Imagery Network

The real-time network is the primary digital network for real-time communications. This network includes gateways for supporting interoperability with CCTT, OTB, TOC and multiple AVCATT-A suites. The HLA protocol is employed on the real-time network for communication, control, initialization and status among AVCATT-A system components. Simulation control, initialization, and status information is communicated between the TE and the MM using the real-time network. The System Network is utilized to transfer non-real-time data between the TE and the MM. The sensor imagery network carries the sensor video for AAR data logging, monitoring and playback. All the data networks are 100BaseT Ethernet providing 100Mbits per second of bandwidth.

AVCATT-A will employ a network centric architecture (see Table 1). This approach provides a modular, flexible and reconfigurable architecture which supports both near-term and long-term collective training requirements for AVCATT-A. This networking approach provides a single simulation architecture for exercises consisting of single or multiple AVCATT-A suites and for exercises interoperating with CCTT suites and/or other DIS/HLA compliant devices. This architecture provides the compliance of AVCATT-A with HLA.

Feature	Benefit
Interoperable training	Multiple or different federates operating to a common set of architecture and interoperability rules provide the flexibility to rapidly configure the training equipment to users immediate needs at very short notice with excellent long term growth objectives.
Capability substitution	Each federate, such as AVCATT-A SAF, etc., may be replaced by a substitute federate from another source to provide increased capabilities as long as the basic interoperability rules are still satisfied. This allows the "best of the best" from all available reusable assets.
Encapsulation of simulation from federation	The application of HLA, allows the choice of federates for the major mission functions and a common set of interoperability rules allows the application models to be hidden from the remainder of the mission or federation to preserve mission integrity. Plug 'n Play capability is now achievable with the ability to rapidly reconfigure for any mission need.
Expandable training	The flexibility of the interoperable system architecture through the use of the network control software allows the architecture to expand or contract or be apportioned to provide integrated mission training or multiple instances of single-ship training, etc.. In other words, the precise mission can be easily created from the assets available to the user.
Affordable, reconfigurable architecture	The architecture within each federate is a complete simulation model to itself. Given common interoperability rules and independence of computational platform, a federate simulation from one weapon system platform can operate within another weapon system platform without violating fundamental architectural boundaries.
Ease of technology upgrade	A highly object oriented architecture with optimized interfaces, services between federates, encapsulation of models, and computational platform independence provides the ability to accommodate significant technology upgrades without a major overhaul of the architecture.
Computational platform independence	Computational resources for each federate or cluster of federates is based on the performance requirements of the set of models, commonality requirements for hardware, and life-cycle cost objectives. Several different computational platforms can easily coexist due to the encapsulation of simulation.

Table 1. Network Centric Architecture Features and Benefits

TRAINING ISSUES

Interoperability

The AVCATT-A design provides an approach to interoperability which supports the life cycle of the AVCATT-A as other CATS systems are integrated. Interoperability includes the capability of separately designed and implemented systems to exchange sufficient data to support an exercise that meets the training objectives. Interoperability involves two basic concepts: *(1)* there must be a mechanism to exchange exercise and entity information in a format that is standardized and understandable by both systems and *(2)* there exists the need for a common natural and tactical synthetic environment.

This first requirement is met on AVCATT-A through the Federation Object Model (FOM) and an HLA gateway that interfaces to non-HLA DIS systems. The second requirement for a common synthetic environment is achieved through the reuse of CCTT visual databases, along with Synthetic Environment Data Representation and Interchange Specification

(SEDRIS) (Skowronski (1999)). AVCATT-A utilizes SEDRIS to derive manned module and AVCATT-A SAF common correlated databases. The data representational models in SEDRIS provide a key to interoperable correlated databases.

Fair Fight

The AVCATT-A design strategy emphasizes the requirement to achieve fair fight between all AVCATT-A participants and interactions with the synthetic entities. Fair fight (Foster et.al., Marshal) provides the ability of the MMs to fight and interact with synthetic forces in a manner that is representative of real world combat. Achieving a high degree of correlation of the virtual battlespace is necessary to ensure conditions for a fair fight will exist among aviators in each of the networked trainers. Fair fight is concerned with two specific issues:

- Correlation of manned module and AVCATT-A SAF synthetic environment databases (terrain, atmospheric, electromagnetic and others).This is an extremely important element of fair fight.
- Modeling compatibility that addresses the differences among the sensor, aerodynamic, and weapon modeling of the MMs and the AVCATT-A SAF entities.

One key to the AVCATT-A design to ensure fair fight is the correlation of terrain databases and special effects and use of common behaviors and physical models. As discussed in the previous section SEDRIS methodology and tools will be used to correlate the MM and AVCATT-A SAF databases.

A solution to the second issue is the use of models with similar performance in the areas of sensor, weapon and aero for both MMs and AVCATT-A SAF. This ensures each system has similar capabilities and limitations so that AVCATT-A SAF behavior is consistent for a given tactical situation. This is particularly important for task frames since the human AVCATT-A SAF operator is a key element in the validity equation. Originally the objective was to achieve common software through the use of products such as FLIGHTLAB to generate both MM and new AVCATT-A SAF entities. This approach ensures a “fair fight” capability by providing consistency in performance and handling qualities between MM and AVCATT-A SAF entities. However, from CAV-T experience most of the existing physical models that are contained in the OTB/ModSAF 5.1 baseline seem to be adequate to fairly fight with the MMs for AVCATT-A. At this time AVCATT-A SAF will use the existing physical models of the SAF baseline and evaluate the modeling compatibility issues later in the program.

Systematic Reuse

In order to cost-effectively develop AVCATT-A and provide much needed Army collective training capability, reuse of numerous existing products and mature technologies are essential. The AVCATT-A architecture is based on selective reuse from OTB, ModSAF 5.1, JSAF, CCTT, B-2, F117A, F-16, F-22, and a number of legacy helicopter simulation projects. Some reuse candidates are:

- Manned module support services, executive control, and time management software reused from L3 Communications, Link Simulation & Training legacy infrastructure software used on such systems as C130, B-2, KC-10, and F-16 Taiwan flight simulators.
- AVCATT-A SAF based on the One Semi-Automated Force (OneSAF) TestBed, and ModSAF 5.1, with additions from JSAF. This provides the core AVCATT-A SAF software with the future AVCATT-A SAF migrating seamlessly to the OneSAF production of the future.
- Selective sensor software provided by the B-2 and the F117A flight simulators.
- Parts of the DEM provided by the F-16 flight simulators.
- The Federated Input/Output (FIO) Linkage, an L3 Communications, Link Simulation & Training product, provided by the F-22 flight simulator.
- Selective pieces of the networking software derived from COTs software with augmentation from the Eighth U.S. Army (EUSA) program along with CCTT and JSAF. The network software currently is a mixture of DIS and HLA systems which utilize gateways to communicate between them.
- Aircraft Systems, Communications, Navigation, Sensors, Weapons, A/C Survivability and Cueing all receive selective software components from legacy helicopter flight simulation projects.

CONCLUSIONS

Development of AVCATT-A is in the beginning stages. AVCATT-A will provide Army aviators a collective training capability and interoperability with other training systems to expand their synthetic battlespace and training capability. AVCATT-A is a paradigm switch from past Army aviation training devices and concepts. AVCATT-A is a program that leverages off past Research & Development (R&D) including SIMNET, experience from the prototype CAV-T and massive systematic reuse of legacy assets. A joint Government and contractor team is developing as an Integrated Product Team (IPT) AVCATT-A using principles of selective fidelity that are well documented and understood to create the Army's aviation collective training capability. This system will provide a cost effective collective aviation training environment using proven and mature components that can be fielded in a timely manner. The AVCATT-A SAF will also merge with OneSAF that will be fielded in the future to further promote interoperability. As we look to the future new technologies to further advance AVCATT-A training capability are in the R&D stages now. They include advanced behavioral modeling techniques and voice control of SAF. This type of advanced research can be applied to the reduction of RPs and workload for the BMC and AAR operators using concepts of intelligent agency that advanced behavioral models produce. As the synthetic battlespace grows and exercises become larger, this will be of particular importance.

ACRONYMS

-A-

A/C	Aircraft
AAR	After Action Review
AC	Active Component
ADCATT	Air Defense Combined Arms Tactical Trainer
ADS	Advanced Distributed Simulation
AFRL	Air Force Research Lab
AMPS	Aviation Mission Planning System
ARPA	Advanced Research Projects Administration
ART	Advanced Rotary Technology
ASE	Air Survivabilty Equipment
ATM	Aircrew Training Manual
AVCATT-A	Aviation Combined Arms Tactical Trainer – Aviation Reconfigurable Manned Simulator
AVCATT-D	Aviation Combined Arms Tactical Trainer – Aviation Reconfigurable Manned Simulator- Demonstrator

-B-

BLUFOR	Blue Forces
BMC	Battle Master Control
BOS	Battle Operating Systems

-C-

C2	Command & Control
C4I	Command, Control, Communications, Computers and Intelligence
CAS	Close Air Support
CATS	Combined Arms Training Strategy
CATT	Combined Arms Tactical Trainer
CAV-T	Combined Aviation Virtual-Trainer
CCTT	Close Combat Tactical Trainer
CGF	Computer Generated Forces
COFT	Conduct of Fire Trainer
CONUS	Continental United States
COTS	Commercial-Off-The-Shelf

-D-

DARPA	Defense Advanced Research Projects Administration
DEM	Distributed Environment Manager
DIS	Distributed Interactive Simulation
DRLMS	Digital Radar Landmass System
DTV	Day Television
DVO	Direct View Optics

-E-

ENCATT	Engineering Combined Arms Tactical Trainer
EUSA	Eighth U.S. Army

-F-

FCC	Fire Control Computer
FIO	Federated Input/Output
FLIR	Forward Looking Infrared
FOM	Federation Object Model
FSCATT	Fire Support Combined Arms Tactical Trainer

-G-

GUI	Graphical User Interface

-H-

HLA	Higher Level Architecture
HMD	Helmet Mounted Display
HVAC	Heating, Ventilation and Air Conditioning

-I-

IG	Image Generator
IPT	Integrated product Team
ISO	International Standards Organization

-J-

JSAF	Joint Semi-Automated Forces
JAAT	Joint Air-to-Air Tactics
JTA-A	Joint Architecture-Army

-L-

LAN	Local Area Network

-M-

METL	Mission Essential Task List

MF	Mobile Facility
MM	Manned Module
ModSAF	Modular Semi-Automated Forces
-N-	
NTSC	Naval Training Systems Center
NVG	Night Vision Goggles
-O-	
OC	Observer Controller
OneSAF	One Semi-Automated Force
OPFOR	Opposing Forces
OTB	OneSAF Test-Bed
OTW	Out The Window
-P-	
PVD	Plan View Display
-R-	
R&D	Research & Development
RC	Reserve Component
RP	Role player
-S-	
SAF	Semi-Automated Forces
SE Core	Synthetic Environment Core
SEE	Software Engineering Environment
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SFA	Selective Fidelity Analysis
SFTS	Synthetic Flight Training System
SISO	Simulation Interoperability Standards Organization
SOA CMS	Special Operations Aviation Combat Mission Simulator
SRD	Systems Requirement Document
SSDD	System/Subsystem Design Document
STRICOM	Simulation, Training and Instrumentation Command
-T-	
TE	Training Environment
TOC	Tactical Operations Center
TSIU	Tactical Simulation Interface Unit
TSA	Task and Skills Analysis
-U-	
UCF	University of Central Florida
UTD	Universal Training Device
-W-	
WAN	Wide Area Network

REFERENCES

[1] Aluisi, E. A. (1991) The Development of Technology for Collective Training: SIMNET a Case History, Human Factors, 33, 343-362.

[2] AVCATT-A SRS,CDRL B002, , Contract N61339-00-C-002, L-3 Communications, 2000.

[3] AVCATT-A SSDD Manned Module, , CDRL A003 R000680, Contract N61339-00-C-002, L-3 Communications, 2000.

[4] AVCATT-A SSDD Training Environment, CDRL A003 R000679, Contract N61339-00-C-002, L-3 Communications, 2000.

[5] AVCATT-A SSDD Mobile Facilities, CDRL A003 R000681, Contract N61339-00-C-002, L-3 Communications, 2000.

[6] George, G. , Knight, S. N., McTiernan, J., Networking of Full Fidelity Simulators for Advanced Mission Training, NAECON, 1989.

[7] George, G., Drew, E., Knight, S. N., AH-64 Combat Mission Simulator Visionics Simulation, NAECON, 1988.

[8] George, G., Drew, E., Knight, S. N., AH-64 Combat Mission Simulator Tactical System, AIAA Flight Simulation Conference, 1987.

[9] George, G.R., Knight, S, Cavitt, D., Harvey, E., The CGF Entity Count, Benchmark Testing to Meet Collective Aviation Training Requirements, 9th CGF and BR Conference, Orlando, Fla., 2000.

[10] Foster, L., Feldmann, P., Defining a Fair Fight, http://stow.spawar.navy.mil/STOWhistory/.

[11] Hapegood, F. (1997), SIMNET, Wired Magazine 5(4)

[12] Herman, J., A New Approach to Collective Training Simulation: The SIMNET Simulation Formula for Success, TR January 1987, Perceptronics Training and Simulation Division, 21122 Erwin St. Woodland Hills, Ca.

[13] Marshall, H., CCTT SAF and Synthetic Environment Core Update 1998, 7th CGF and BR Conference, Orlando, Fla., 1998.

[14] Marshall, H., E. Chandler, B McEnany, J. Thomas, SAF and Manned Simulators Correlation Issues in CCTT, IITSEC, 1996.

[15] Monette, R., Knight, S. N., George, G., Multiple Simulator Networking - The Way to Provide Effective Training Today, I/ITSC, 1989

[16] Pope, A. R., The SIMNET Network and Protocols (1997), Version 6.6.1, BBN.

[17] Skowronski, V. J., Using SEDRIS for CGF Terrain Database Generation, Eighth CGF and BR Conference, Orlando, Fla., 1999.

[18] Stark, E. A., George, G., Knight, S. N., Fidelity Requirements in Aviator Training Networks, AIAA Flight Simulation Conference, 1989.

[19] Thorpe, J. A., The New Technology of Large Scale Simulator Networking: Implications for Mastering the Art of Warfighting, IITSEC Proceedings, 1987.