

Live Training Transformation (LT2) Product Line Applied Standards For Reusable Integrated And Interoperable Solutions

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ABSTRACT

The U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI) has established a Live Training Transformation (LT2) product line approach to developing a Family of Training Systems (FTS) that provide the ground maneuver training range functions supporting Army live and Joint training environments. The success of the LT2 program strategy is dependent on defining standards and initiatives derived to promote systematic reuse of software and interoperability solutions for the LT2 products. Application of LT2 product line standards have matured reducing life cycle development and sustainment costs through the creation of common reusable architectures providing integrated and interoperable training solutions for the LT2-FTS deployable to Army Ranges. LT2 standard initiatives cover the following primary areas of technology development: Tactical Engagement Simulation System (TESS), training instrumentation systems, software architecture, targetry and battlefield effects, and Joint Live-Virtual-Constructive interoperability. Approved and established standards include Common Training Instrumentation Architecture (CTIA), OneTESS, Family of Army Systems and Integrated Targetry (FASIT), Integrated Player Unit (IPU), Common Player Unit Interface Control Document (ICD), Consolidated Product Line Management (CPM), Graphical User Interface (GUI) Framework, and LT2 HCI Style guide. The LT2 standards provide industry the 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. This paper provides an overview of how government and industry worked together to establish the LT2 standard initiatives based on common LT2-FTS use cases and details the relevant solution sets resulting in achievement of the PEO STRI mission and the LT2-FTS product line interoperability and reuse objectives.

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INTRODUCTION

The U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI) has established a Live Training Transformation (LT2) product line approach to developing a Family of Training Systems (FTS) that provide the ground maneuver training range functions supporting Army live and Joint training environments. The success of the LT2 program strategy is dependent on defining standards and initiatives derived to promote systematic reuse of software and interoperability solutions for the products. Application of product line standards have matured reducing life cycle development and sustainment costs through the creation of common reusable architectures providing integrated and interoperable training solutions for the products deployable to Army Live Ranges. Standard initiatives cover the following primary areas of technology development: Tactical Engagement Simulation System (TESS), training instrumentation systems, software architecture, targetry, battlefield effects, and Joint Live-Virtual-Constructive interoperability solutions. Approved and established standards promoting reuse and interoperability include Common Training Instrumentation Architecture (CTIA), OneTESS, Family of Army Systems and Integrated Targetry (FASIT), Common Integrated Player Unit Performance Specification Common Player Unit Interface Control Document that includes MILES standard compliance, and Consolidated Product Line Management (CPM) strategy. The LT2 standards provide industry the 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. This paper provides an overview of how government and industry worked together to establish the standard initiatives based on common use cases and details the relevant solution sets resulting in achievement of the PEO STRI mission and the product line interoperability and reuse objectives.

BACKGROUND

Live Training Transformation (LT2)

LT2 is an Army initiative to develop a live training range product line that includes capabilities centered on a common architecture, known as the Common Training Instrumentation Architecture (CTIA), and common plug-and-train components. The CTIA and LT2 components are used to instantiate a specific modernized set of Live Ground Maneuver Training Systems deployable by PEO STRI to the Army live Combat Training Centers and Homestation training environments, see figure 1. The product line strategy is required to synergize training instrumentation, targets, and tactical engagement simulation systems to ensure the efficiency and effectiveness of training during peacetime, mobilization, mission rehearsal, and in-theatre during deployed military operations. Products are constructed using a “family of components” approach, which maximizes software reuse, provides common functionality, interfaces and standards. The CTIA recently released its version 2.0 architecture on March 2008 and is supporting the following S

product deployments: Combat Training Center Objective Instrumentation System (CTC-OIS) to National Training Center at Fort Irwin and Joint Range Training Center at Fort Polk Fy08/Fy09; Homestation Instrumentation Training System (HITS) Fort Bliss proof of concept Fy09; and multiple Instrumentation Ranges sites to include Fort Carson Fy09. Future product instantiation shall maximize existing software core assets located in the LT2 Portal derived from product instantiations and other common LT2 solutions discussed within this paper.

Live Training Domain Problem Space

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 are characterized by the following:

- Actual soldier/vehicle activity on terrain under simulated combat conditions.
- FOF weapon engagement with instrumented players via Tactical Engagement Simulation and FOT with actual targets and live fire.

The live training domain includes all of the training requirements and capabilities deployed by PEO STRI PM Training Devices (TRADE) modernization strategy for the Army’s Live Ground Maneuver Training Ranges. In order to promote efficiencies for the Army live ranges across PM TRADE programs, Goals focus on capitalizing standardization and interoperability efforts that address both Government and Industry identified technology gaps, see figure 2. The technology gaps require common live training solutions to achieve the LT2 strategic mission to establish a product line set of training systems that reduce total ownership life cycle costs for the Army. The following technology gap categories have been identified and have or will be addressed by standardization efforts:

- Indoor Tracking requires high-fidelity, high-resolution tracking data while indoors
- Scalability of communications infrastructure performance with increased range coverage and mobility
- LVC Training, Test, and Joint Range end to end application interoperability to include Common Data Model Schema and fair fight correlation of models
- Dismount and Tactical Engagement System Portable Area Network Common Communications Solution that provides seamless, wireless communications between Player Units, communication infrastructure, and TES
- Standardized based Common Integrated Player Unit (IPU) interchangeable between PUs and TES variants that supports configurable multi-spectrum radios
- Battle Realism for Non-Line Of Sight engagements to include munitions penetration effects
- Information Assurance support effort with Cross Domain Solution to integrate Sensitive But Unclassified with classified system secret high networks using lower cost encryption solutions

- Support common target integration solution to include all existing deployed targets and modernized target deployments for all FOT and FOF exercise types

Standardization evolution will be predicated on resolving the common technology gaps identified in alignment with Army Live Training Transformation modernization strategy in order to maximize the total available set of Army training assets used currently or planned for future deployment to the Army's Live Ground Maneuver Ranges.

LT2 Standards Evolution

One of the main cornerstones of the LT2 strategy is to capitalize on standardization to maximize commonality and facilitate interoperability, and subsequently promote cost savings across PM TRADE acquisitions.

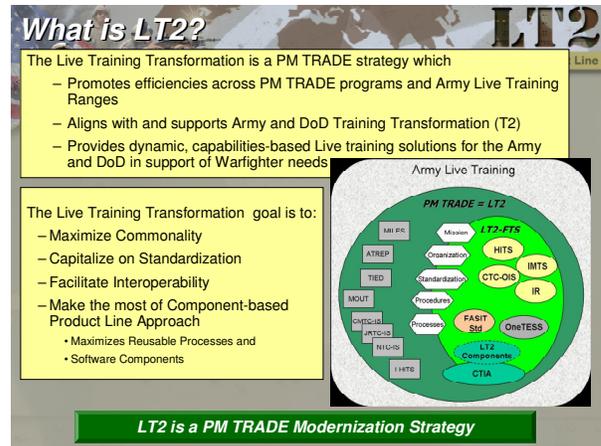


Figure 1. Live Training Transformation

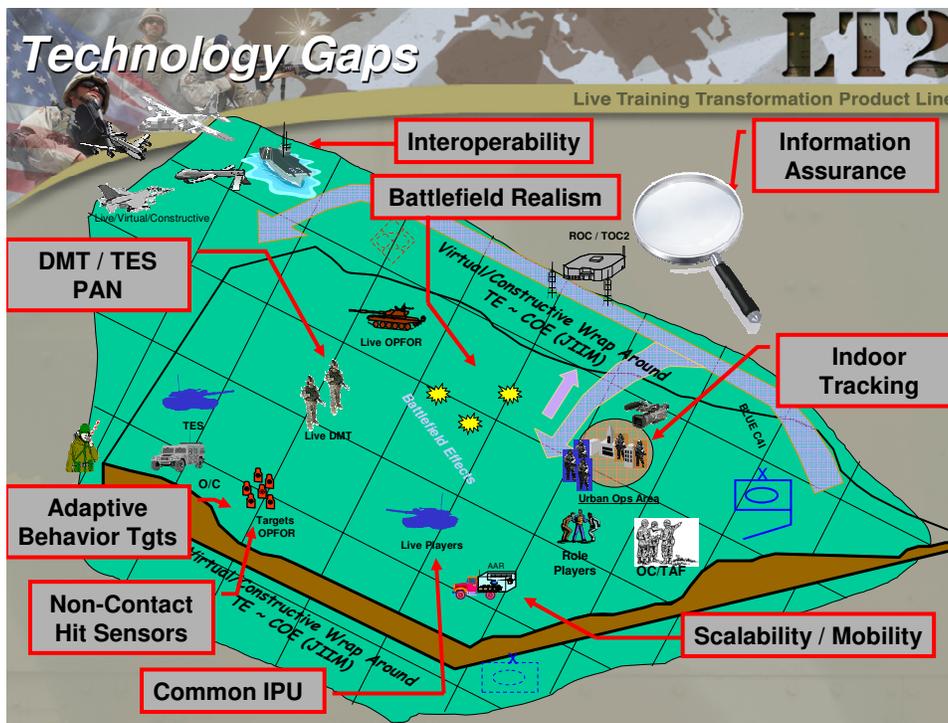


Figure 2. LT2 Domain Problem Space

Live Training Transformation (LT2) Technology Gaps Addressed

A definition of “standardization,” in the context related to technologies and industries, is “the process of establishing a technical standard among competing entities in a market, where this will bring benefits without hurting competition.” PM TRADE’s goal of standardization centers around a universally agreed upon set of guidelines that support interoperability efforts within PM TRADE, across PEO STRI and the Army. Within this context, PM TRADE will follow a systematic Consolidated Product Line (CPM) management approach which uses a centralized repository, known as the LT2 Portal, to manage, develop, and sustain its architectures,

standards, interfaces, processes, and requirements that directly support the LT2-FTS programs. Figure 3 shows CPM strategy to consolidate all LT2-FTS Post Product Software Support and Post Deployment Software Support within a single management structure and organization to maintain the product line integrity of the LT2-FTS programs.

LT2 Standardization Process

LT2 uses multiple approaches in working with industry and stakeholders to establish standardized processes for development and interoperability. One of the methods successfully employed is, Industry Days, where Government comes together with industry to describe the current live

training problem domain space and state the prioritized non-interoperability or stovepipe issues that exist at the Army live ranges between deployed simulation systems. In addition LT2 vision and mission strategies are briefed to industry along with current plans to deliver future modernized training devices in order to educate training needs to industry and encourage adoption of LT2 and CTIA capabilities and strategies (i.e. LT2 CPM concept).

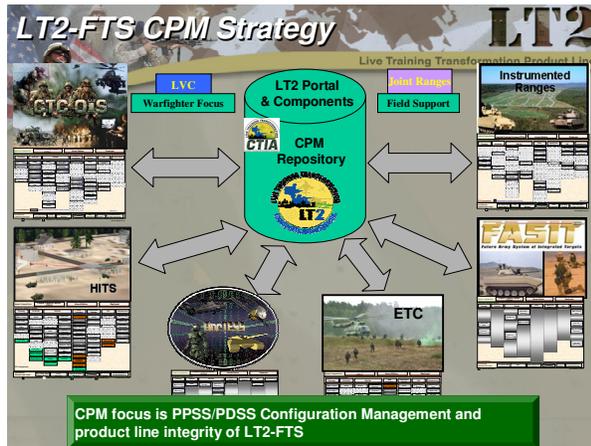


Figure 3. LT2-FTS CPM Strategy

With the establishment of the web-based LT2 portal as a CPM repository, LT2 has created collaboration working groups with participation from Government and Industry that support standards evolution and common solutions within the following areas:

- Common Component Working Group. The goal of this group is to discover and foster the evolution of components that can be reused across the Product Line.
- Architecture Working Group facilitates the coordination of the CTIA Architecture Change Process
- Test Tools group provides available tools used to test the CTIA architecture and LT2 components.
- Development and review of the Instrumented Player Unit Performance Specification (IPUPS).
- LT2-FTS product working groups support analysis of software requirements and development of software components developed new, modified, or reused for future reuse by specific programs (i.e. HITS).
- LVC Integration and Interoperability assesses the existing Service Oriented Architecture type architectures for support of developing a prototype LVC strategy Development, documentation, and maintenance of ICDs and the architecture for a common messaging format and protocol between PUs and CTIA services.
- LT2 Portal Content and Common Portal Engine standards
- Future Army System of Integrated Targets (FASIT) standards between PEO STRI, Industry, and other interested parties.

LT2 has created and documented standard processes for approving architecture changes, common component changes and development standards using the Portal as a formal review and sign-off mechanism for evolving standards and

processes. In addition, approved a concept of operations that establishes the PM TRADE management structure and processes necessary to execute the LT2 strategy and standardization efforts across all PM TRADE programs, and the new live training capabilities defined in the approved Live Training Transformation Family of Training Systems (LT2-FTS) Initial Capabilities Document (ICD). The LT2 ConOps provides for a Technical Advisory Group (TAG) structure to bring stakeholders together in evolving new standards and providing the necessary recommendations to lower and higher level management via either the Product Advisory Group (PAG) or Board of Directors (BOD) (2006). Documented standards and processes are referenced within the PM TRADE acquisition process to foster reuse and reduce total life cycle costs for new products. Examples of standards referenced in the acquisition process include the following:

- Component Agreement Template contains an overall description of the component, interface definition, and its purpose and provides context for the Industry vendor.
- Human Computer Interface Style Guide leads application developers in the design and implementation of compliant applications, displays, controls and visual components. A common framework for Human Control Interface (HCI) design is provided, enabling all applications to appear and operate in a reasonably consistent manner. Design guidelines in the form of a style guide provide three major benefits: higher productivity, reduced development time, and reduced training time
- LT2 Developer's Guide provides the background, procedures, and required reference material for a software developer or organization to successfully craft software using the existing assets of the LT2 Product Line and to submit potential assets for future LT2 Product Line inclusion.

LT2 INTEGRATED AND INTEROPERABLE SOLUTIONS

Common Training Instrumentation Architecture (CTIA)

CTIA is the product line architecture that provides commonality across training instrumentation systems and interoperability across Live, Virtual, Constructive (LVC), and Joint training systems. It consists of standards and protocols to be used by systems developers and is the core software component of the LT2-FTS. CTIA is a component-based, domain specific, product line architecture that enables the LT2 strategy and leverages the high degree of commonality of requirements among the products deployed to CTCs and home stations. This emphasis on commonality by the CTIA will improve the quality of training while significantly reducing development, logistics, training, and maintenance costs. CTIA and associated processes will be the basis for subsequent product line members to leverage the product line architecture and common software components.

CTIA implements a set of domain-specific services to support Army Live Training. These can be thought of as logically centralized, but potentially, physically distributed services. The CTIA Services component provides a set of APIs

(defined using CORBA IDL and XML) that interact with LT2 components, allow for the interaction between other components, and provide common LT2 database schema implemented in Structured Query Language (SQL). For ease of use object model frameworks are provided for the primary languages (C++, Java, C# and .NET) that wrap services and provide easier programmatic interface.

CTIA Standard Solutions

CTIA provides a compliance definition that specifies the requirements for LT2 components to be assessed as CTIA-compliant for systemic or opportunistic reuse by the Family of Training Systems. Additionally, CTIA specifies the requirements for a Product to be CTIA Product compliant. A training range consists of many systems and components. There will be systems that will not be CTIA Product compliant; however they can interoperate with LT2 FTS through CTIA Component compliance. CTIA components which need to operate within LT2-FTS will have differing integration needs and different levels of compliance.

A CTIA compliant component is developed to conform to CTIA architecture object model frameworks and interface specification requirements to support reuse and instantiation within LT2 products using CTIA as its core architecture. The CTIA Product Line Architecture Specification (PLAS), Product Line Architecture Framework (PLAF), and associated processes will be used to realize CTIA-based LT2 products composed of plug and train common and unique LT2 components. .

The component agreement serves as an agreement between the component developer, the users, and PEO STRI LT2 management organization. Higher levels of CTIA-compliance realize greater reusability across the product line because:

- Providing Component Agreements specifies the requirements, interfaces, behaviors and dependencies of components, which allows lead system integrators the selection of appropriate components for reuse within their product.
- Providing Component Agreements also fosters systematic reuse by allowing the product line to collaborate on the development of requirements for components during design and development phases, so that components can be designed to be reused across products and ranges.
- Adherence to the interfaces defined in the CTIA PLAS supports reusability by ensuring that component interfaces are defined and managed by the product line.
- Adherence to the LT2 GUI Style Guide facilitates reusability by ensuring common approaches to user interface design across independently developed applications.
- Use of CTIA Frameworks reduces development and maintenance costs by encapsulating architecture changes and providing a reusable library of common software.

The LT2 Product Line uses communication standards to integrate component based elements that can run distributed across many hardware platforms for large scale exercises or logically combined across a few hardware platforms for small scale exercises. The flexibility in scaling of the system is achieved by the “plug and play” design of the architecture. Figure 4 shows the data distribution, including plug and play design.

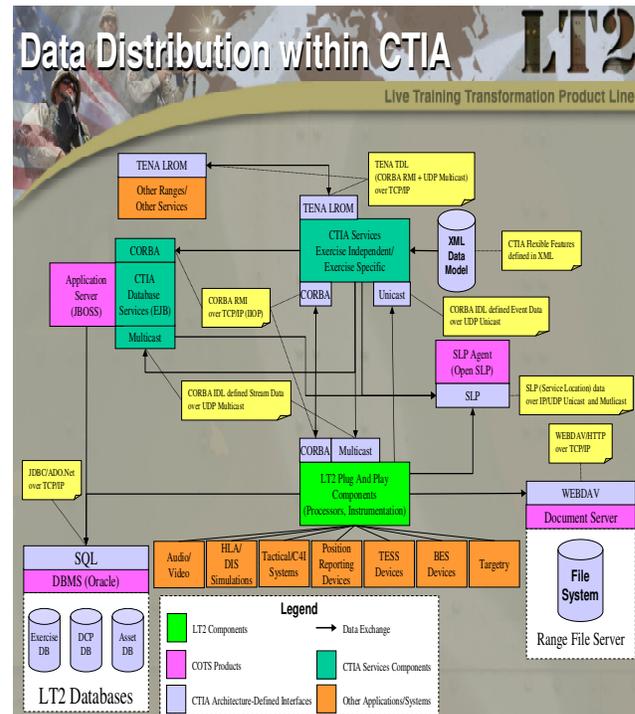


Figure 4. CTIA Data Distribution Standards

Future Army Systems of Integrated Targets (FASIT)

LT2 has created FASIT common standards to support component plug and play technology insertion relative to integration of targetry and range devices used to support live Force on Target training objectives as follows:

- Provides Army Common Standards for Live Fire Training Devices
- Includes Protocols for Target/Device Control in Training Circular 25-8 that includes Urban Operations, Instrumented Ranges, CTCs and home stations
- Allows mixing of different vendor's products (also supports range non-FASIT RETS targetry that are obsolete) on a single range under a single control system (TRACR)

FASIT has requirements to provide the common standards, interfaces, and protocols to develop a CTIA compliant Common Target Controller comprised of a Universal Target Controller (UTC) and the Targetry Range Automated Control

and Recording System (TRACR) for reuse by LT2 products. FASIT allows LT2 products to support live fire exercises (LFXs) for individual and crew served weapon skill qualification and sustainment, and, collective training events at local training areas, combat training centers, and in tactical force projection environments. FASIT has developed LT2 common components to provide realistic friendly, neutral, and threat targets and weapon effect simulation; define targetry range (Range Data Editor); target scenario preparation and execution (Scenario Development Tool); target status; data collection; automated maintenance support; test suite; and after exercise execution, FASIT supports training preparation, presentation, and feedback. FASIT supports Interface Control Documents for following: battle effects and targets; battle position sensors; small range ERETS protocol adaptor software; and LT2 Instrumented PU systems.

FASIT has allowed integration of multiple vendor hardware to work seamlessly with LT2 products. In addition FASIT has provided a solution to replacing obsolete RETS range targetry with FASIT compliant targets at a significant cost savings to the Army and has also supported a retrofit of small non-instrumented ranges obsolete targets with FASIT compliant interoperability to LT2 products.

One Tactical Engagement Simulation Systems (OneTESS)

The OneTESS is a product that provides a common TES architecture for integrating current and future vehicles, and weaponry found in the heavy, infantry and Stryker Brigade Combat Teams and OPFOR. The components of OneTESS will be compliant with the Common Training Instrumentation Architecture (CTIA) that is used throughout the LT2-FTS. OneTESS will use actual or simulated weapons systems equipped with tactical engagement simulators to replicate weapons' effects and battle damage. OneTESS will operate predominantly in conjunction with a Combat Training Center (CTC) or Homestation Instrumentation Training System (HITS) to provide the common TES capability in an exercise. OneTESS also will have a standalone mode that provides the exercise management function as well as the TES capability to support company-size homestation training exercises.

OneTESS Increment 1 will enable the Real Time Casualty Assessment of live FOF and FOT training with vehicles and weapons found in the Brigade Combat Teams and in the OPFOR at the Combat Training Centers. It will provide non-line-of sight (NLOS) capability to adjudicate employment of indirect fire/area effects weapons as well as line of sight (LOS) capability for direct fire weapons. The focus of training is at the Brigade Combat Team (BCT)-level and below. Increment 1 of OneTESS uses the geographic position, weapon orientation vector and trajectory computation of geometric-pairing for simulating indirect fire engagements and laser generators/detectors to simulate direct fire engagements thus providing a comprehensive system to fairly adjudicate live training and testing exercises. OneTESS components will be integrated across the live training domain and support all phases in the training cycle at all echelons from a joint level

exercise to crew/squad drills to prepare the Force to execute its wartime mission. The OneTESS will support the execution of proper engagement procedures; provide simulated weapon system's accuracy and effects; and adjudicate results of engagements. Creation of an OneTESS Standard is necessary to establish and maintain configuration control over functionality and ensure hardware and software interoperability with MILES variants and fielded equipment. Standard will eliminate variation in results that discredit the validity of a training exercise or test event. OneTESS will also provide modeling, troubleshooting, and conformance tools to assist in implementation of the standard.

Common Integrated Player Instrumentation (IPU)

This Integrated Player Unit Performance Specification (IPUPS) establishes the performance and validation requirements for the Instrumented Player Unit (IPU) for various programs. The IPUPS standard will foster future design efforts to replace the current set of legacy IPU or Data Communications Interface (DCI) designs. This new family of live training IPU design will provide the same functions as before, and will also be based on a modular, open architecture approach that accommodates simulating new weapon systems, stresses "train as you fight" concepts, incorporates the Future Force requirements, provides enhanced training data collection and After Action Review (AAR) capabilities, power requirements, Personal Area Network (PAN) requirements, verification methods, independence of radio communications protocols, performance measures, common message formats, common connector standards, improved maintenance, and facilitates interoperability and technology insertion. The goal is for this IPU design to incorporate current Tactical Engagement Simulation Systems (TESS) interoperability as well as provide a base for the development of future TESS and IPU interoperability evolution as LT2 migrates to future OneTESS Standard.

The IPU provides all live entities networked in the training FOF or FOT exercise the capability to process the necessary casualty assessment information, and communicates this information back to the Range Operating Complex. The four main types of players in a live training exercise that require the functions of an IPU are: (1) the Dismount, or individual Soldier, (2) the Vehicle, to include all ground and air vehicles, (3) Targets, and (4) Observer Controller. The IPU consists of three main modules: (1) the Instrumentation Processor (IP), (2) the Platform Interface Processor (PIP), and (3) the TESS Processing Unit (TPU).

The PU Interface Control Document (ICD) mitigates the challenge of having stovepipe communications systems and PU networks by defining a single interface method with common XML protocols for passing messages to all types of Player Units (legacy and common IPU), and for facilitating interoperability between all types of Player Units and the Common Training Instrumentation Architecture (CTIA) services. Live Training products that are part of the LT2

Family of Training Systems (LT2-FTS) may develop or extend software modules (PU gateways and common PU controller) used to integrate PUs previously developed by utilizing a “plug-and-play” approach via CTIA Services, CTIA compliance definitions, and PU ICD as design guidance. The PU ICD standard provided the following benefits:

- Allowed reuse for LT2 Player Unit Common Message Set. Instead of creating multiple stovepipe custom communications mechanisms for different player types, this ICD establishes a standard for the LT2 domain. A single LT2 component can be developed to work with all PU types. Helper software modules can be created and disseminated to assist with the development of new PU gateways.
- Provided automatic compliance when using the LT2 Component. When developers utilize this ICD and the associated components and helper software modules, the developers can be assured of LT2 compliance.
- Provided a simple path for trusted guard certification. XML is a mature and well-known software communications mechanism and allows for relatively easy and fast Information Assurance (IA) accreditation for Cross-Domain Solutions. Furthermore, even if a new PU type is introduced to an existing system the architecture across the Trusted Guard is unchanged and allows for IA consistency across LT2-FTS programs. The use of XML minimizes any performance impact because a wide array of mature tools is available for quick XML serialization/deserialization. In fact, translating XML is faster for Trusted Guards than translation of other standard protocols.

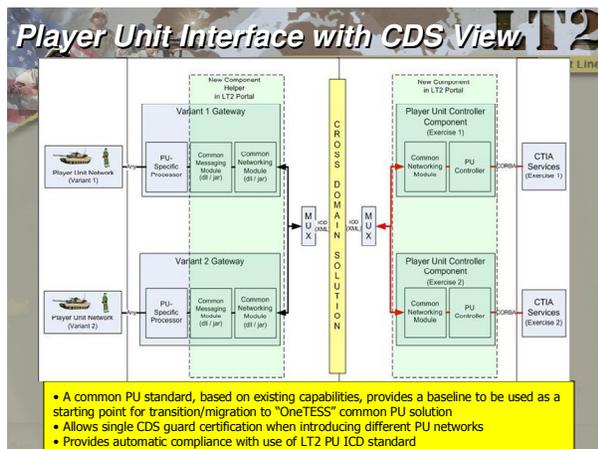


Figure 5. Common IPU Interface Standard

Video Service-Oriented Architecture (SOA)

LT2 has standardized on a service-oriented architecture to accommodate its video management, transmission, storage, streaming, viewing and recording requirements. Video technologies, structures, and even standards are well in place

today within industry, however, how to consistently utilize these capabilities in LT2 applications was the challenge.

A video SOA was established to allow a consistent mechanism for accessing and manipulating video within LT2, while allowing flexibility in the underlying video technologies actually being used. By specifying how to describe video sources and how to retrieve them without mandating specific technology choices provides LT2 applications the flexibility to select the type of video hardware and software that makes sense for that application. The video SOA also provides the means to exchange video services between applications, and provide additional incremental functionality to be added as necessary. For instance, one defined video service may simply provide video feeds from known geographic locations within a building. A second video service may combine known locations from live players as they traverse that building, with the known locations of the video sources to provide automatic video tracking of live players as they move throughout a building. This is one example how SOA-based technology can grow to flexibly accommodate new requirements without permutation to existing services. The current existing video SOA services include:

- Camera Position
- Source Metadata
- Play List
- Stream Collection
- Camera Control
- Live Streams
- Recording
- Video Query
- Video Work Station

Conclusions and Summary

The LT2 Standardization efforts and Consolidated Product Line Management strategy provides the following benefits and lessons learned:

- CPM provides a single management mechanism to consolidate all LT2-FTS sustainment and enhancement development efforts fostering common live training solutions while lowering total ownership life cycle costs across programs and mitigating potential cost, schedule and performance risks
- CPM allows for consolidated lab and test resources at a single facility site reduces overhead and Integration and Test costs, reduces IAVA management and IA certification costs across LT2-FTS, reduces configuration and inventory management costs, and provides for help desk support
- Quality of service and products are increased through testing and resolving issues once and deployment of common solutions to all programs and training sites
- Funding consolidation of budget for all LT2-FTS maximizing each program contribution for the benefits of all programs

- Government and Industry work together to establish interoperability and technology insertion standards that foster Government product line evolution and simplify acquisition processes while allowing industry to maintain its competitive edge or business model.

Collaboration working groups include Government and industry stakeholders that follow LT2 standard processes fostering standardized solutions to LT2-FTS identified product line stovepipe issues and technology gaps. Solutions support open source delivery and access to existing products to extend and modernize into new products via LT2 web-based Portal or CPM repository. Standardization provides the abilities to create new product lines from our products for external customers.

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