OneSAF Interoperability with CTIA – A LVC Connectivity Approach

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ABSTRACT

The U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI) is using a product line approach to develop two major simulation domain products – OneSAF Objective System (OOS) for the Computer Generated Forces (CGFs) domain and the Common Training Instrumentation Architecture (CTIA) for the live training instrumentation domain. The OOS is the Army's next generation entity level brigade and below constructive simulation, specifically designed to meet the needs of the three major Army modeling and simulation (M&S) domains. OOS is based on a Product Line Architecture Framework (PLAF), which provides a mechanism to organize, categorize, and define the layered software structure to incrementally meet the OneSAF requirements. The OOS PLAF identifies functionally relevant software components that can be used as building blocks for higher level functionality. The CTIA is a product line architecture that provides the foundation by which the Live Training Transformation (LT2) product line common and product-unique components are developed and then employed by the LT2 applications. The CTIA provides its own PLAF (protocols, standards, interfaces, etc.) to leverage commonality of requirements in support of integrated exercises using multiple training range instrumentation, Tactical Engagement Simulation System (TESS), and targetry systems at Combat Training Centers, home station, institutions, and while deployed. This paper provides an overview of these two simulation products and proposes a concept whereby these two products work together in conjunction with the Army Constructive Training Federate (ACTF) and the Combined Arms Tactical Trainer (CATT) family of virtual simulators to provide a seamless Army and Joint interoperable Live-Virtual- Constructive (LVC) connectivity solution.

ABOUT THE AUTHORS

Paul Dumanoir is the project director for OneSAF development at U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI), Product Manager (PM) One Semi-Automated Forces (OneSAF). Prior to his involvement with OneSAF he was a principal investigator at US Army RDECOM managing individual combatant simulation Science and Technology Objective (STO) programs. His current interests include Computer Generated Forces (CGFs), and embedded training and simulation applications. He has 17 years experience working in DoD simulation and training programs. He earned his B.S. in Electrical Engineering from the University of South Alabama in 1987 and his M.S. in Computer Systems from the University of Central Florida in 1991.

Barbara J. Pemberton is currently the Common Training Instrumentation Architecture (CTIA) Software Architect for the U. S. Army PEO STRI. Previously, she served as the AMSO and PEO STRI Simulation & Modeling for Acquisition, Requirements & Training (SMART) engineer; the Intelligence and Electronic Warfare Tactical Proficiency Trainer (IEWTPT) lead systems engineer and software engineer; the lead Government engineer for the WARSIM Research Testbed; and a Principal Investigator for the Naval Air Warfare Center Training Systems Division Research Department.

William Samper is currently assigned as the PEOSTRI Lead Engineer for the CTIA program. Experience includes fifteen years of engineering and two years of project director experience working with Department of Defense (DOD) military acquisition systems and simulation technology in Army, Navy, and Marine programs. Supported acquisition procurement processes for multiple services through all phases of the life cycle process that include the following programs: Corp Battle Simulation (CBS) and After Action Review, Functional Description of the Battlespace, WARSIM program, and Close Combat Tactical Trainer (CCTT).

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INTRODUCTION

Training transformation across the Department of Defense (DoD) is a primary effort (Army Modernization Plan, 2003). The 2002 "Strategic Plan for Transforming DoD Training" identified three specified strategic goals for transforming and modernizing training and training support capability of the U.S. military: 1) making training more joint, 2) maximizing the use of the live–virtual–constructive (LVC) training environment, and 3) addressing training requirements in the acquisition process. The first DoD training transformation objective implemented was for the U.S. Joint Forces Command (JFCOM) to establish a Joint National Training Capability (JNTC), which in part links designated Services' training centers and training support capabilities.

The Army G-3 has issued guidance and taskings to achieve this JNTC and its key enabler of a Live–Virtual–Constructive Training Environment (LVCTE). This paper describes how some key Program Executive Office (PEO) Simulation Training and Instrumentation (STRI) programs and products are supporting this Army G-3 guidance and the JNTC.

BACKGROUND

The U.S. Army One Semi Automated Forces (OneSAF) and Common Training Instrumentation Architecture (CTIA) programs are producing products that will help meet the DoD training transformation objectives and Soldier needs in a new era of war fighting. These two programs, and their product line architectures, will be the cornerstone of future LVCTEs and Army training domains. This section provides background on the Army training domains, OneSAF and CTIA.

Army Training Domains

The following section describes how the CTIA and OneSAF products will be used within the four Army training domains – Institutional Training, Homestation Training, Training at the Combat Training Centers (CTCs), and Training while deployed.

Simulation tools such as the OneSAF Objective System (OOS) suite of tools will support Institutional Training. These tools will be at the disposal of Professional Military Education instructors to use as key learning artifacts in the classrooms.

The Home Station Training environment will use live, virtual, and constructive simulations to approximate the operational environment. Simulations will be required to support individual and unit training depending on the robustness and capabilities of the Future Force operational systems. The OOS and CTIA suite of tools will be critical enablers for the use of constructive and live simulations within this training domain, and provide the capabilities needed to fully stress battle staff proficiency.

Soldier and units will train at the Combat Training Centers, which support the Army's capstone training events for battalions, brigades, divisions, and corps. The focus at the CTCs is leader development and readiness. CTCs are being modernized to keep pace with Army Transformation and to remain relevant to the training audience - Current Forces and Future Forces. Training scenarios offer full-spectrum operations in a contemporary operational environment, fighting against a freethinking and adaptive opposing force. Training will be instrumented to provide accurate feedback. Instrumentation will be based on CTIA based product at each CTC to facilitate sharing of lessons learned to home station, institutions, and deployed units. OneSAF will be the constructive "wrap around" simulation, within the Army Constructive Training Federation (ACTF) program (ACTF, 2004), that will provide brigade and below operations to complement the live forces in a training event.

For the Soldier and unit Training When Deployed will be just like training at home station or a CTC**.** The Future Force systems will allow the Soldier and unit to train before, during, and after deployment into the operational area. The deployed training environment will be seamless, training products will be readily

available, and simulation will provide for robust training for each Future Force Soldier and unit. This will allow them to both enhance their theater specific skills and sustain operational readiness while responding to mission requirements. OOS will be the simulation system used for embedded training on all Future Combat System (FCS) variants (Anderson and Simons, 2004). CTIA will be the key instrumentation framework used by deployable live fire range systems to support the Current Force and Future Force worldwide.

One Semi Automated Forces (OneSAF)

The OneSAF program is an evolutionary step to replace and assimilate current simulation and training systems and to meet Soldier needs in a new era of war fighting. Although the OOS is the main thrust of today's OneSAF program, the OneSAF program is composed of two major components—the OneSAF Testbed Baseline (OTB) and the OOS. The OTB is a software simulation product that started with the Modular Semi-Automated Forces (ModSAF) 5.0 simulation. The OTB serves as a mechanism for risk reduction in terms of producing OTB versions, which include early releases (i.e. beta versions) of the OOS components, for the modeling and simulation community. In this manner, the OneSAF program is gaining valuable feedback and users are becoming familiar with OneSAF years ahead of OOS fielding.

The OOS is the Army's next generation Computer Generated Forces (CGF) simulation system designed to train leaders at the brigade level and below. OOS will ultimately be deployed to all active duty brigades and battalions, Army schools, labs and engineering centers, National Guard and Army Reserve units, and other destinations as approved. OOS version 1.0 will be fielded beginning second quarter of fiscal year 2006. The OOS, when completed and fully deployed in 2007-2008, will be a single simulation to support all the Army's modeling and simulation domains: Research, Development and Acquisition (RDA); Advanced Concepts and Requirements (ACR); and Training Exercise and Military Operations (TEMO); and provide leaders with a tool for analysis and design, mission planning and rehearsal. The OOS will also support interoperability between training simulations, virtual simulators such as the Close Combat Tactical Trainer (CCTT), and other large constructive simulations. Finally, OOS will reside on all FCS platforms to enable embedded training.

The OOS will represent a full range of operations, systems and control processes from the individual up to the battalion level. The system simulates activities of ground warfare, specifically engagement and maneuver. It will include battle command as well as combat support. Using a detailed terrain database, the OOS will employ highly realistic representations of the physical environment where Soldier movements and behaviors can be reproduced to enhance training value.

OneSAF is connected to the ACTF program by providing the constructive simulation at brigade and below operations. OOS extends its simulation training capability down to the individual Soldier. ACTF will provide the mechanism that links OOS with other constructive simulations and adds brigade to echelons above Corps operations.

Live Training Transformation (LT2)

LT2 is an Army initiative to develop a live training product line that includes current capabilities centered on a common architecture, and expands on those capabilities by eliminating gaps between current and future weapons systems and those live training systems available to support them. This LT2 product line will incorporate the entire Live Training Environment, and will meet the live training requirements of current forces, joint forces, and the Future Force.

The CTIA (CTIA, 2004) is the product line architecture that will be used to implement the LT2 and leverage the high degree of commonality of requirements among the Army's instrumented ranges and home stations. The CTIA and associated processes will be the basis for subsequent LT2 product line members to leverage the product line architecture and common software components. Through the LT2 CTIA based systems, training units will be able to plan, prepare, execute and evaluate individual and unit performance in multiple training areas/ranges and/or multi-echelon exercises that employ one or more of the instrumented live training ranges or facilities available at the installation. Common component functional capabilities within LT2 are essentially the same regardless of whether the component is employed within a CTC or homestation. This commonality reduces the learning curve across all training domains. Reducing the education burden allows units to train earlier with less preparation and equates to more efficient use of training time.

The live training domain encompassed by the LT2 product line is the current Army collective training capabilities in the live environment, which include interoperability with Joint environments, and other Army virtual and constructive training environments. The product types included in the LT2 live training domain are as follows.

- Combat Training Center (CTC) – Objective Instrumentation Systems (OIS),
- Homestation Instrumented Training Systems (HITS),
- Instrumented - Military Operations in Urban Terrain (MOUT) Training Systems (I-MTS),
- Deployed Army sites, and
- Digital Multi-Purpose Range Complexes (DMPRC).

A LT2 product is a specific instantiation of one of the product types. For example, the National Training Center (NTC) – OIS is an instantiation of a CTC-OIS. A battalion level HITS installation at Fort Knox is an instantiation of a HITS product type. All LT2 products will be composed of CTIA compliant components. Through the CTIA, LT2 systems support the integration of new technologies over time that is essential for maintaining training system relevance and training future force units to effectively employ the force-multiplier capabilities of the advanced digital technologies being fielded in the coming years

ARCHITECTURAL VIEWS

The Department of Defense (DoD) Architecture Framework (DoDAF), Version 1.0, defines a common approach for DoD architecture description development, presentation, and integration for both warfighting operations and business operations and processes (DoDAF, 2004). This section provides an overview of the OOS and LT2 architectures, based on DoDAF systems view perspective, and briefly describes other relevant architectures that support OneSAF and CTIA interoperability within a LVCTE.

OneSAF Objective System (OOS)

The OOS simulation is being developed using a product line approach (Wittman and Harrison, 2001). Some of the key products of this approach are the Product Line Architecture Framework (PLAF), and the Product Line Architecture Specification (PLAS). The PLAF, shown in figure 1, shows the breakout of system configurations, products, and components using a layering approach, and is intended to identify basic products, components, and interfaces that support the entirety of the OOS requirements (OneSAF PLAF, 2003). The PLAS (OneSAF PLAS, 2003) fully specifies the architectural products, components, interfaces, and services identified in the PLAF. The PLAF is used as a mechanism to organize, categorize, and define the layered software structure to incrementally meet the OOS requirements. The PLAF supports a hierarchical composition process to create specific system configurations to support the different user domains. At the highest level, products are combined to create the system configurations.

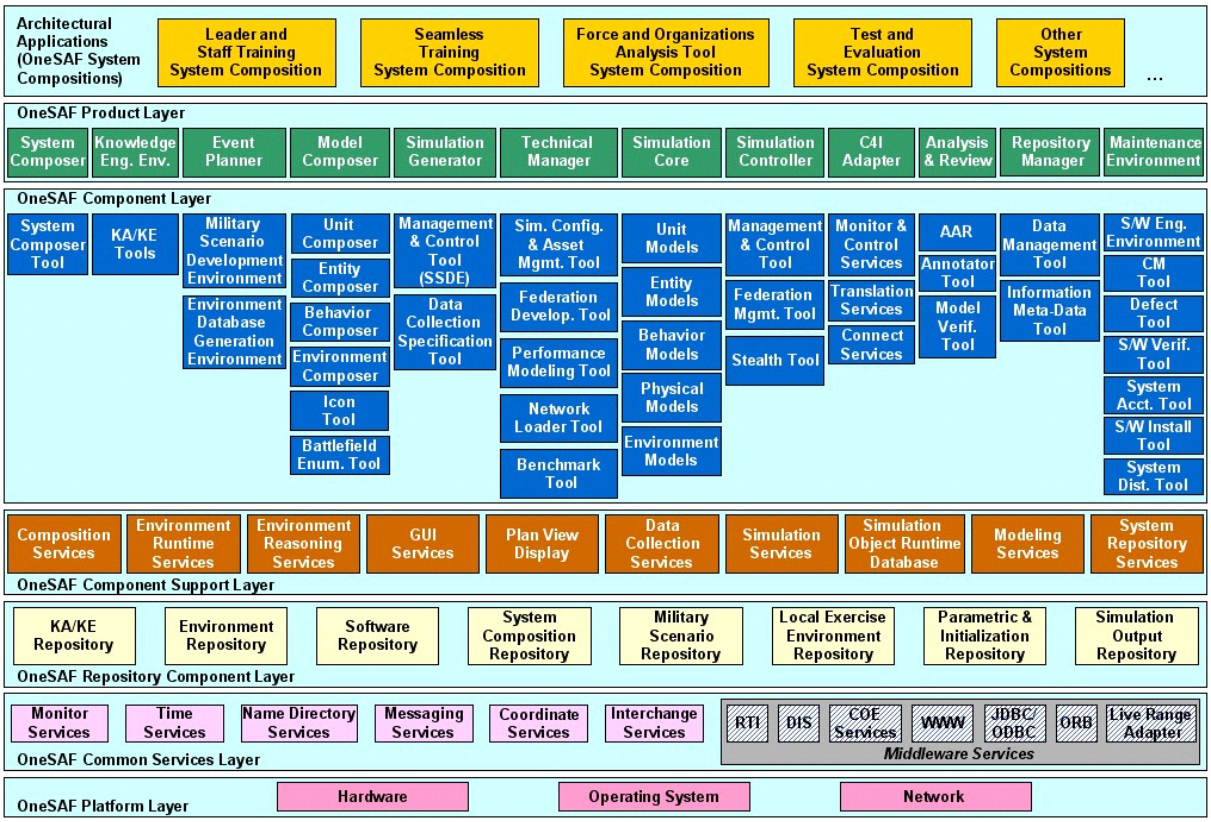

Figure 1. OneSAF Product Line Architecture Framework (PLAF)

The top layer of the PLAF, the system compositions layer, provides configured end-user functionality for operational use within the TEMO, ACR, and RDA domains. These system compositions are created from products existing within the product layer of the PLAF and support identified OOS end state scenarios and operational use cases. The product layer includes all of the OOS products that will be configured to support the mission area applications. These are the top-level building blocks within the OOS architecture; they provide the specific functionality that makes up a part of setting up, executing, and analyzing simulation results. The component layer contains the components that are to be developed independently in support of the products contained in the product layer. Specific products use one or more of these components in order to create the necessary functionality. The PLAF supports multiple implementations of each of these components in order to support a specific product for a specific composition; however, a single component implementation may support multiple products, multiple same kind products, and multiple compositions. The component support layer holds the software services that are used by more than one of the components. The repository layer represents an electronic storage mechanism that keeps all of the information, data, and meta-data for one logical area pertaining to OOS. The repository may utilize a file-based system, a single physical database or multiple physical databases, but they all have a consistent, well-defined interface and access methodology. They also conform to industry standards such as eXtensible Markup Language (XML) or Open Database Connectivity, where applicable. The common services layer includes those services that are commonly available as COTS, such as database management, operating system time synchronization services and network distribution services. Included in common services layer are the middleware services, which provide support for middleware solutions to gain distributed interoperable simulation and software services. These services include the High Level Architecture (HLA) Run-Time Infrastructure, Object Request Brokers (ORB), Java Database Connectivity/ Open Database Connectivity service implementations, and World Wide Web servers and information brokers.

Common Training Instrumentation Architecture (CTIA)

The CTIA is a component-based client server architecture, which includes plug and play components that interact with the CTIA infrastructure. Figure 2 provides a layered view of this architecture. The infrastructure components include the wired and wireless communications components, the Operating System (OS), the Data Distribution Manager (DDM), and CTIA Services, Object Model and Graphical User Interface (GUI) Framework.

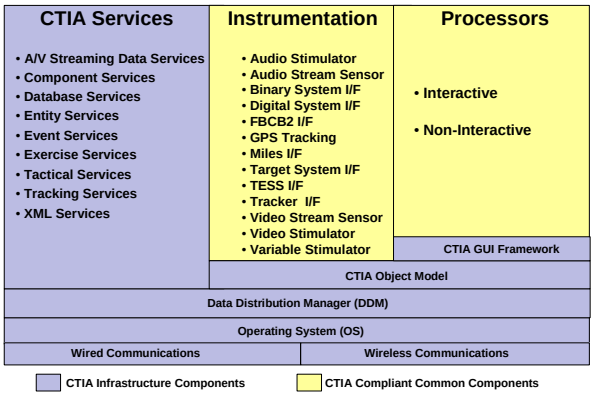

Figure 2. CTIA Layered View

The CTIA compliant plug and play components may be common to multiple products or unique to a specific product. The plug and play components have been divided into two primary types, instrumentation and processor. The instrumentation plug and play components perform data collection and stimulation functions in support of live training. Instrumentation components provide the interfaces to other subsystems and systems such as Tactical Engagement Simulation Systems (TESS), target systems, and Command and Control (C2) systems. In addition, they provide encapsulation of instrumentation such as individual TESS devices, trackers, video cameras, Battlefield Effects Simulators, and control devices in a MOUT facility.

The CTIA processor plug and play components provide data manipulation and analysis capabilities. Processor components can be interactive or non-interactive. Interactive processor components have a user interface and are comprised of the common toolset required across the family of LT2 systems to plan, prepare, execute and evaluate training. Non-interactive processor components include gateways to other simulation or training systems and instrumentation system-based simulations (e.g., Area Weapon Effects). Processors components encapsulate computational functions that have the capability of producing and consuming all types of CTIA data.

The CTIA Services provide domain specific services to support plug & play component clients. When deployed, these services are tailored to account for things such as training exercise scale, available infrastructure, and network variability. The service

interfaces use a predefined object data model to ensure component interoperability and eliminate "stove pipe" systems. These interfaces are defined using the Common Object Request Broker Architecture (CORBA) interface definition language (IDL), which defines object data structures without methods. The CTIA Object Models provide methods and higher-level abstractions (e.g. proxies for remote objects). The CTIA services maintain objects representing exercises, organizations, and participants. It provides services accessible through the DDM such as unique ID, entity filtering, and brokering control of instrumentation. It provides access to databases for exercise specific and exercise independent data, and encapsulates the databases. The DDM provides the backbone into which other components plug. The GUI Framework provides a common mechanism for the LT2 Interactive Processors to have a consistent look and feel.

Figure 3 provides a notional diagram of how the CTIA components would be deployed to support a training exercise.

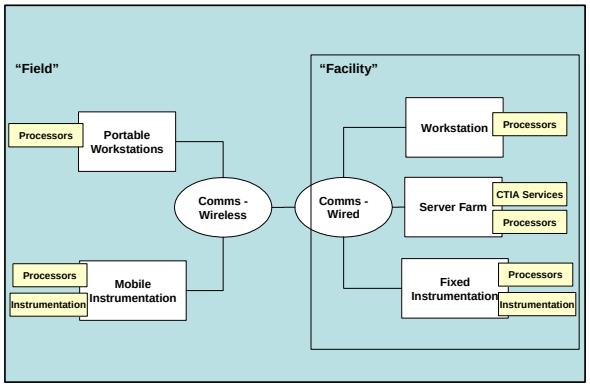

Figure 3. CTIA Notional Deployment Diagram

Other Architectures

There are several other architectures that play an important role in enabling the linkages between the LT2 family of products, the constructive simulation domain, and other external systems and domains. These are briefly described below within the context of this paper.

The Joint Technical Architecture (JTA), along with the Joint Operational Architecture (JOA), and Joint Systems Architecture (JTA), serve as the foundation for development of mission area integrated architectures (DoDAF, 2004). The JTA defines the service areas, interfaces, and standards applicable to all DoD systems (JTA, 2003). It provides the minimum set of essential standards that, when implemented, facilitates this flow of information in support of the warfighter. Besides the core standards defined by the JTA, there is a set of standards defined for 4 specific Information Technology (IT) domains: C4ISR, Weapon Systems, Modeling & Simulation (M&S), and Combat Support. The High Level Architecture (HLA, 2003) is an example standard of the JTA M&S domain. The CTIA and OneSAF are HLA and Distributed Interactive Simulation (DIS) standard compliant.

The Test & Training Enabling Architecture (TENA) is a product of the Foundation Initiative 2010 (FI 2010) project (Cozby, 1998). The FI 2010 concept builds on the HLA and includes a core set of tools, inter-range communication capabilities, interfaces to existing assets, a repository of reusable software and procedures for conducting an object-oriented exercise. The FI 2010 overall vision is to design and prototype a technological infrastructure to enable interoperability and reuse within the range community. This infrastructure would provide seamless environments that integrate test ranges and facilities, training ranges, laboratories, and M&S assets. The purpose of TENA is to provide the architecture and the software implementation necessary to enable interoperability among range systems, facilities, simulations, and C4ISR systems in a quick, cost-efficient manner, and foster reuse for range asset utilization and for future developments (TENA, 2003). The CTIA program is currently planning to integrate the TENA standard middleware component with CTIA Services that shall support future LT2 product participation within JNTC training environment and inter-range interoperability. Currently a study team has been chartered to document the changes to CTIA and TENA to develop an implementation plan for the path forward.

The Army Training Information Architecture (ATIA) is one of two major parts of the ATIA program. The other part of the ATIA program is the integrated set of automated information systems (AIS) that deliver training management functionality to system users. The collection of these AIS delivered in accordance with the architectural framework is referred to as the ATIA-Migrated (ATIA-M). ATIA-M provides an integrated, interoperable training information automation infrastructure with user configurations. The ATIA-M provides development, storage, and delivery of Army doctrine and training materials to Soldiers and units anywhere in the world. The ATIA-M supports all levels of Army training and includes training products for all three pillars of Army training (Unit, Institutional and Self-development). When fully implemented, the ATIA will enable the provision of real-time training and training support to the Army worldwide (institutions, operational units, and individuals),

through a logically centralized, physically distributed network. LT2 systems will access training information systems by interfacing with the ATIA.

The LVC- Integrated Architecture (LVC-IA) is a set of protocols, specifications and standards that support a seamless and interoperable, integrated LVC environment where common hardware, software and network components and modules are interchangeable with other LVC components and Battle Command Systems (BCS). The goal of the LVC-IA is to seamlessly interconnect and ensure interoperability with JNTC, ACTF, ATIA-Migrated (ATIA-M), CTIA, and SE Core. A LVC-IA Initial Capabilities Document (ICD), which provides the foundation for overarching requirements, is currently being finalized. PEO STRI is in the initial phases of executing the solicitation process to procure a lead integration manager to facilitate the development of a LVC-IA in support of Program Manager (PM) Future Force Simulation (FFS). The LVC-IA required capabilities will drive extant and future programs to modify existing Operational Requirements Documents (ORDs) and allow PM FFS to focus on developing the most critical capabilities that have the highest return on training and readiness. The "LVC Interoperability" section, in this paper, describes some of the LVC-IA ICD capabilities and specific areas, within those capabilities, being addressed by the OneSAF and CTIA project teams.

LVC TRAINING

A Training Support System (TSS) is the full range of integrated training support products and training development and management tools enabled by architectures and infrastructures to facilitate training anywhere at any time (Army Modernization Plan, 2003). The following section describes how OneSAF, CTIA and other key systems will be used as part of the TSS to support LVC training.

LVC Training Components

The LVC and FCS embedded training environments must be fully integrated and networked to support full spectrum training. A deliberate linkage of the three environments with the Battle Command system-of systems architecture must be developed to support training of the Soldier on demand, anywhere or anytime. The goal is a seamless integration of the training environments to realistically replicate the operational environment. System and non-system Training Aids, Devices, Simulations, and Simulators (TADSS) support the major objective of an overarching Army training strategy, which is the establishment of policy supported by adequate resources to accomplish defined training and mission rehearsal capabilities for the current and future forces. From a modernization viewpoint, this objective is supported by the effective and efficient integration of systems and non-systems training technologies and development within the live, virtual, and constructive simulation environments across the home station, deployed, Combat Training Center (CTCs), and institution domains. While today's TADSS supplement live training, tomorrow's TADSS will provide the commander with deployable and portable combined-arms collective training and mission rehearsal capabilities, to include joint operations, and enable units to train and rehearse missions in a resource constrained environment at home station and deployed locations. The vision is to build a synthetic training environment that links LVC and embedded simulation environments with "fair fight" capability. "Digitizing the battlefield" to provide seamless, digital C2 capabilities for the entire fighting force is one of the Army's top priorities. The following are the non-system TADSS that support the home station, deployed and CTC domains and are relevant to this paper. These systems are also referred to as objective systems in subsequent sections of this paper.

The One Semi-Automated Forces (OneSAF) Objective System (OOS) will be the future entity level brigade command team and below constructive simulation that, when linked with the Warfighters Simulation (WARSIM), the Combined Arms Tactical Trainer (CATT) family of virtual simulators, and the LT2 systems, will support seamless interoperability of LVC simulations as part of realistic synthetic battlespaces. OOS will be one of the keys to merging an interoperable LVC environment with future FCS embedded training environment.

The Synthetic Environment Core (SE Core) includes development and integration of synthetic environment technology that supports the development and fielding of the Army's virtual simulation program required by Army Transformation for the current and future forces. SE Core extends and expands the capability of the common virtual environment created by the interoperability of current simulations and embedded virtual simulators developed for current and future forces (e.g., Synthetic Training Environment / Future Force Training Environment solution). SE Core supports Army Transformation by providing commanders the ability to simultaneously train and execute rehearsals for all battlefield operating systems, in real time, on the virtual terrain of choice, and under all operating conditions demanded of a force projection

Army conducting military operations in a Joint Interagency, and Multinational (JIM) environment.

The Common Training Instrumentation Architecture (CTIA) will form the common underlying foundation for the LT2 products and promote interoperability, standardization, and reuse across the three CTCs, home stations, digital multipurpose range complexes, and military operations in urbanized terrain facilities. The CTIA will support todays and future Instrumentation Systems, Tactical Engagement Systems and Target Systems. CTIA external linkages will include JNTC using TENA; C4ISR using JTA-A; Constructive and Virtual Training Systems using LVC-IA; and Training Information Systems using ATIA.

The One Tactical Engagement Simulation System (One TESS) is a family of Tactical Engagement Simulation (TES) systems that support Force-on-Force (FOF) and Force-on-Target (FOT) training exercises at Brigade and below, in all Battlefield Operating Systems at home station, maneuver Combat Training Centers, and deployed sites. OneTESS will require execution of proper engagement procedures; will simulate weapon system's accuracy and effects; and stimulate detectors, sensors, monitors and countermeasures. OneTESS will use a common architecture compliant with the CTIA.

The Objective Instrumentation System (OIS) is an upgrade from current instrumentation systems and is based on and compliant with the CTIA and LT2 concept. The CTIA serves as the common core architecture for the OIS programs at the National Training Center (NTC) and the Joint Readiness Training Center (JRTC), Combat Maneuver Training Center (CMTC) as well as the instrumentation system programs for several home stations and the JRTC MOUT facility.

LVC Training Environment (LVCTE)

The PEO STRI LVCTE concept is built atop a common framework, as depicted in Figure 4. At the core of this framework are the common Data Interface Formats (DIFs), Application Programming Interfaces (APIs) and other protocols. Common components, such as the SE Core, C4I Adapter, After Action Review, Synthetic Natural Environment (SNE), and scenarios generation tools are built using these common data structures, interfaces, and protocols. The core LVC architectures, such as CTIA and OOS PLAF, are composed of these common components, and are the enablers for interoperability between different systems.

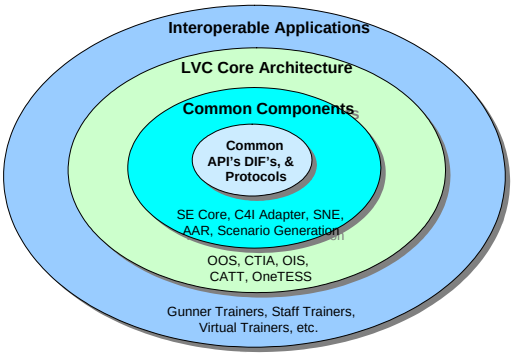

Figure 4. LVCTE Common Framework

Figure 5 provides a notional diagram of a fully interoperable Joint LVCTE enabled by the objective systems described in this section. Within the constructive environment, the objective constructive simulations (WARSIM and OneSAF) will share components to provide flexibility and adaptability.

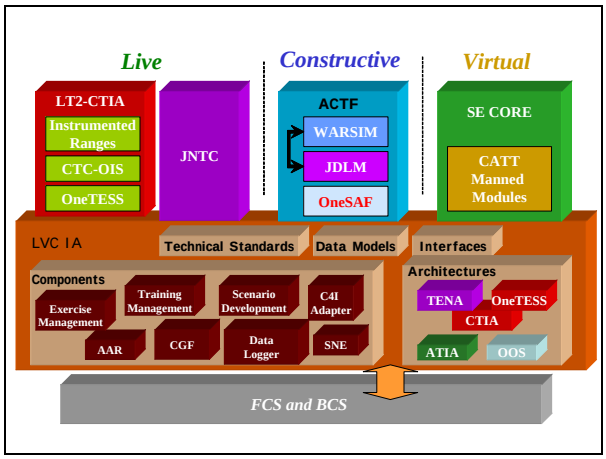

Figure 5. LVCTE Objective Systems

The ACTF simulations will be integrated and interoperable, to include interoperability with the Joint Deployment Logistics Model (JDLM). In the virtual environment, virtual simulators will be built on top of SE Core. SE Core will consist of a series of interoperable software and hardware components to enable an Army common virtual environment and integrate virtual simulations to the LVCTE. In the live environment, the LT2 CTIA will be the foundation of the Instrumented Ranges, CTC-OIS and OneTESS. The LT2 CTIA will also use common components, derived from objective systems. These LVCTE objective systems, in conjunction with a LVC IA, will

provide interoperability to BCS and provide the training common components for FCS.

LVC INTEROPERABILITY

The OneSAF and CTIA project teams are currently working together to address challenges that the OOS - CTIA interoperability requirements impose and recommend solutions that leverage OOS and CTIA assets to meet LVC-IA needs. In particular, the OneSAF and CTIA program offices are focusing resources to identify issues and solutions associated with end-to-end interoperability between the two architectures. Initial results of this OneSAF-CTIA interoperability effort will yield an execution strategy that provides the building blocks for achieving interoperability between CTIA and OOS, in support of a LVCTE. Areas of initial focus and their relationship to a LVC-IA capability are briefly described below

Scenario Generation & Initializing Exercise Preparation

The LVC-IA will provide an easy-to-use, composable exercise preparation toolkit that automates the capability to plan, design, prepare, and initialize a multi-echelon LVC exercise with detailed CGF and JIM forces. A LVC exercise preparation toolkit will enable the commander to quickly design and prepare an integrated LVC exercise reducing exercise preparation time increasing time available for training. This toolkit will allow system operators under the commander's guidance to reach into repositories of information to access exercise databases, scenarios, and other ATIA-M information required to populate on-board embedded training systems, simulation systems and operational equipment. OneSAF and CTIA project teams are currently investigating how a coordinated live and constructive scenario definition will occur within the context of OOS and CTIA tools and processes, and how training objectives will be consistently transformed into a simulation scenario for OOS and a live scenario for CTIA. OOS PLAF components, such as the Military Scenario Development Environment, Military Scenario Definition Language, and the Management Control Tool, in conjunction with the CTIA exercise planning tools, are being investigated as potential pieces of a solution set to meet this capability.

Environmental Representations and Correlated Terrain Databases

The LVC-IA will provide a set of correlated and dynamic terrain models and standard algorithms. The terrain model must be interoperable with current and future force terrain services and address "fair fight" issues. Currently, LVC federates use different numerical systems to calculate simulated actions (e.g. line of sight, consumption, etc.) that involve digitized terrain. This method exacerbates terrain calculation when combined as a federation, as each of the respective federates has a different numerical system for interacting with the terrain. Correlated dynamic terrain models remove the need for translating or re-generating the terrain and supports efficient terrain calculations. Initial analysis results lean toward assuring OOS/CTIA Synthetic Natural Environment (SNE) compatibility, which in turn facilitates coordinated environment representations, by using the OOS SNE capabilities. In the short term, until SE Core becomes available, the OOS environment database generation processes and tools and the environment runtime component will be used to support the development of correlated terrain databases (TDBs) for both OOS and CTIA. These correlated TDBs include Synthetic Environment Data Representation and Interchange Specification (SEDRIS) Transmittal Format and Objective Terrain Format. OneSAF is currently producing an initial sample of these correlated TDBs to support the NTC-OIS project. This will provide the first test of live-constructive correlated environmental representations and TDBs supporting interoperability between a CTIA LT2 system and OOS.

Data Collection and Specification

The LVC-IA will provide means to collect exercise data based on the commander's specified criteria to facilitate the conduct of In-Progress Reviews and AARs. Data collection will be linked to unit Mission Essential Task List (METL), Army Universal Task List (AUTL), and Universal Joint Task List (UJTL) tasks and other ATIA-M managed training information. A dynamic, automated data collection system based on specific criteria will enable commanders and leaders to objectively evaluate the training status of their crews, units and battle staffs. Linking data collection to METL, AUTL and UJTL tasks supports training across the full spectrum of warfare. Analysis of collected data and reports will result in recommendations to enhance training and provide more efficient and effective training with and across all domains. OneSAF and CTIA project teams are currently investigating how a coordinated live and constructive data collection process will occur in support of a training exercise within the context of OOS and CTIA tools and processes. Data collection specification in OOS, accomplished through a combination of the AAR tool and the Data Collection Specification Tool, seems to be a subset or a different set of data than that required by

the live training audiences. An option being considered assumes CTIA is able to collect necessary data about wraparound forces from OOS, therefore there might not be a need for the OOS data collection services during a LVC services. CTIA data collection planning and observation tools, used by Observers/Controllers to support Live training, analysis, and feedback functions, are being considered as part of a solution set to meet this capability.

In Progress and After Action Reviews

The LVC-IA will provide a set of easy-to-use, multimedia data organization, presentation, and production capabilities required to assist in the development of in-progress review and AAR products, as well as teaching and training aids to assist in the facilitation of an AAR. AAR production tools, teaching and training aids linked to all LVC components, embedded training systems, and operational equipment give commanders and leaders at all levels the ability to control their own exercises, provide for immediate feedback, and reduce the need for the high overhead support. OneSAF and CTIA project teams are currently investigating how a coordinated live-constructive exercise in progress review and AAR will occur in the context of OOS and CTIA tools and processes. An option being considered assumes the in-progress review or AAR data required for a live exercise is a super set of the data necessary for a constructive exercise, and since CTIA has well defined AAR tools and requirements, CTIA AAR components and services are being considered for reuse

Multi Directional Stimulation/Interaction of Operational & Training Equipment

During combat operations the entire spectrum of information operations contributes to the generation and update of the Common Operating Picture (COP). The BCS constantly collects, collates and fuses inputs from various levels of command in order to provide commanders, battle staffs and Soldiers with the information they need to execute their mission. During training and mission planning, preparation and rehearsal the entire spectrum of information stimulus that contributes to a COP must also be present in order to facilitate battle-focused training.

The LVC-IA will fully stimulate and interact with joint and unit force battle command systems so commanders, leaders, and staffs can fully interact with the battle command operational process and manipulate LVC components. In addition, the LVC-IA will simulate and emulate information exchange from other battle command systems. The LVC-IA will also provide linkages with on-board, embedded training systems when necessary and stimulate those systems with simulated and/or live data. OneSAF and CTIA project teams are currently investigating how coordinated live-constructive battle command system connectivity will be handled within the context of OOS and CTIA tools and processes. In particular, solutions centered on the PEO STRI common C4I Adapter are being considered as options to interfacing with BCS. Current efforts are under way to define how FCS training common components will provide the required linkages between on-board embedded training systems within a LVCTE.

The LVC-IA will also exchange data and services with TADSS systems, enabling the exchanged services to operate effectively together. This will include backward interoperability with current force LVC systems adhering to DIS and HLA standards. Backward interoperability assumes translation of integrated LVC environment communication protocols to DIS protocol data units, HLA's federation objective models, simulation objective models, and communication object models. OOS PLAF and CTIA provide the framework for interactions between heterogeneous simulations using DIS and/or HLA.

Runtime Interaction Between CTIA and OOS

LT2 systems using CTIA and OneSAF need a method of interacting and exchanging data during runtime in support of a LVC–IA. OneSAF and CTIA project teams are currently investigating how coordinated live-constructive exercise runtime data, to include interaction and exercise control data, will be handled in the context of OOS and CTIA tools and processes. One option being considered is based on the OOS Live Range Adapter middleware component, which is part of the OOS PLAF middleware services. This OOS Live Range Adapter middleware component has been established to provide middleware services to connect OneSAF simulations with operational live range equipment and configurations. Initial OneSAF-CTIA interoperability analyses indicate that linkages between the OneSAF constructive simulation and live systems compliant with CTIA might be best implemented by connecting the OOS Simulation Object Runtime Database to the CTIA ORB, or directly to the CTIA Object Model. Such approach might result in the merging of the Live Range Adapter middleware component and the OOS middleware ORB component.

CONCLUSION

Training transformation creates joint warfighting conditions through a network of interoperable training sites and nodes that bring together personnel, doctrine, and technology to achieve both joint and service training objectives. Providing realistic combat training, offering an adaptive and credible opposing force, establishing common ground truth, and giving high quality feedback are the founding pillars of this joint training capability. As a result of this enhanced training environment, participants will have a global, network-centric capability that strengthens military transformation efforts to promote war fighter effectiveness. It is important from a Service perspective to build our JNTC participation upon existing Service training programs. We must retain the training that builds individual Service core capabilities while improving the joint context of training, in order to maintain the operational tempo levels important to the well being of our Soldiers and their families.

The US Army PEO STRI, PM FFS, and the OneSAF and CTIA programs are committed to establishing the environment, culture, and processes required to generate and sustain transformation training. Co-evolving the OneSAF and CTIA emerging technologies, innovative training, and operational concepts provided by JNTC, while allowing organizational relationships to exploit them, will allow DoD to develop new dimensions of military capability.

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REFERENCES

Anderson, L. S. & Simons, J. Training the Future Combat Systems, *Army AL&T Magazine*, January - February 2004, 34-37. Retrieved 4 Jun 2004 from http://asc.army.mil/pubs/alt/default.cfm

Army Constructive Training Federation (ACTF) web site. Retrieved 4 Jun 2004 from http://www.peostri.army.mil/PM-CS/ACTF.jsp

Army Modernization Plan (2003). Washington, DC: Department of Army.

Common Training Instrumentation Architecture (CTIA) (2004) web site. Retrieved from https://ssl.peostri.army.mil/CTIAPortal/index.jsp

Cozby, Rick (1998). *Foundation Initiative 2010 Report.* Aberdeen Proving Ground, MD: U.S. Army Test & Evaluation Command.

DoD Architecture Framework (DoDAF), Vol I, (2004, 9 Feb). Washington, DC: Department of Defense (DOD). Retrieved 10 Sep 2004 from http://www.defenselink.mil/nii/doc/DoDAF_v1_Volume_I.pdf

High Level Architecture (HLA) (2003). Washington, DC: Defense Modeling & Simulation Office (DMSO). Retrieved 4 Jun 2004 from https://www.dmso.mil/public/transition/hla/

Joint Technical Architecture (JTA) (2003). Washington, DC: Defense Information Systems Agency (DISA). Retrieved 4 Jun 2004 from http://jta.disa.mil/

One Semi-Automated Forces (OneSAF) Product Line Architecture Framework (PLAF) (2004). Orlando FL: U.S. Army PEO-STRI.

One Semi-Automated Forces (OneSAF) Product Line Architecture Specification (PLAS) (2004). Orlando FL: U.S. Army PEO-STRI.

Test and Training Enabling Architecture (TENA) - The Foundation for DoD Range Interoperability (2003). Washington, DC: US Army Development Test Command (DTC). Test Technology Symposium '03 proceedings retrieved 4 Jun 2004 from http://www.dtc.army.mil/tts/2003/proceed/hudgins/

Wittman, R. Jr., & Harrison, C., (2001*). OneSAF: A Product Line Approach to Simulation Development.* 2001 Euro Simulation Interoperability Workshop, London England.