Communication Interoperability: FCS at the Live Training Ranges

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ABSTRACT

The Future Combat Systems (FCS) program is modernizing the way the United States Army provides communications for tactical and training operations. Use of the tactical network and tactical radios provides realistic training and will enhance the live training experience (individual and collective). The unique challenge for the FCS Brigade Combat Team (BCT) is to be able to utilize its fully embedded training capability, while remaining seamlessly interoperable with a multitude of Tactical Engagement Systems (TES), target systems, Instrumentation Systems and their inherent communication backbones.

This paper will focus on the communication and radio requirements for the Combat Training Centers (CTCs), the challenges associated with bandwidth and spectrum availability, and how the operational data collected during training will be used for the training exercise After Action Reviews (AARs). The authors get to the core of the Live embedded training paradigm facing FCS and address the seemingly unrelenting questions. How can we design an embedded dual-purpose tactical and training communication system that can interoperate with the Army Combat Training Centers (CTC) and Homestation Instrumentation Systems, as well as replicate an instrumented range training environment during non-range training in a deployed posture? Furthermore, how do we achieve this goal given the Army-wide bandwidth constraints, limited spectrum and range-specific communication systems, all within the size and weight constraints of the combat systems? This paper will present the current status of an on-going multiple year study that focuses on FCS platform communication interoperability with the combat training ranges.

ABOUT THE AUTHORS

Ms. Oxana Fedak is a Systems Engineer leading the Future Combat Systems Embedded Tactical Engagement Simulation System (E-TESS) development. Her current focus is the development of a common TES solution, which will enable the future force to train at the Combat Training Centers, Homestation and while deployed. She leads a team of One Team Partner engineers and training/simulation subject matter experts working together to design a tactical engagement simulation system which will utilize common operational/training hardware and software components, and will be interoperable with the current Army TES - MILES and the future TES OneTESS. She is responsible for the development of requirements, implementation strategy, test and integration plans, and execution of the E-TESS platform/system design reviews. Throughout her career as Systems and Software Engineer, Ms. Fedak worked on requirements decomposition and management, system and data architecture, laser and geometric pairing technology research, training fidelity analysis, application software development and hardware component design, focusing on simulation devices and training systems. Ms. Fedak holds a Bachelor of Science in Information Technology and a Masters of Engineering in Software Engineering.

Mr. Ron Moore has over 25 years experience directing modeling, simulation, training and entertainment software applications engineering at leading technology companies with specialty in software, video, audio, 3D computer graphics, computer image generation, simulation database and display development. He is currently working for SAIC as Senior Training Systems Engineer on the Army's Future Combat System (FCS) with focus on platform network, computing, video and audio architecture dual-use for embedded training. His previous assignments include three years at Evans & Sutherland as Chief Scientist developing game technology based computer image generation; four years as Chief Technology Officer at Infogrames, an entertainment software publisher, leading research and development efforts; eight years at Evans & Sutherland where he headed the companies' efforts to pioneer Ground Systems Applications for the US Army Close Combat Tactical Trainer (CCTT) System; and an seven year tenure at Boeing's Visual Flight Simulation Laboratory as lead engineer working cockpit automation technology and air combat team training using distributed network technology. Ron has held significant industry

positions including Distributed Interactive Simulation (DIS) Standards Steering Committee member, and Chairman of the Environment Working Group and Chairman of the Simulation Interoperability Standards Organization (SISO) Simulated Environment Working Group. Ron holds a BSE from Brigham Young University.

Mrs. Deborah (Debbie) Ratliff is the Live Domain Lead for the Project Manager, Future Forces (Simulation) for the Future Combat Systems Training IPT at the Army's PEO STRI (Program Executive Office for Simulation, Training & Instrumentation). Debbie's current focus is the development of a common tactical engagement simulation (TES) solution, which will enable the future force to train at the Combat Training Centers (CTCs), Homestation and while deployed. She co-leads a team of One Team Partner engineers and training/simulation subject matter experts working together to design a tactical engagement simulation system which will utilize common operational/training hardware and software components, and will be interoperable with the current Army TES (MILES) and the future Army TES (OneTESS). Debbie began her government service in 1991 at the Naval Air Warfare Center co-located with PEO STRI in Orlando, Florida. Debbie holds a Bachelor of Science in Electrical Engineering from the University of Central Florida.

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EMBEDDED TRAINING GOALS

The Army stands on the threshold of a new era in combat readiness while also being in the midst of an ongoing process of transformation with a broad mandate to change across many domains. The ability of the Army to maintain its high state of readiness through embedded training is a key component of the Future Combat Systems (FCS). Embedded training applies to both deployed and range training. The need is driving an embedded training design instead of training-unique appended equipment, and affects all hardware and software components that enable Live, Virtual, Constructive and mixed mode training. It is intended that the same operational communication systems would be suitable for conducting training, such that no training radio or training network would be added to support a rotation at an Instrumented Range. Communication assets employed during combat would essentially be utilized in the same fashion during a training exercise, with specific network management rules in place to maximize training data throughput and decrease training exercise latency. As in combat operations, FCS units will rely on Battle Command applications during Live exercises, thus increasing the realism of trained missions. Utilization of the tactical waveforms during training provides for most efficient training battlefield bandwidth utilization and rapid exchange of mission critical information.

Future Combat Systems (Brigade Combat Team) (FCS (BCT)) is a key materiel solution for the future force, and one that's going to bring a spectrum of training innovations to the Army. The FCS network facilitates the Soldier's ability to train anywhere, anytime. Technology has matured to a level that supports these requirements. Unlike historical programs, Embedded Training (ET), as demonstrated in Figure 1, is being developed as an integral part of the FCS manned platform and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) architectures.

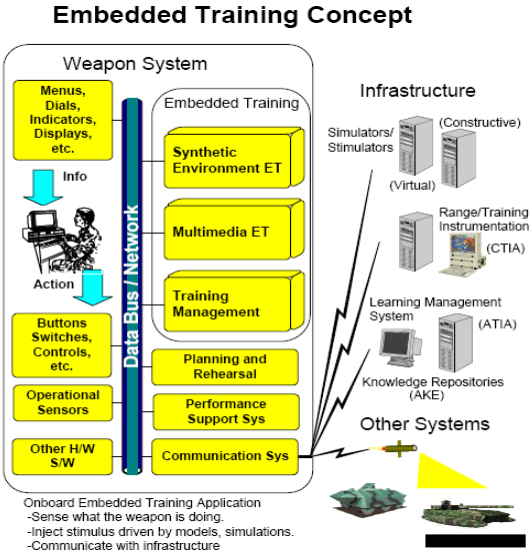

Figure 1. Embedded Training Concept

COMPONENTS OF FCS-CTC INTEROPERABILITY

FCS interoperability with the Combat Training Centers (CTCs) is an important and significant requirement, one that's a challenge to meet due to ever changing Army training needs.

Key elements defining FCS interoperability at the CTCs are (1) the ability to exchange data between the FCS C4ISR Subsystems and the CTCs and (2) the need for the FCS communication infrastructure to support exercise management and control functions utilized at the CTCs for live and multi-mode embedded training. Communication interoperability must be accomplished using the embedded C4ISR assets, such as Battle Command, Embedded Tactical Engagement Simulation System (E-TESS), tactical network and radios. With the need to seamlessly train at three existing CTCs, Homestation ranges and while deployed, FCS faces a challenge of designing to a single network/communications architecture to accommodate all Live training scenarios. Communications interoperability at the CTCs is by far one of the most difficult tasks for the FCS Training

community, and one that has historically been solved through the use of appended radio kits specific to the training installation. CTCs currently have different radio configurations, varied waveforms and unique spectrum – all of which must be accounted for in the design of FCS communications.

FCS platforms are equipped with a Joint Tactical Radio System (JTRS) (Figure 2). "JTRS is a software-defined radio (SDR) that will enable Soldiers to communicate with a wide variety of new and existing communications systems, as well as help older radios network with one another." (McHale, 2004)

Figure 2. Joint Tactical Radio System

"JTRS network will replace stovepipe radio-frequency communications with software-defined radio in the 2-MHz to 2-GHz spectrum, with room for growth to frequencies above that." (McHale, 2004) JTRS will support both tactical and training missions as a single communication component, requiring no modifications or appended hardware for conducting Live training. FCS communication will heavily rely on the Warfighter Information Network-Tactical (WIN-T). "WIN-T employs a combination of terrestrial, airborne, and satellite-based transport options, to provide robust connectivity. WIN-T will exploit the Global Information Grid (GIG) to allow worldwide connectivity." (WIN-T CONOPS, 1999) FCS platforms utilize information services that require high throughput, such as video and imagery transmission, collaborative mission planning software, distributed databases and high resolution graphics data exchange. WIN-T is a critical element in the Live training exercise, as it allows for efficient transfer of information to Observer/Controllers (OCs), allowing them to monitor the exercise in real time.

In order to seamlessly integrate into the existing exercise management functions of live training exercises at instrumented ranges, FCS must consider the mission of the CTCs. NTC trains the transformed Army by conducting force-on-force and live-fire training for ground and aviation brigades in a joint scenario across the spectrum of conflict, using a live-virtual-constructive training model, as portrayed by a highly lethal and capable Opposing Force and controlled by an expert and experienced Operations Group. The brigade and its joint partners use the full complement of its combat, combat support and combat service support (CS/CSS) systems in an expanded NTC maneuver area that has multiple urban operations sites and portrays the complexity and human dimension of the modern battlefield. Rotational training is supported by modernized and fully capable joint organizations, facilities and equipment – and thereby providing tough, realistic joint and combined arms training. OCs are utilized at the CTCs to identify unit training deficiencies, provide feedback to improve the force and prepare for success on the future joint battlefield. To accomplish this, data (in the form of voice, video, and training-unique engagement data) is transmitted from the battlefield to the Training Analysis Feedback (TAF) cells located in garrison.

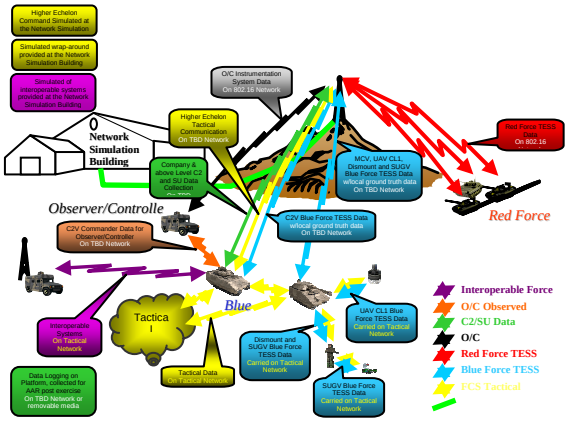

Figure 3. Live Training Communications at a CTC

Information needing to be transmitted is depicted in Figure 3 and includes:

- Blue Force tactical engagement simulation system (TESS) data to and from the instrumentation system
- Commander data to the OCs
- Command and Control (C2) and situational understanding (SU) data collection to the instrumentation system
- Higher echelon command tactical communications
- Interoperability communications
- OC command data
- Opposing Force (OPFOR) TESS data to and from the instrumentation system

Operational sensor data (e.g., unattended ground sensor (UGS) and unmanned aerial systems (UAS) data) is also required to be transmitted and captured for use in the training audience after action reviews (AAR).

CHALLENGES AT THE NATIONAL TRAINING CENTER

The National Training Center (NTC) is considered to be one of the most restrictive CONUS ranges in terms of available spectrum. There is no specific allocation of spectrum for the training mission of FCS because there is no allocation to Future Brigade Combat Team (FBCT) overall. A primary challenge for training FCS equipped Soldiers at the NTC is the stiff competition for spectrum between the U.S. Army (NTC and Ft. Irwin), the U.S. Navy (Naval Air Weapons Station China Lake), the U.S. Air Force (Edwards Air Force Base), and NASA (Goldstone Deep Space Communication Complex). The NTC is also within a few hours of two large population areas with radio and television and other commercial users flooding the airways. Training at the NTC provides the opportunity for the communication rich FCS platforms to perform in one of the thickest radio environments in the world. In fact, to create the most realistic training experience possible, the NTC also outfits the small training cities with typical commercial communications equipment including mobile phones, wireless handsets, wireless computer networks, hand radios, etc. It is critical that the NTC trainees experience the chaotic radio environment of a real tactical deployment. FCS's goal is to minimize the impact to the NTC Spectrum by taking advantage of existing tactical waveforms and capitalizing on the use of higher band frequencies which have lesser utilization today.

INTEROPERABILITY STUDY

Analysis of the communication interoperability requirements between FCS and the NTC became the subject of an on-going two year study being conducted by the FCS team of training and communication engineers. The study compares and contrasts potential transport layer solutions to satisfy the requirement of FCS interoperability with the Combat Training Centers (CTCs). The goal of the trade study is to determine the best method for the FCS to communicate with the instrumentation system at the NTC, and subsequently other CTCs. The strategy is to reuse the operational radios, and fully embed the communication to the instrumentation system.

Important considerations in identifying a viable communications technical solution will include the following:

(1) FCS and CTC radios may not be compatible, resulting in analysis of waveform and message format compatibility. For example, the currently projected 802.16 WiMAX radio for the CTC-OIS program operates in a different frequency band from the FCS tactical GMR. Additionally the CTC-OIS program has not finalized the selection of the radio, which poses an additional challenge to the FCS engineers attempting to define the communications architecture in the near term.

(2) Information Assurance (IA) and security requirements will impact the selection of the future solution. Information Assurance restricts the installation of certain types of encryption devices in unattended installations. In addition to the co-site issues of installing JTRS receivers on the NTC instrumentation systems towers, the engineers will be faced with the restriction of the specific configuration of the radios that could be installed on the towers.

(3) The key FCS requirement is embedded training, with the desired solution being utilization of dual-use hardware . If findings of the study indicate that a non-tactical radio may be required to conduct CTC training, then such radios must be embeddable on the FCS manned vehicles.

(4) Separation of the E-TESS (or training data) and the tactical data on different radio links (same or separate radio) instead of combining them on a single instrumentation link will eliminate the impact to the tactical link. Additionally it will mitigate a highly probable oversubscription risk if both data types are combined on a single link. Oversubscription would result in unacceptable levels of congestion, increased latencies and lost data.

(5) As with tactical messages, bandwidth is of big concern for training data. Selection of the CTC interoperable communication solution must have minimal impact on the available bandwidth and allow for reduced network latency for engagement message traffic.

FOLLOW-ON RESEARCH

FCS-CTC interoperability study is due to be completed mid 2009. The trade study team will update the I/ITSEC conference on the findings in 2009. To meet the requirements to provide embedded live training at the CTCs, at Homestation and also when deployed requires additional analysis, as the CTC Interoperability study does not consider deployed scenarios. The scope of the study didn't address requirements outside of network/communication challenges, therefore additional studies are planned for 2009 to analyze platform interoperability requirements during a live training exercise at the CTCs. Once completed and approved, FCS-CTC interoperability study will serve as the basis for follow-on analysis to address the communication needs of deployed training. For live training in a deployed setting FCS will use the tactical radios, which will be configured to act as a fully embedded live instrumentation range. The deployed live training will be restricted in the total number of live participants, but fully live capabilities will be available for Company level exercises.

REFERENCES

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