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Evolving Standards in US Army Live Simulations

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ABSTRACT: *The U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI) has a vast set of capabilities in its portfolio that support the development of simulation products and facilitate interoperability standards and reuse. A primary focus is training live participants in a realistic field environment. Real time data is collected on the participants and used in After Action Reviews to greatly improve training. PEO STRI has developed various standards in this domain, which provide an efficient way to design, develop, and operate interoperable, non-stove-piped training solutions. Specifically these standards include a common service-oriented architecture for camera control and video handling; a common protocol to control and obtain feedback from field devices like popup targets and effects; room lighting and sound control, and even smell generators; a common protocol for communicating with participant instrumentation networks that report real time position/location information and status indoors and in open terrain; and a runtime terrain service that supports a broad range of terrain capabilities for interaction with live, virtual, and constructive simulations. These standards establish appropriate development guidelines and interface definitions in order to maximize industry involvement in developing product-line solutions and providing advanced training capabilities through technology insertion. In addition, these standards allow a new level of interoperability among participating industry vendors, greater opportunity for taking advantage of legacy technology, and greater vendor depth in providing product solutions. Finally, these standards work hand in hand with information assurance requirements and provide a new flexibility in system accreditation. This paper provides an overview and lessons learned in the cooperative effort between government and industry to establish these standard initiatives.*

1. Introduction

PEO STRI is in the business of training Soldiers and growing leaders by providing responsive, interoperable simulation, training, and testing solutions and acquisition services for the Warfighter and the Nation. Within its training and testing capabilities portfolio there is a dynamic set of Live, Virtual, Constructive, embedded and interoperable products that are fielded and used throughout the world. For purposes of this paper we will categorize theses capabilities into legacy and objective systems. Legacy systems are systems that were designed and fielded several years ago and are now in active sustainment mode. Objective systems are fairly new systems that, for the most part, have been designed to facilitate reuse of components and interoperability with other heterogeneous simulation systems through the use of common standards protocols and interfaces, and have just recently started to be fielded. Examples of the STRI objective training systems include the Synthetic Environment CORE (SE CORE) product line in the Virtual domain; the Joint Land Component Constructive Training Capability (JLCCTC), and One Semi-automated Forces (OneSAF) in the Constructive domain; and the Live Training Transformation (LT2) product line in the Live domain. This paper provides an overview of some of the latest capabilities and standards being implemented by the Live training domain, and their objective systems, as well as lessons regarding the cooperative effort between government and industry to establish these standard initiatives.

2. Background

The Army's peacetime mission is to prepare its force to perform (fight, win and survive) across the entire spectrum of military operations [1]. The major concern of all commanders is to ensure their Soldiers and units are trained to perform their mission to standard and survive. To ensure mission-focused training, the army trains its Soldiers, staff, and units to perform under realistic and stressful conditions. However, this training/education must ensure both the well being of the Army personnel being trained (i.e. force protection) and protection of the environment. What is trained and the way it is trained is always changing due to current theater operations needs, downsizing, environmental and resource constraints, and technological advances. As a tool for planning training for the future, the Army develops unit and individual Combined Arms Training Strategies to determine the elements of critical tasks to be trained (i.e., who (units/Soldiers/staff), when, where (site), environment (live, constructive, virtual) and how (methods/products)). The Army accomplishes its peacetime mission training through the three components of the Army training system: (1) Unit Training, (2) Individual Training and Education, and (3) Self-Development Training. It also produces products to support these components at: (1) Homestations; Deployed Locations; Combat Training Centers (CTCs), (2) Army Schools; Distance Learning Classrooms, (3), and (4) Soldier's Homes.

Training products focus on providing a training solution that spans the live, virtual and constructive training domains. The following definitions, although not authoritative, are provided to facilitate the understanding of these training domains. A live simulation, used for live training, involves live forces, acting in a real environment, using their organic equipment to execute a training exercise or scenario. A virtual simulation involves a live trainee interacting with a simulated environment. Proficiency trainers, such as driving or flight simulators, use virtual simulations. Constructive simulations involve simulated actors interacting in a simulated environment; live role players or controllers may give input to the simulation, but do not determine the outcomes. Constructive simulations are used to create a layer of reality around a trainee. For example, in leadership training, an organic Tactical Operations Center (TOC) could interact with a constructive simulation that represents the upper- and lower-echelon forces with which the TOC interacts. From the point-of-view of the trainees in the TOC, the forces that a commander/staff are receiving orders from, or giving orders to, are real.

2.1 Live Collective Training

Live training range systems provide the means to plan, prepare, execute and provide training feedback for Force-on-Force (FOF) and Force-on-Target (FOT) training. Live collective training exercises at these ranges are characterized by the following:

- Live, organic Soldier/vehicle activity on physical terrain under simulated combat conditions,
- FOF weapon engagement with instrumented targets via a Tactical Engagement Simulation (TES),
- FOT with physical targets and live fire,
- Tracking the position of the training audience is done through an Instrumentation System (IS),
- Training analysts link observations, events, and training reports to build Cause and Effect reports
- Alerts (training-related) and alarms (safety-related) can be triggered when Soldiers or vehicles cross control measures or enter restricted areas
- Human- and IS-implemented real and simulated visual and sound effects for battlefield events (e.g., vehicle kill indicators, smoke, pyrotechnics, barricaded bridges, etc.)

2.2 Live Training Transformation (LT2)

The primary source of common standards and software reuse for the Army Live training objective systems is the Live Training Transformation (LT2) program. LT2 includes a product line of capabilities for live training ranges which improves the efficiency of live collective training exercises through common components and yields significant cost avoidance over the training range life cycle. The LT2 product line is centered on a software framework which includes a set of common architectures shared across the product line – the Common Training Instrumentation Architecture (CTIA) for instrumentation system components, the One Tactical Engagement Simulation System (OneTESS) architecture for Tactical Engagement Simulation (TES) components, and the Future Army System of Integrated Targets (FASIT) architecture for target components – and a set of reusable software components that are designed to provide specific live training capabilities and interact via common standards, protocols and interfaces [2]. These software components can be "mixed and matched" and composed using a "toolbox of components" approach to satisfy specific live training needs, maximize software reuse and provide common functionality, interfaces and standards across the various Army training ranges. LT2-based training systems, known as the LT2 – Family of Training Systems (LT2-FTS), also provide common interfaces to virtual and constructive training domain systems, the Army's C4ISR infrastructure systems, Future Combat Systems (FCS) platforms, and to components of the Joint National Training Capability (JNTC). The use of these common software components, standards and protocols have been key in facilitating interoperability among the LT2-FTS domain and with systems from other Live, Virtual, and Constructive domains..

3. Standards in the Live Training Domain

One of the main cornerstones of the LT2 strategy is to capitalize on standardization, maximize commonality, facilitate interoperability, and subsequently promote cost savings across Army training system acquisitions [3]. This section will address several standards that have been applied across the LT2 Software Product Line, in terms of the following: (1) The problem they were addressing, (2) How the standard addressed the problem and how it was implemented, (3) The impacts the standard has caused (both positive and negative), and finally, (4) How well industry has embraced the standard.

3.1 The Common Player Unit Gateway

<u>The Problem</u>: The US Army has training requirements to track the position location of soldiers inside buildings and in open terrain during training exercises. The soldiers are tracked in real time on 2D and 3D maps. Replay and screen shots of the maps enhance after action reviews. The problem encountered by the Army was that each vendor's solution to soldier tracking was proprietary, was not interoperable with any other tracking system, and was sold as a set, player unit hardware and a matched software exercise control system. This created several undesirable outcomes. Vendor's systems could not be combined when large training exercises were conducted. In addition, the Army had to maintain specific expertise in the software control systems and the hardware associated with each vendor's installation to perform essentially the same functions. Finally, this limited the ability to utilize legacy player unit equipment from one site to another and created information assurance concerns if player unit systems were ever swapped out; potentially requiring a costly new accreditation.

<u>The Standard</u>: A common bi-directional protocol was developed for interfacing the player unit network to a software control system. As depicted in Figure 3.1, the abstraction of the interface is placed between the player network base station and the control software, in this manner there is no permutation required of the communication between the base station and the player units themselves, therefore the vendors retain their proprietary advantages. All player messages from the player network are passed via the protocol, as well as commands from the software control software to the individual player units, and the network base station itself. XML messages were created after analysis of six vendor player network solutions that provide an estimated 90% coverage of Army utilization. All existing player network capabilities were included, and periodically the LT2 community meets and new features are evaluated for inclusion. The XML is defined in an ICD and in associated XSD files [4].

<u>The Impacts</u>: This standard, introduced in the spring of 2008, has already made great impacts in the interoperability of player units within US Army training events. For proof of principle, two separate player unit networks (one IP-based, one TDMA) were brought together under a single exercise control system and tested using the common player gateway. The development team of the software control software wrote both required gateways of the two disparate player networks. The gateways are small development efforts, and depending on the complexity of the player network, take between a few days to several weeks to develop. The test demonstrated that not only could both player networks be simultaneously displayed and controlled by the single software control system, but additionally, the player units of the different player networks could interact, firing upon each other and adjudicating damage. 2009 included the simultaneous use of four player networks and their interaction.

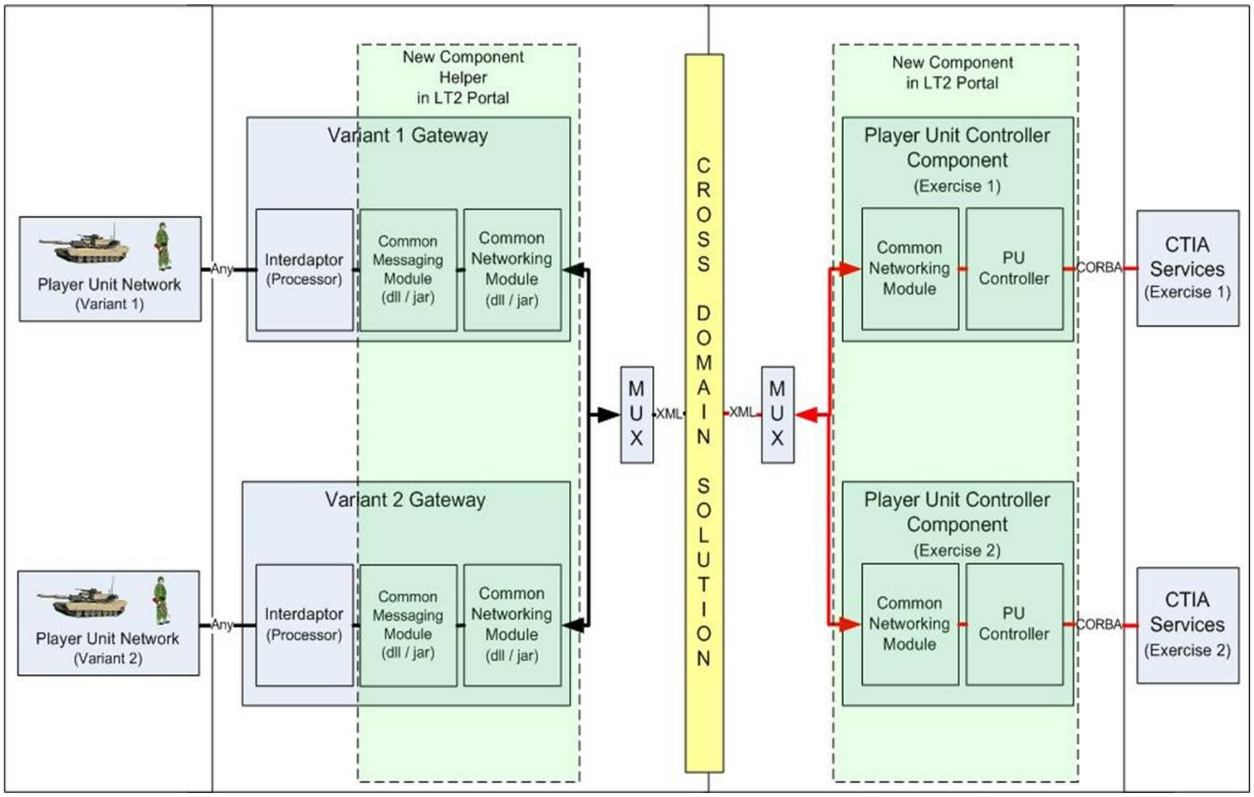

Figure 3.1 - Common Player Unit Gateway

A secondary positive impact has been in the area of information assurance (IA). Due to the introduction of a well defined interface delineating the software control system from the player network, a cross-domain solution or high assurance guard can be put into place with a well-define rule set. Since the data and structures passed across the guard do not change when a new player network is introduced to a system, no accreditation boundaries are modified and therefore no IA re-accreditation is necessary.

Industry Response: The initial gateways were created by the software control system development team. However, since the successful demonstrations, several industry partners are now developing gateways for their player network at their cost. The rational for this is that these vendors want their player networks to be eligible and compatible with LT2 software products. At the time of this printing there are no less than eight vendor gateways complete or in construction.

Summary: Implementation of this standard has allowed the US Army to merge player unit networks under a single software control system to provide a much larger population of instrumented players for training events. Although the LT2 software product line had the burden to produce the first few gateways to prove the concept, industry has now accepted the approach and is spending its own resources to create gateways. Future requests for proposals (RFPs) from LT2 requiring force-on-force player unit networks will contain language that mandates compliancy with the LT2 Common Player Unit Gateway ICD. This single standard is greatly extending the usability of existing legacy player networks, as well as the interoperability of multiple vendor networks now, and into the foreseeable future.

3.2 Video Service Oriented Architecture (SOA)

The Problem: Much like in the case of the Common Player Unit Gateway, use of video in Army training presented similar challenges. The US Army uses video to enhance AARs and as a safety mechanism. The usage of video ranges from simple, fixed analog field cameras, to in-vehicle video feeds, to television news gathering type footage. Vendors were predisposed to providing specialized video processing and storage hardware devices, non-interoperable digital encoding, and custom software applications to control cameras, monitor video streams, and manage and edit video clips. Due to the rapid changes in technology in the video domain, there is a vast amount of non-interoperable hardware resident at Army installations among different programs, and even within the same program at different sites as hardware and technology was modified to take advantage of newer technology improvements.

The Standard: A Service Oriented Architecture (SOA) was created for providing video-related functionality. The industry standard model of service discovery, service selection, and service execution was followed in the creation of the LT2 Video Services standard. As depicted in Figure 3.2, the major services implemented were: Camera Control, Live Stream Management, a Recording Service, Video Query, and a Stream Collection Service. Through the use of these services, the LT2 application software was able to communicate at the abstracted SOA interfaces, regardless of the actual hardware or application-specific implementations [5]. Web Services Description Language (WSDL) was chosen as the implementation for the SOA standard due to its availability to the .NET family of languages (prevalent within LT2), and its ability to strongly type and robustly describe the service interfaces. The definition of the programmatic interfaces as a SOA was instantiated, as well as a restriction of the digital codecs allowed. A set of low resolution and high resolution allowable codecs was defined and is a living document adjusting as new technology emerges.

The Impacts: The Video SOA was established in the spring of 2008 by a collaboration of three LT2 software product teams who were the most intensive consumers of video-related services. The use cases of homestation, military in urban terrain (MOUT), and instrumented live fire ranges were analyzed. The use cases varied greatly in how the video was used, hardware and capacity, and concept of operations. By the consolidation of these use cases, the LT2 product line video services requirements were established, as all other products fell under subsets of these three forerunners. The SOA ICD was published and weathered through several rounds of industry reviews. There have been multiple updates to the ICD since its inception in 2008.

Information assurance has impacted the SOA slightly, due to the fact that video from the field is inherently unclassified, and several of the LT2 products operate at a classified level. Special one-way hardware devices must be installed that convert the digital signal to analog, and then back into digital again to guard the classified systems from malicious intrusion threats via the video feeds.

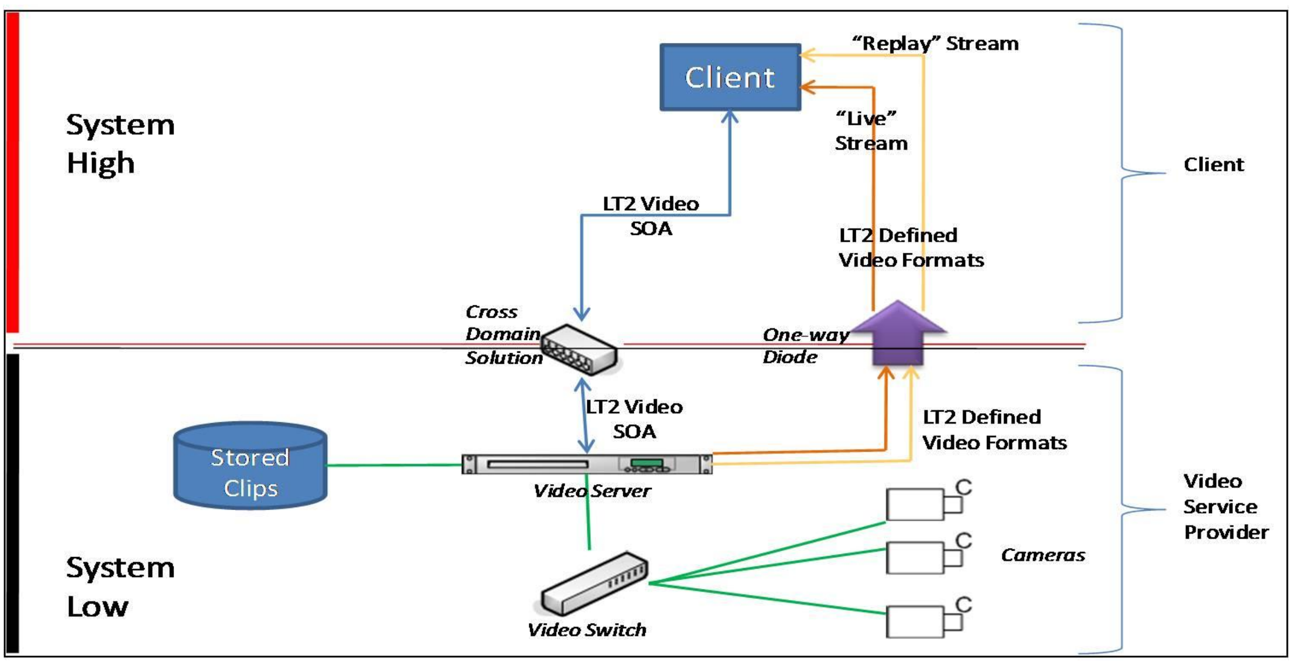

Figure 3.2 – Video SOA Concept

Industry Response: Industry in general, was slower to respond to this standard in comparison to the common player unit gateway. The rationale being that these video systems were commercially offered, the US Army being only one of their clients, and the video industry does not work as closely to the US Army as the player unit industry. In that respect, it was the LT2 product developers themselves who drove this standard, built, and layered the SOA abstractions onto, for the most part, commercially available video systems. Now that the standard is established for the LT2 product line, RFP language may reference the video SOA ICD and mandate compliance from vendors bidding for video service efforts.

Summary: Presently three commercial vendors are pursuing or have implemented LT2 Video SOA compliant implementations. We expect that number to rapidly increase now with the establishment of the standard and the RFP language to define it.

3.3 Future Army System of Integrated Targets (FASIT)

The Problem: The US Army constructs and operates many live fire ranges and MOUT facilities domestically and internationally that command and control targetry devices. These devices vary from traditional pop up targets, to sound and smell generators, to lighting and door controls, to pyrotechnics and IED explosions. As with the vendors providing player units, the target vendors traditionally offered software control systems paired with their specific brand of targetry devices. The devices from one vendor to another were not interoperable, or even compatible in terms of required infrastructure, like power and data communication. Aside from stovepipe systems, the Army was left with many different types of targetry scattered across multiple ranges at a single post which led to costly sustainment issues in terms of replacement parts and maintenance.

The Standard: To solve this problem, the Army created FASIT standard. FASIT provides the specifications for industry to construct targets and targetry devices that when delivered, will be interoperable with any other FASIT equipment provided by any vendor. FASIT provides the physical characteristics of the equipment, the power specifications, everything down to the connector. FASIT also provides the command, control, and feedback protocol, such that, a single target control software system may command any number of vendor's FASIT compliant targetry devices [6]. The first version of the standard was released in December 2006.

The FASIT standard has the following subsystems [7]:

- Control system whereby the events and messages are defines to command the targtry devices.
- Range interface module, an interface between the control system and the devices located at the target location.
- Presentation devices, devices that present themselves as targets.
- Representation devices composed of the physical silhouette and the mechanism for providing accurate thermal representation consistent with the silhouette.
- Range effect devices, devices such as audio devices, IED simulators, smoke generators, smell generators, illumination, etc.
- Engagement scoring devices, devices capable of detecting hits to the target.
- Ancillary range systems which include items such as facades, moving target rails, and non-instrumented targets.

The Impacts: The targetry device industry had already experienced a similar, failed standard presented by the government called NGATS (Next Generation Army Target System). The industry had mostly embraced the NGATS standard and committed research and development funding in producing NGATS standard targets. When NGATS failed, several vendors went forward with their now NGAT-like versions of targets, other vendors returned to prior versions of proprietary targets.

With the announcement of the new FASIT standard, industry was understandably cautious, and even resistant. The FASIT government team held several industry days and tried to involve industry as much as industry would allow in the review and creation of the FASIT standard. A FASIT compliancy testing tool was created and delivered to the target vendors and are intended to be used during development of new target devices to test for FASIT compliancy at the vendors manufacturing facility. This saves time over creating a device, shipping to a government test facility, and awaiting results.

Industry Response: A range was selected at Ft. Eustis to be the proving ground of the FASIT standard to demonstrate multiple target vendor products working in concert. That range has been operational for a year now, and FASIT is accepted as a viable solution from the government and industry, although its acceptance has been slow.

The acceptance of industry utilizing the compliancy tool has been well received. All major vendors have been provided copies of the tool and use in their development life cycle. In addition, all the large target device vendors have delivered complimentary FASIT compliant targets to the FASIT development lab, so that as modifications are considered in future releases of the FASIT standard, or the target control software, the impacts will be immediately realized on the vendor hardware.

Summary: With the FASIT target controller now deployed at over 60 ranges, acceptance of FASIT is growing. The major industry vendors now all have FASIT offerings in the basic target types. Only three of the FASIT subsystems ICDs have been defined: the control system, the presentation device, and the representation device. The definition of the remaining subsystems has been slowed by budget and demand by the Army.

3.4 Common Instrumented Player Unit

The Problem: The Army has a requirement to track and transmit information (i.e. time, space, position, video, voice, etc.) related to individual live entity platforms in the training box. Those live entity platforms could be a human (trainee or trainer), a vehicle or a target. This requirement is satisfied primarily through an instrumentation sub-component, referred to as the Instrumented Player Unit (IPU) system herein. The IPU is part of the Live simulation system and provides the Training Analysts and Observer Controllers the necessary situational awareness and exercise management capabilities to provide effective battlefield challenges and After Action Reviews (AAR). The basic IPU includes Tactical Engagement Simulation (TES) devices that permit players (soldiers and weapons platforms) to engage and perform Real Time Casualty Assessments (RTCA) to simulate a battle. More sophisticated systems allow Observer/Controllers (O/C) to remotely monitor and control the simulated battle by adding player status tracking, GPS positioning, realistic battlefield effects, and appropriately secure communication links. Although this requirement to track and transmit information has significant commonality across different live entity platforms, the products currently available in the market differ significantly in design, interfaces, and introduce their own limitations. In addition these products encumber reusability and interoperability with other training and operational equipment.

The Standard: To address this problem, the Army set out to develop a Common Player Unit standard that specifies the capabilities required to collect and transmit the information required to support any given Live training exercise. These included the TES, the RTCA processor, the engagement sensors, the battle field effects generators, the GPS positioning, the Personal Area Network (PAN) linking the simulation devices, and the secure communications transceiver for remote data collection, and exercise control. An IPU Performance Specification was developed to ensure that any future IPU acquisition would adhere to this common IPU specification. The document can be tailored to meet specific IPU component acquisitions but insures that all components are interoperable and meet the IPU requirements. The specification structure provides performance specifications for an instrumentation processor (to control or monitor TES, Targetry (FASIT), and vehicle data), position location, PAN, and communications. While the instrumentation processor and instrumented devices are well specified, the PAN and communications requirements focus on specifying communications standards that support a family of Radio Solutions with Software Defined Radio technology, multiple waveforms, frequency agility, and address required bandwidth and throughput for Voice / Data / Video, and Information Assurance requirements.

The Impacts: The use of a common IPU specification has provided a common blueprint of the design capabilities required to support current Live training, interoperability, and sustainment demands. The specification allows all IPU vendors to design their products based on a common specification baseline. Consequently, this allows the Government to evaluate different vendor designs from a common requirements baseline. Along with the common player unit gateway, and the FASIT standard, this common player unit standard fosters healthy competition among vendors providing the Government state of the art solutions, while supporting robust interoperability between different IPUs in a given exercise and different exercises.

Industry Response: The first version of the IPU performance specification was approved in the spring of 2008. Since then it has been used in several acquisitions which intend to procure IPUs. Although not much time has passed since its approval, at least two major Army training system acquisitions have benefited from this standard. Industry has been very supportive of this standard by proving feedback during the initial development of the specification, and proposing innovative IPU designs that support the goals of commonality, interoperability and reuse. In addition, Industry is encouraged to provide continuous feedback on way the standard should evolve to support changing technology.

With the use of a common player unit specification and corresponding communication standards, there is a high potential for tactical communication technology to be leveraged to satisfy training and testing requirements.

Currently, there is an incremental series of demonstrations and test events that are being executed to evaluate the feasibility of utilizing tactical radios as the basis for a common IPU solution for training and testing.

Summary: The acceptance of IPU performance specification is growing. The major industry vendors are aware of the IPU performance specification and are developing products that comply with this standard. The next challenge is to promote this standard at the DoD level, give it wider exposure and vetting to facilitate not only appended but embedded solutions and interoperability across services.

3.5 Layered Terrain Format (LTF)

The Problem: Current terrain databases don't adequately support fidelity requirements across the Live-Virtual – Constructive (LVC) training domains. Each domain has its own terrain database format that meets only a subset of the full LVC set of requirements. This limitation has resulted in the development and support of many run time terrain databases, as opposed to one common terrain representation that provides Modeling and Simulation (M&S) capabilities across the full spectrum of activities and operations. For example, in the constructive domain, modern semi-automated forces (SAF) systems support a wide range of services and functionality. And in some cases (e.g. Close Combat Tactical Trainer) the same terrain services must support applications beyond SAF (manned simulators, user workstations, etc.). The need to support services as diverse as height of terrain, line of sight, route planning, collision detection/avoidance, and cover/concealment complicates tradeoffs, quite often to the extent that multiple terrain formats are created within the context of a single system. ModSAF/OTB, CCTT SAF, and OneSAF all use multiple on-disk formats to handle specialized functions (e.g. OneSAF stores route planning networks separate from the file containing terrain polygons).

The Standard: The LTF was designed from the ground up to meet the specific needs of the live training community while maintaining design support for the virtual and constructive domains. LTF borrows heavily from current industry standard terrain representations and incorporates elements from computer graphics and gaming. The major design elements of the LTF provide a layered/scalable solution, a small memory/storage footprint, optimized LOS performance, and dynamic environment capabilities. LTF separates disparate data types into their own storage and functional layers. This approach allows the development of specialized algorithms for each data type and a scalable, composable system across the LVC training domains.

The Impacts: This standard, introduced in the spring of 2007, successfully supported the capabilities required for the One Tactical Engagement Simulation System (OneTESS). It moved the live training and testing program from low fidelity Digital Terrain Elevation Data (DTED) to a high resolution capability which was leveraged across other programs such as the FCS Live Training - Tactical Engagement Simulation (LT TES). The LT-TES program is the TESS component of the Future Combat System (FCS). As such, it is at the center of the data fusion problem inherent in modern military training systems. Specifically, LT TES must support interfaces across the LVC domains as it is part of a solution containing capabilities for constructive solutions in the form of the One Semi Automated Forces (OneSAF) as well as out the window type visual domain solutions. LTF is successfully supporting the LT TES requirements and will be used to demonstrate how operational source data and training data requirements will work together in the near future.

Industry Response: The industry has responded well to LTF in the form of both current usage and determining future usage. Besides the FCS program use of it, there is work ongoing on its usage with OneSAF and the OneSAF Terrain Format (OTF), focused on what principles and capabilities can be leveraged in the OTF capability. The Research and Development Command (RDEC) has taken the LTF and used it as its base for the High Fidelity Runtine Database Engine (HFRDE) in order to explore how LTF capabilities can be used within the embedded training community and embedded operational capability. The Institute for Simulation and Training (IST) ported the LTF capabilities to the Nomad computing environment which provided a hand held high resolution terrain elevation query never envisioned before.

Summary: Implementation of this standard has allowed the US Army to have runtime terrain services for the live domain. Providing interoperability and cost savings across live programs, product lines, and capabilities. Additionally, the standard has provided a basis for moving towards a runtime common Modeling & Simulation capability. Finally, the standard has shown the potential for cross Department of Defense collaboration by providing operational and training capabilities.

4. Live -Virtual – Constructive Interoperability

The Live simulations and standards described in the previous sections facilitate interoperability with various constructive simulations, virtual simulations, and operational systems to provide a more robust and comprehensive training and simulation experience. While the DoD has been conducting research and development in several areas related to LVC interoperability to include object models, metadata, architectures, and standards, the Live training domain has implemented innovative solution sets which re-use components such as data translators and information assurance cross domain solutions which support these DoD initiatives. The following sections describe some of those Live training domain implementations.

Currently, LVC events use multiple types and instances of protocol translators to integrate the necessary assets. Examples of these interfaces include High Level Architecture (HLA), Distributed Interactive Simulation (DIS), Test and Training Enabling Architecture (TENA), Tactical Data Links (TADIL), Command, Control, Communications, Computers and Intelligence (C4I), and digital and analog voice interfaces, among others. The majority of these interfaces are developed by different vendors, utilize different techniques for achieving their functions, and require technical subject matter experts to install, configure, test, operate, and maintain [8].

By the use of JBUS (formerly known as JLVCDT – Joint Live Virtual Constructive Data Translator), the number of required protocol translators has been greatly reduced as well as the complexity. JBUS provides a scalable software architecture that acts as a system and software platform for the common LVC architecture. LVC Interface Modules, or LIMs, provide the mechanism for disparate protocols to interoperate. The LIM is accepted into the framework and provides basic services for its protocol for functionality such as: registration and subscriptions, data handling, and packing and distributing outbound messages. Each LIM runs in its own thread to avoid affecting other applications and subscribes to data and events via an observer interface. Through the use of the JBUS mapping tool, attribute and entity type mappings are at the user level, not at the developer level which reduces the time and level of expertise required to interoperate within a distributed LVC environment.

5. Conclusion

The Army Live training domain has made a significant investment and applied rigorous systems engineering processes to achieve openness, extensibility, flexibility, and scalability of its product line and architectures. These solution sets are based on standards which provide an efficient way to design, develop, and operate interoperable, non-stove-piped training solutions. These standards establish appropriate development guidelines and interface definitions in order to maximize industry involvement in developing product-line solutions and providing advanced training capabilities through technology insertion. In addition, these standards allow a new level of interoperability among participating industry vendors, greater opportunity for taking advantage of legacy technology, and greater vendor depth in providing product solutions. Finally, these standards work hand in hand with information assurance requirements and provide a new flexibility in system accreditation.

This paper may be a stimulus for additional work between the DoD and the Army Live Training domain community, in the area of standardization. To this end, a primary goal is “to promote and achieve reuse.” In this paper, we have explored ways to achieve this goal by way of leveraging the capabilities of the Army Live training domain. We also encourage the simulation interoperability community to continue to explore and mature technologies that focus on standardization.

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