Applying the Live Training Transformation (LT2) Software Reuse Strategy to the Homestation Instrumentation Training System

Jorge Rivera, William Samper
U.S. Army PEO STRI
Orlando, Florida
Jorge.Rivera2@peostri.army.mil,
william.samper@peostri.army.mil

Barry Clinger
Riptide Software, Inc.
Orlando, Florida
Barry.Clinger@Riptidesoftware.com

ABSTRACT

Realizing cost savings from systematic software reuse through component-based development strategies has traditionally been a challenging undertaking. Software component reuse will never occur automatically; it must be strongly supported by management, methodology, and process. Factors including technical, managerial, and economic have hastened the failure of many corporate reuse initiatives in the software development industry (Frankes and Fox 1996). For the U.S. Army Program Executive Office (PEO) Simulation Training and Instrumentation (STRI), Program Manager for Training Devices (PM TRADE), their software reuse initiative was further compounded by the complications of coordinating the development of a software product line among several different government contracting corporations who view themselves as competitors. The objective of the PM TRADE product line is to achieve a reduction of software development and maintenance cost by maximizing component reuse and to reduce product fielding times while enhancing training benefits to the Soldier. Through successful execution of the product line strategy, PM TRADE will deliver a set of common components that provide integrated and interoperable training solutions for live collective training across the home stations, Combat Training Centers (CTCs), deployed, and joint training domains. This paper describes the innovative approach PM TRADE is using to establish a LT2 Homestation Instrumentation Training System (HITS) Command & Control (C2). The LT2 HITS C2 Core Software is being developed primarily from a reuse of existing LT2 software components created for use in other live training systems. It is the intent of this paper to capture the successes and failures while implementing this strategy to assist similar projects in the future and further the PM TRADE product line strategy.

ABOUT THE AUTHORS

BARRY CLINGER is the Chief Technical Officer for Riptide Software, Inc. and for NetPads Inc. He is an experienced software solutions expert who specializes in the design and architecture of large-scale distributed systems. Barry has over 16 years of commercial, DoD, and NASA software development experience. He earned his B.S. in Computer Science from Eckerd College in 1988 and his M.S. in Business from Kennedy Western University in 2003. He holds multiple software design and architecture certifications from Sun and Microsoft.

JORGE RIVERA is the Assistant Project Manager (APM) for LT2 at PEO STRI. His experience includes a strong software engineering and program management background in the Instrumentation System, Instrumented Ranges, and Urban Operations arenas. He has 21 years experience working in DoD acquisition both from a technical and program management perspective. He earned his B.S. in Electrical Engineering from the University of Puerto Rico in 1983 and his M.S. in Electrical Engineering from Fairleigh Dickinson University, NJ in 1987.

WILLIAM SAMPER is currently assigned as the PEOSTRI Lead Engineer for the Common Training Instrumentation Architecture (CTIA) and Live Training Transformation (LT2) Training Operations Center Command and Control (TOC2) program supporting Homestation Instrumentation Trainnig Systems (HITS) solutions. He earned a BS in Electrical Engineering from the University of Florida. Experience includes 18 years of project engineering and project management working with Department of Defense (DOD) military acquisition systems and simulation technology associated Army, Navy, and Marine programs.

Applying the Live Training Transformation (LT2) Software Reuse Strategy to the Homestation Instrumentation Training System

Jorge Rivera, William Samper
U.S. Army PEO STRI
Orlando, Florida
Jorge.Rivera2@peostri.army.mil,
william.samper@peostri.army.mil

Barry Clinger
Riptide Software, Inc.
Orlando, Florida

Barry.Clinger@Riptidesoftware.com

INTRODUCTION

Realizing cost savings from systematic software reuse through component-based development strategies has traditionally been a challenging undertaking. Software component reuse must be strongly supported by management business goals, strategic planned reuse methodology, standardized development practices and processes. This paper describes how the U.S. Army's Live Training Transformation (LT2) product line strategy can be applied to developing a solution for a future Objective Homestation Instrumentation Training System (HITS) as the third instantiated product within the LT2 Family of Training Systems (LT2-FTS) product line. The HITS program will be leveraging the benefits of prior product development related to the Instrumented Ranges and Combat Training Centers achieving a significantly larger return on investment by reduction of software development, maintenance cost, component reuse, reduction in time to field, and enhancing training benefits to the Soldier. Through successful execution of the product line strategy, Program Executive Office (PEO) Simulation, Training, and Instrumentation (STRI) Project Manager (PM) Training Devices (TRADE) will deliver a set of common components integrated as the Training Operations Command and Control (TOC2) that provide an interoperable C2 infrastructure training solution for live collective training across the homestation training environment. This paper describes the benefits derived from the existing innovative approach PM TRADE is using to manage, facilitate, and implement its product line, using the HITS and TOC2 acquisition strategy solutions along with the successes and failures encountered during the implementation of this strategy. The paper concludes with lessons learned derived from the execution of the HITS product and core asset development.

BACKGROUND

Live Collective Training at Homestation Ranges

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, see figure 1. Live collective training exercises at Homestation ranges (i.e. LT2 HITS at Fort Bliss) 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 (TES) and FOT with actual targets and Live fire.
  - Position and tracking of training audience accomplished through an Instrumentation System (IS).
  - Training system allows analyst to link observations, events, and training reports to create Cause and Effect relationships.
  - Alerts (training) and alarms (safety) can be triggered under defined conditions, for example, when soldiers/vehicles cross control measures or enter restricted areas.
  - Humans and IS implemented real and simulated visual and audio effects for battlefield events (e.g., vehicle kill indicators, smoke, pyro-effects, barricaded bridges, etc.).
  - Virtual Constructive synthetic training areas and simulated wrap-around Army/Joint forces are used to provide enhanced battlefield realism to Homestation exercises.

Provide capability to interoperate with other LVC training devices thereby increasing training capabilities for the combined arms warfighter experience via external interfaces and system linkages (such as Unmanned Air Vehicle (UAV), Future Combat Systems (FCS) and Operational Test Command (OTC) systems).

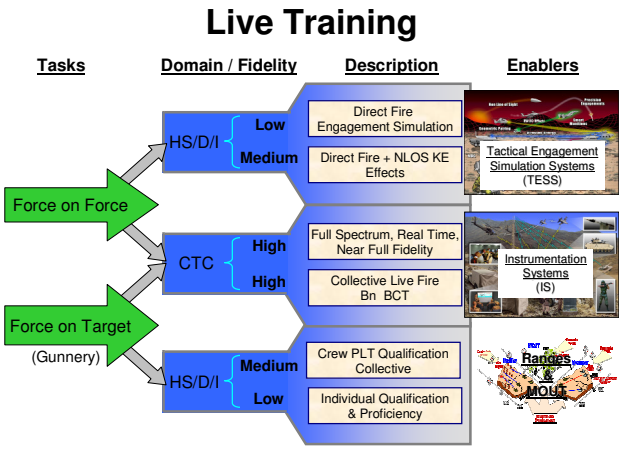

Figure 1. Live Training Methodology

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 called LT2 components, see figure 2. The LT2 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. LT2 products are constructed using a "family of components" approach, which maximizes software reuse, provides common functionality, interfaces and standards. (See Dumanoir, Rivera 2005). The HITS is the third product instantiation whose migration plan is to maximize existing LT2 assets located in the LT2 Portal derived from earlier product instantiations (CTIA, Instrumented Ranges, Combat Training Centers programs) and Future Army Systems Integrated Targetry (FASIT) solutions. Future HITS will also integrate OneTESS program standard Training Engagement Simulation System (TESS) solutions.

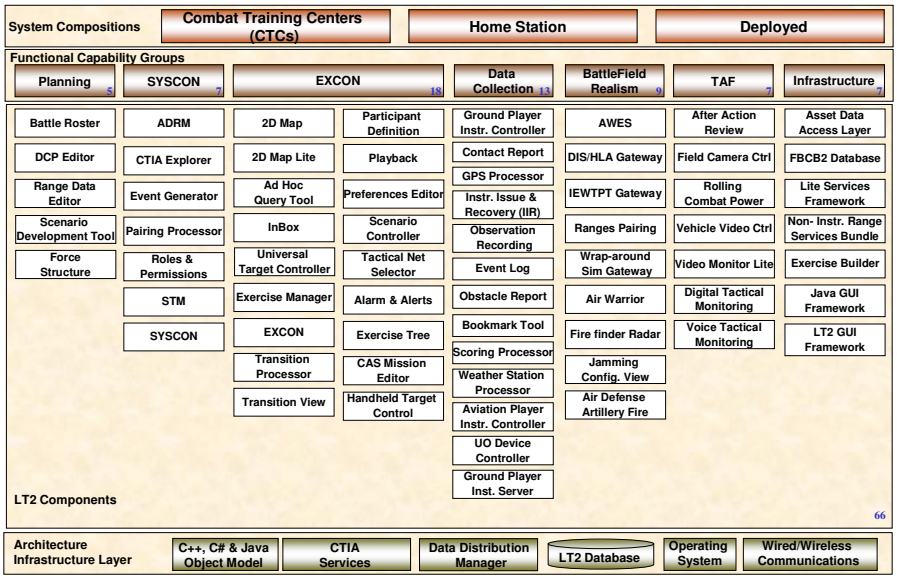

Figure 2. LT2 Component Product Line Framework

LT2 Concept of Operations applied to HomeStation Instrumentation System (HITS)

The LT2 Product Line Management Concept of Operations (PLM CONOPS) focuses on the holistic requirements of all live domain training systems, with the LT2 strategy objectives to maximize commonality and component reuse and to ensure interoperability. This CONOPS establishes the PM TRADE management structure and processes necessary to execute the LT2 strategy 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 product line includes all PM TRADE systems that interface to LT2 systems and support the Army's LT2-FTS ICD requirements.

The LT2-FTS is the Army's effort to purge existing live training systems of redundant requirements, to develop a family of systems that absorbs current

capabilities centered on a common architecture, and to expand on those capabilities by eliminating gaps between current and future weapons systems and those live Army and Joint training systems available to support them. The LT2-FTS is the genesis for meeting the live training requirements of current forces, and Future Force of 2015 and beyond. LT2-FTS will be fully integrated, interoperable, and support the full spectrum of training needs.

Over the next few years it is imperative that live training systems evolve into a product line with a common architecture to provide consistent live training capabilities. The product line architecture will provide a common live interface capability with constructive and virtual (LVC) domain systems, as well as with the tactical Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) and joint training environments.

Through successful execution of the product line acquisition and management strategies, LT2 delivers integrated and interoperable training solutions for live collective training across the Homestation, Maneuver Combat Training Centers (MCTC), deployed, and Joint training domains. The LT2 vision for the product line is captured in Figure 3 and the following strategic objectives:

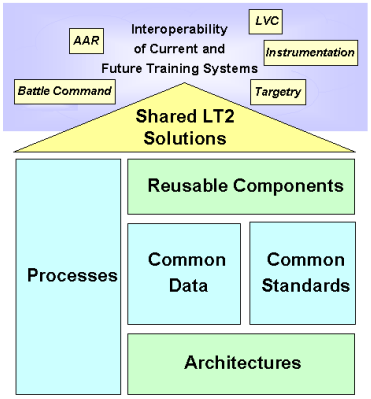

Figure 3. LT2 Product Line Vision

- Produce a product line architecture that completely supports live instrumentation, Tactical Engagement Simulation Systems (TESS), targetry, domain-specific services, and associated equipment for live training within the Army's doctrine-based training process.
- Engineer a product line process and associated standards, specifications, tools, rules, and guidelines that foster development of both components and programs that are compliant with the product line architecture.
- Produce a set of common components that plug-and-play in the product line architecture, are applicable across a wide range of programs within the LT2 domain, and that are available from a LT2 Portal.
- Encourage development of common applications and programs, and capture convincing evidence of the benefits of a product line approach.
- Provide a flexible architectural environment that will support evolution of the architecture to support all Army live training simulation systems, and integration with emerging Army and Joint architectures, such as the Test and Training Enabling Architecture (TENA) and the Live/Virtual/Constructive Integrating Architecture (LVC-IA).

LT2 Standardization Strategy

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. 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 knowledge management approach which uses a centralized repository, known as the LT2 Portal, to manage and control its architectures, standards, interfaces, processes, and requirements. Figure 4 shows the key stakeholders within this approach, and provides an overview of this knowledge management approach. Subsequent sections herein, describe in more detail, roles and responsibilities of the stakeholders.

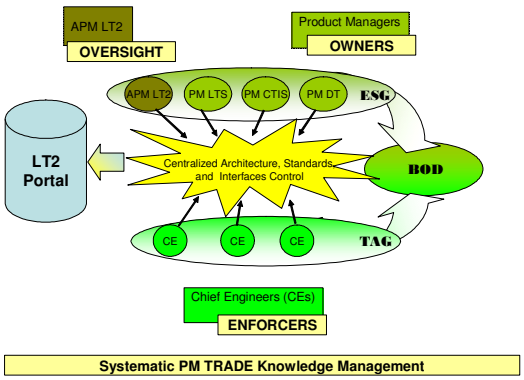

Figure 4. LT2 Standardization

KEY LT2 ARTIFACTS TO FACILITATE REUSE AND SUCCESS OF THE PRODUCT LINE

LT2 Configuration Management (CM) Plan

Under the LT2 supportability strategy, the fielding PM retains Configuration Management (CM) responsibility of fielded systems and assigned LT2 components. All LT2 components will be stored in the LT2 Portal under CM control as defined in the LT2 Portal CM Plan.
The LT2 Portal CM plan is a standard document describing the management and life cycle of the LT2 assets that are under configuration control within the LT2 Portal (Version 0.3, PEO STRI 2006).

LT2 Metrics Plan

A key to determining success of the product line is to establish, maintain, and track a set of metrics that produce accurate, reliable, and meaningful information. Management and implementation of the LT2 strategy will use metrics to monitor programmatic/management, development, and technical efforts. The LT2 Metrics Plan includes candidate metrics to be used by each program to establish a metrics plan that supports the LT2 strategy including methodology, means of measurement, collection, storage, and analysis of the metrics (Version 0.4, PEO STRI 2006).

LT2 Processes & Working Groups

A key element of the development infrastructure are processes that can be easily understood and implemented and the organization of working groups so that all LT2 stakeholders are aligned and efficiently support one LT2 strategy.

- LT2 component assignment – Development tasks for systematic reuse of LT2 components are clearly assigned to the responsible organizations, as well as the planned reuse.
- Component hand-over process – a specific process is also defined, which dictates how the developed LT2 components are verified and delivered to the LT2 Portal for potential future extraction by appropriate stakeholders. The LT2 component development processes prescribe how and when those stakeholders should be involved in component development via peer reviews, established published milestones, and monitored testing.
- Advisory and working groups – Several working groups have been established, with a specific scope and finite duration, to support the LT2 product-line strategy. These groups can be categorized into Working Groups (WGs) and advisory groups. WGs composed of Government and contractor teams who focus specifically on how to improve specific LT2 components or the CTIA, for the benefit of the product line. The advisory groups are mainly comprised of Government teams that make recommendations and or decisions on the technical and management aspects of the product line. These WGs and advisory groups are governed by processes, roles and responsibilities described in the LT2 PLM CONOPS. The HITS program makes significant use of the Common Component Working Group (CCWG) due to the significant amount of reuse being leveraged by the existing LT2 programs and need to publicize new training concepts created by HITS for all stakeholders.
- Collaborative development process – From a LT2 perspective, collaborative development is defined as two or more LT2 organizations or programs working cooperatively to develop a LT2 component, process, or infrastructure support. The collaboration process provides guidance in identifying a facilitator and organization chart, the implementation of the software lifecycle for the component, configuration management for the software and associated documentation of the component, and a description of the roles and responsibilities required for LT2 collaborative development. The outlined LT2 collaborative process is intended to be tailorable.

  Collaborative efforts attempt to resolve implementation issues that include:
  - Overall component responsibility
  - Ownership of the software configuration management
  - Status & progress reporting

- Work share distribution
- Conflict resolution

LT2 Component Agreement (CA)

The component agreement serves as an agreement between the component developer, the users, and PEO STRI LT2 management organization. The component agreement includes:

- CTIA compliance levels define the level (1-4) a component could be reused by other LT2 products. Level 1 equals least level of reuse.
- Component requirements (e.g. functional, quality, physical, and interface) Specification (e.g. Software Requirements Specifications (SRS), Interface Control Definition (ICD), etc),
- Design (e.g. Unified Modeling Language (UML) and/or DOD Architecture Framework (DODAF) artifacts),
- Test documentation used for verification and validation of components during asset handover (e.g. test conditions, procedures, build / install procedures, etc) ,
- User manuals used for guidance in the usage of the component, and component dependencies that may include other components, data stores, and Commercial Off The Shelf (COTS) /Government Off The Shelf (GOTS) equipment.

The HITS program will produce a combination of new component agreements and modified extensions of existing component agreements. New LT2 components developed by HITS require new component agreements, components that will be extended to provide additional HITS required functionality will require their corresponding component agreements to be modified to include the additional information. HITS will also heavily rely on the existing library of components agreements while performing analysis, implementation, testing, and documentation.

LT2 Developer's Guide

The LT2 Developer's Guide is a set of guidelines written from a software developer's perspective that provides the background, procedures, and required reference material to successfully create, or reuse the existing assets of the LT2 Product Line, and to submit potential assets for future LT2 Product Line inclusion (Version 4, PEO STRI 2006). All HITS developers follow the guidelines established by the LT2 Developer's Guide.

LT2 Web-Enabled Portal

The intent of the portal is to create a web-enabled interface to facilitate development, support, and management of the product line. The portal has been designed to accommodate varying types of end users with disparate objectives: program managers requiring status on schedule, risks, and metrics; software developers charged with constructing software applications that reuse common components; end users requiring support and training on deployed LT2 products; and organizations new to the LT2 concept requiring information and guidance.

The HITS program has used the LT2 portal to extract existing LT2 components and documentation relative to HITS requirements. HITS also uses a collaboration forum capability to upload design and program documents for peer review by all identified HITS stakeholders including developers, customers, and LT2 Government organization representatives. Program managers come to the portal to review schedules, identify risks, review metrics, and produce reports. All the LT2 component schedules are tracked and updated on a weekly basis allowing the HITS program to reduce its development risks and make it easier to track HITS development strategy and plan mitigation efforts to align component development schedules with the HITS schedule. Pre-canned searches and filters are used to determine the dependencies a program manager may have on other products and the items he or she is responsible for providing. On-line calendars track important milestones and provide easy import into a user's Microsoft outlook calendar.

HITS software developers use the portal to download the most recent versions of the CTIA architecture and components for use in their product development. They can review ICDs, hardware specs and make comments on future revisions of these documents. Software developers have access to libraries of documentation on the architecture, on the components themselves, and on the LT2 development practices. Forums are available to allow the developers to interact with each other in an informal fashion across product and corporate boundaries exchanging lessons learned and new concepts. HITS uses Portal collaboration areas to facilitate working groups by providing common file storage, action item maintenance, calendars, email distribution list, virtual meeting capability with desktop sharing, common configuration managed area for storing source code, forum for idea

exchange, and other items all under tightly controlled roles and permissions. The LT2 help desk allows users to submit currently known issues for their product, and request supplementary support as required. Monitored discussion forums can help ascertain user concerns and usability issues that can be addressed in subsequent versions of the product.

LT2 Graphical User Interface (GUI) Framework

A software developer framework was created as a sister product of the LT2 HCI style guide. The HCI style guide leads application developers in the design and implementation of LT2 compliant applications, displays, controls and visual components (Version 2.1, PEO STRI 2006). The purpose of the framework is to assist the software developer in creating LT2 compliant graphical user interfaces as part of LT2 products. The framework reduces development costs by providing a set of fully tested, user approved software "widgets" that are compliant with the LT2 HCI style guide. Use of these widgets in multiple LT2 products further reduces the cost of training the user community as the same common "look & feel" for applications becomes prevalent across LT2. The GUI Framework was the first LT2 common component created, and also the first collaboratively developed component.

The HITS program is developing new design approaches within the GUI Framework to improve training efficiencies making it easier to perform Homestation training operations. The HITS TOC2 software shall support bundling of LT2 components into "Perspective Bundles" allowing a component grouping layout defined within the GUI Framework to perform specific training tasks via combined interactive windows on the training operators desktop. The perspective bundles allows multiple component functions to be integrated within a common interactive display for the user, minimizing the level of effort to initiate, manage, and control training tasks using HITS.

LT2 COMPONENTS AND SOFTWARE REUSE

LT2 Components are used to implement an instance of a LT2 system in conjunction with the Architecture Infrastructure layer. The Architecture Infrastructure layer figure represents the "core architecture components provided by the CTIA. The LT2 components are grouped into Functional Capability Groups (FCGs) that focus on U.S. Army doctrine of plan, execute and assess (FM 7-0). LT2 components are considered candidates for reuse within the LT2 product line under the following categories:

- **Systematic**: The component was originally intended and designed to be reused by more than one LT2 product. This approach assumes that the consolidated set of product component requirements were available and well understood prior to component development. The majority of the HITS TOC2 strategy is based on systematic reuse.

- **Opportunistic**: This category describes components that may be reused by other programs, but were not specifically identified for that reuse. This could be because the reusing program was not well-defined during the original component development, or simply a well-designed component was deemed suitable for use within another product. The HITS TOC2 has identified a few areas for opportunistic reuse such as 3D mapping functionality and Player Unit to CTIA Interface.

There are also different manners in which a component can be reused:

- **Complete**: In this case, the reusing product uses the common component "as is" without modification. Use of this component requires no additional development effort by the using product.

- **Extended, New Version**: The common component is "extended" in some fashion to create a new extended version of the reused component. The extended version maintains backward compatibility with the reused component. The majority of the HITS TOC2 effort shall require component extensions primarily to increase usability of the components for Homestation training.

- **Extended, New Component**: The common component is "extended" in some fashion to create a new component that has been based on the reused component. The new component then becomes an additional component that meets other requirements with new functionality and interfaces. This process can occur with varying amounts of reuse from the original component, but focuses on adding new functionality to the new component which warrants making it a separate "new" component. Some examples of extended new components include CTIA Lite Services Frameworks derived from the original set of CTIA services and GUI Frameworks, and Force Structure component used to build entities within the simulation.

LT2 HITS REUSE PLANNING AND ANALYSIS

The HITS is an instrumentation system capable of monitoring real time live, constructive and virtual simulation exercises for the purposes of data collection, analysis, and review. Data is collected while monitoring, controlling, and recording the force-on-force or force-on-target engagements that occur in the battlefield environment. The instrumentation will be capable of supporting live and virtual exercises.

Functionally, the instrumentation is divided into three main groups:

- The Training Operations Command and Control (TOC2)
- The Instrumented Player Unit (IPU)
- The Range Digital Communications System (RDCS)

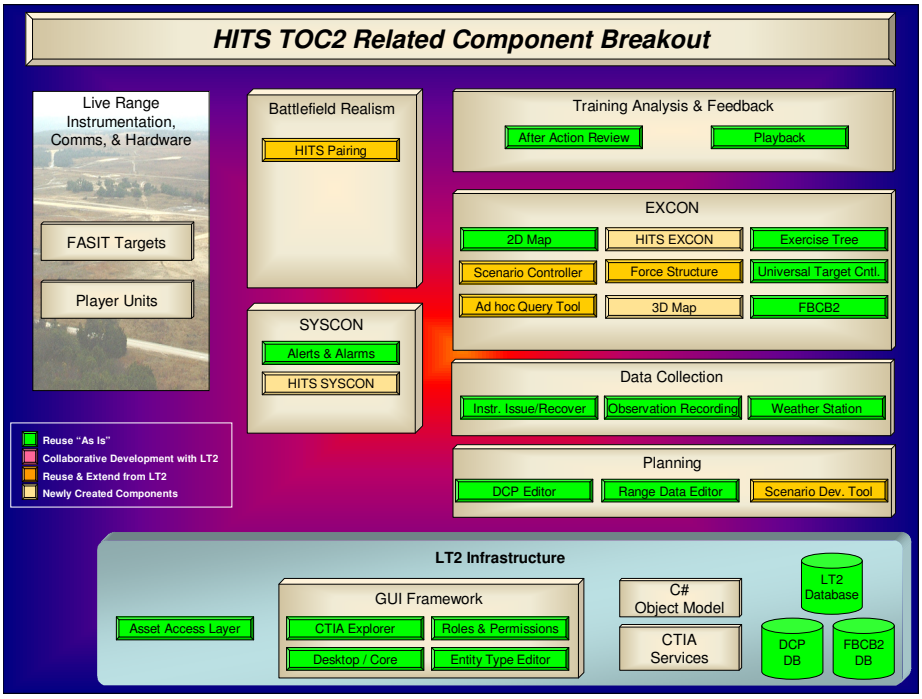

Figure 5. HITS notional framework.

The foundation for the HITS program is derived from this evolutionary development approach and detailed LT2 HITS requirements domain analysis that was conducted by PEO STRI to ensure the feasibility of developing a prototype HITS with limited resources, figure 5. The HITS specification is derived from the LT2 set of Product Line Component Specifications (PLCS) captured in the Component Agreements traceable to the HITS ORD and requirement traceability matrix database, called the Domain Object Model (DOM).

Program analysis working groups, composed of representatives from PEO STRI, LT2 support staff, and the HITS program itself were created to perform the requirements and component reuse analysis. The HITS program developed a capability matrix that captured available, existing LT2 component functionality; components currently under development within LT2, and additional existing functionality available through LT2 legacy training products currently fielded at Homestation sites. It was estimated that 80-90% commonality was available from the LT2 Portal Repository including the common CTIA architecture and significant number of LT2 components designed to meet the requirements of the newly created HITS performance specification. The capabilities matrix served as a starting point for evolving a HITS program development strategy that included discussion on proposed development options to field incremental HITS capabilities until an Objective HITS capability is fielded.

HITS development strategy shall occur in three phases. Figure 6 provides a high level view of the projected way ahead for the HITS development strategy. Phase I has completed a requirements analysis effort for the HITS TOC2 capabilities, HITS performance specification, and HITS development strategy plan. Phase II is broken into three parts. Phase IIa shall demonstrate integrated LT2 functionality from the ranges within the TOC2 reuse program effort. Phase IIb shall demonstrate a functional HITS prototype system at the Fort Bliss training range that shall support a permanent leave behind training capability. Phase IIc approach shall provide the necessary extensions to field an Objective HITS training capability at Fort Bliss and potentially leverage Fort Bliss capabilities for follow-on acquisitions at Homestation ranges, such as Fort Wainwright in Alaska. The results of each phase support necessary assumptions to estimate resources required to complete follow on phases.

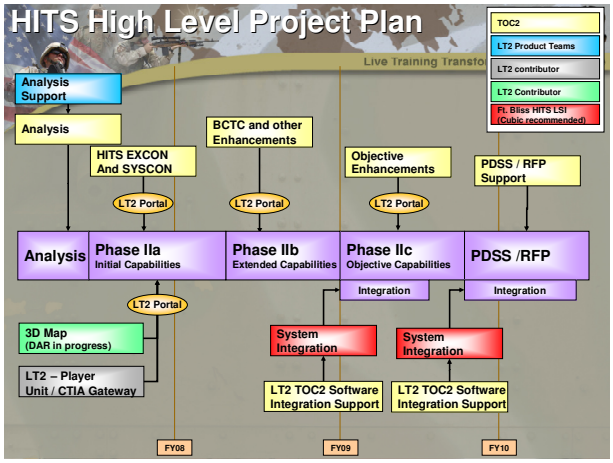

Figure 6. HITS development strategy

The LT2 TOC2 requirements call for the development of new components and the integration of existing software and hardware products to create reusable core assets for the Army's HITS TOC2 and linking LT2 TOC2 software with existing PEO STRI instrumentation systems providing an integrated training capability. The LT2 TOC2 components will be available for integration into host Live LT2 Training Aids, Devices, Simulators, and Simulations (TADSS) that will undergo development or upgrade based on emerging requirements.

The TOC2 incremental development approach will extend or create more then 30 LT2 component capabilities within the following LT2 functional areas: exercise management and control, system control, and after action review. The component extensions will focus on increasing usability of the system through the development of Homestation perspective views. A perspective is a view into an Exercise that an operator would use during the corresponding system state. Perspectives are used to easily bring up layouts with the most common components used during a state of the system to complete the given task to move on to the next state. Switching between perspectives will be accomplished by selecting appropriate perspective from the menu in the desktop. A key advantage to the perspective views allows a user with less system training to be "guided" through the system operation with supplemental help and guidance by means of a wizard and auto-completion scripts while using the identical screens of standard LT2 components. In operation this allows an expert user to easily access and review all available details, but allows a less familiar user to adequately function within the same context of screens.

New TOC2 concepts and new components will be discussed within the LT2 working groups and made available to other LT2 products through the portal enabling usability improvements across LT2 FTS. The TOC2 program will mine for new components from existing legacy Homestation training systems (i.e. 3D map) and will collaborate with designated HITS Large System Integrators (LSIs) to provide the necessary interfaces allowing future TOC2 integration with fielded Homestation instrumentation targeting Fort Bliss as the first site in FY08. The TOC2 software will migrate towards objective HITS capabilities that may also provide reuse benefits for future OneTESS stand-alone requirements and future deployable live training capability.

LT2 HITS PRODUCT LINE BENEFITS

The HITS program development strategy provides significant benefits to the Army in areas concerning acquisition costs, schedule, and technical performance. The development costs are reduced because of the existing 80% to 90% derived TOC2 software solution is already provided by the LT2 programs that have developed and distributed LT2 core software assets (common architecture and components) via the LT2 Portal.

The HITS developers have gained experience, training, and additional expertise working previous collaboration efforts increasing productivity rates as each new product was introduced into the Product Line. The HITS TOC2 software extensions provide additional

capabilities to LT2-FTS in area of usability. The HITS maximizes operational efficiency and LT2 common look and feel through the development of perspective views for the training operator simplifying control of the training environment. The HITS program supports a faster fielding schedule because the TOC2 solution requires small modifications that can be quickly integrated with existing range instrumentation into a HITS prototype and be fielded as a training system. The majority of the HITS training capability has already been tested and validated in other CTC and Instrumented range environments ensuring high quality and reliable HITS product. The establishment of an organizational structure and infrastructure to support all product line development activities provides improved decision making, risk reduction, and common solutions that can be used by HITS such as the TOC2 solution and approach.

LT2 HITS LESSONS LEARNED

This section discusses management issues that have been encountered by PM TRADE during the execution of the LT2 HITS program. It also proposes a set of management guidelines that should be considered when executing a product-line, based on LT2 experiences.

Stakeholder expectation management- Different stakeholders have their own needs from the product line. Therefore, their expectations and priorities are not the same and sometimes are in competition. An approved and recognized management structure, that resolves problems and priorities, is vital for the success of a product line approach. HITS program stakeholder expectations are initially derived from both the availability of LT2 core assets, LT2 product line goals, and Fort Bliss Training range requirements. Currently the Fort Bliss training concept includes unique capabilities that extends beyond the current LT2 HITS definition and capabilities planned to be fielded at all future Homestation sites. Stakeholder expectations need to be managed to ensure the Army can extract a common HITS capability from within the Fort Bliss future HITS that will support combined intra Army and Joint LVC training solutions. The LT2 goals shall be to derive common training and interoperability solutions with Government ownership that can be reused by the LT2-FTS product line to the maximum extent possible while minimizing single point solutions. It is crucial to show the benefits to management and the specific products/systems teams so that the initial investment can be defended and executed. The product line management structure, defined in our LT2 PLM CONOPS, constantly evaluates these conflicting needs and determines, objectively, the best course of action from the Army and customer perspective while balancing the need to achieve the product line goals. To successfully manage these constant conflicting objectives, an experienced product line manager, with good leadership skills, is required to maintain the product line vision, establish realistic goals, sustain morale, and solicit feedback to continuously improve the process**.**

Funding – Institutionalization of a product line is a long term effort that requires years to achieve and a well defined and stable funding flow. Current funding process is focused on delivering systems that support the Soldier now, as it should, and balancing with latest DoD needs, in addition to constantly facing budget cuts. Therefore, clearly communicating the need and the dependencies of each product line component against each of the products/systems is critical in defending funding cuts since resources are normally associated with a system/product and not with pieces/components that will be shared and reused by many. In the HITS use case, we are able to leverage from existing Instrumented Ranges and Combat Training Centers development efforts allowing management to provide more accurate estimates to complete a HITS prototype based on actual work completed and experience fielding LT2 products. The LT2 product line approach allows the flexibility to reallocate resources from existing legacy programs to easily extend completed LT2 common software into a TOC2 application that can be reused by HITS program and potentially other future LT2 programs such as OneTESS. The LT2 HITS supports an incremental development approach with respect to supporting reuse and extensibility of components when resources cant be provided upfront that still provides benefits to the product line. We have found the LT2 management infrastructure very useful to oversee the overall funding availability, resolve funding issues, and provide recommendations on how to quickly adapt the plan to execute the product line.

Product line management Concept of Operations (CONOPS) – The HITS program is managed with PM Trade by PM CTIS organization. The common TOC2 software application for future HITS is managed by APM LT2. It is essential that CONOPS communication mechanisms and dedicated empowered personnel are defined within the management infrastructure to ensure dependency expectations are met within cost, schedule, and technical performance for the LT2 organization. HITS management issues are discussed and resolved via Executive Steering Committee (ESG) and unresolved management issues are addressed via Board of

Directors (BOD). New HITS technical concepts and extensions are introduced via Common Component Working Group (CCWG) for reuse and standardization analysis by the other LT2 programs and technical issues affecting multiple programs are resolved. Unresolved technical issues are addressed by the Technical Advisory Board (TAG) in coordination with ESG. Common Component changes may result in CTIA architecture modifications handled within the AWG using the Architecture Change Process (ACP). The HITS program derives great benefit from existing defined, implemented, and approved CONOPs that will ensure success in acquisition strategy and increase product performance at lower cost, and shorten time to product fielding. Communication between product teams, stakeholders, and ensuring all product line teams are following common processes is key to success for the product line.

Getting competitive contractors working together - A clear definition of the goals, the architecture/framework, and each component, to include requirements, security, documentation, testing, design, etc is a key so that information can be placed on contract. The HITS program shall include multiple contracts and contractors working together. The TOC2 contractor shall be required to collaborate with HITS LSI contractor for Fort Bliss and future LT2 HITS acquisition efforts. In addition, to support TOC2 verification efforts with legacy Instrumentation Systems (IS) fielded at Fort Bliss in support of prototype development, the TOC2 contractor shall require Subject Matter Expertise (SME) from multiple contractors to ensure success. The TOC2 development effort shall also support mining components from existing legacy systems where capabilities have yet to be developed by LT2. A challenge for DoD PMs is to motivate contractors to buy into a product line approach since it may sometimes conflict with contractor's business models. However, contractors can still contribute to the Product Line technology insertion needs based on contractor expertise in a specific technological area and Government management care to protect each contractor's business model. The Government has a need to keep their industry base interest on the product line strategy. This needs to be done by constantly demonstrating the product line benefit, not only to the Army but to industry as well so that they support the concept and influence their own internal research and development investment toward the product line.

Metrics – LT2 has derived a set of metrics using the Goal-Question-Metric (GQM) method. GQM is used to define measurement in such a way that:

- Resulting metrics are tailored to the LT2 organization and its goals
- Resulting measurement data play a constructive and instructive role within the LT2 Product Line
- Metrics and their interpretation reflect the values and the viewpoints of the different groups affected (e.g., PM TRADE management, developers, and users)

LT2 metrics that benefit the HITS program include amount of reusable software common to the multiple LT2 programs allowing cost avoidance savings estimates dependent on the targeted HITS common components reused. In addition, requirements metrics are tracked based on implementation to date for each component and cost to build each component. LT2 metrics also track program dependencies relative to component needs, costs and schedule to build. All relevant product line metrics shall be accessible via the LT2 Portal in the future. The availability of LT2 metrics allows the HITS team to better continuously forecast future life cycle costs and estimates to complete program acquisition based on current available LT2 capabilities.

Success criteria – In the case of LT2 HITS, an incremental phased approach is being followed based on future HITS requirements and Fort Bliss training range requirements. A HITS performance specification derived from applicable Product line requirements traceable to the ORD shall be used to define domain scope for HITS. The product line execution plan should be incremental to allow for early fielding of some of the capabilities. For HITS, the plan allows for early integration of TOC2 within the existing Fort Bliss Instrumentation System supporting an early HITS prototype fielding effort. This will allow for not only the maturation of the product, but also keep the interest of the community and stakeholders/investors. It will show progress and viability of the final goal. You should be ready to show small successes throughout the product line development so that you can get long term investment commitment for the future.

Teaming – The HITS program includes teams of contractors developing TOC2 product line components. It includes Government program teams, within the product line domain, working together to leverage new TOC2 capabilities for the product line assets. It includes Government and contractors working together as a team toward a common goal, where the Government is sensitive to the each contractor's business model and the contractor is sensitive to Government's HITS funding constraints.

CM and requirements baselines – The initial HITS development phase looks to extract all available LT2 software from the LT2 portal and uses the portal collaboration forums to work with Government and other contractors to produce a product that will also be distributed through the Portal. The Portal provides HITS program the means to analyze existing solutions for integration within the HITS product and allows notification and distribution of new solutions provided by HITS. By maintaining knowledge of existing requirements through Component Agreements documentation at any time in the life cycle, HITS program can minimize requirements creep. The LT2 Portal can provide an 80% or grerater solution for the TOC2 effort which can be extended for HITS. HITS prioritization of requirements can be allocated in phases or increments addressing most important critical requirements first likely ensuring program 80% of what is required.

Cost Avoidance Data – The HITS program is the third product planned to be fielded by the product line after Instrumented Ranges and CTC-OIS. This allows HITS to reap the benefits of prior development and proof of concept efforts. The HITS product will produce large cost avoidance data due to the minimal development costs resulting from starting from an existing software mature baseline and the small amount of extensions needed due to overarching commonality of capabilities and training requirements across the LT2 product line. Maintenance (supportability) cost savings aspect is another cost avoidance data set that should be readily available based on sustainment of same components verified once and used by multiple products.

ACKNOWLEDGEMENTS

The authors wish to thank COL James Ralph, Project Manager Training Devices (PM TRADE), Mr. Wayne Koenig and COL Whitehead, Training and Doctrine Command (TRADOC) Program and Integration Office (TPIO) – Live, and Mr. Robert Parrish, Director Live Engineering Division, PEO STRI for their vision, contributions and assistance in the evolution of the LT2 product-line.

REFERENCES

Dumanoir, P., Rivera, J. (2006). Component-Based Software Reuse Strategy for Army Live Training Ranges. 2006 Simulation Interoperability Workshop (SIW).

Homestation Instrumentation Training System (HITS) Development Strategy, Version 1, (2007). Orlando FL: U.S. Army PEO-STRI.

HITS System Architecture and Design, Version 1.0, (2007). Orlando FL: U.S. Army PEO-STRI.

Combat Training Center-Objective Instrumentation System (CTC-OIS) web site. Retrieved 2005 from http://www.peostri.army.mil/PRODUCTS/CMTC-OIS/

Common Training Instrumentation Architecture (CTIA) web site. Retrieved 2006 from https://ssl.peostri.army.mil/CTIAPortal/index.jsp

Dumanoir, P., Rivera, J. (2005). *LT2- A Strategy for Future Army and Joint Live Training*. 2005 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando Florida.

FM 7-0 Training the Force (2002). Washington DC: Headquarters Department of the Army. http://www.army.mil/features/FM7/FM%207-0.PDF

Instrumented Ranges (IR) web site. Retrieved 2005 from *http://www.peostri.army.mil/PM-TRADE/dmprc.jsp*

Live Training Transformation (LT2) Developers Guide, Version 4, (2006). Orlando FL: U.S. Army PEO-STRI.

Live Training Transformation (LT2) DRAFT Configuration Management (CM) Plan, V0.3, (2006). Orlando FL: U.S. Army PEO-STRI.

Live Training Transformation (LT2) DRAFT Metric Plan, V0.4, (2006). Orlando FL: U.S. Army PEO-STRI.

Live Training Transformation (LT2) HCI Style Guide Version 2.1 (2004). Orlando FL: U.S. Army PEO-STRI.

Live Training Transformation (LT2) Product Line Management Concept Of Operations, Version 4, (2006). Orlando FL: U.S. Army PEO-STRI.

One Tactical Engagement Simulation System (OneTESS) web site. Retrieved 2005 from http://www.peostri.army.mil/PRODUCTS/ONETESS