Live Synthetic Training and Test & Evaluation Infrastructure Architecture (LS TTE IA) Prototype

Paul Dumanoir, Mike Willoughby

U.S. Army PEO STRI

Orlando, FL

paul.h.dumanoir.civ@mail.mil, michael.b.willoughby.civ@mail.mil

Burt Grippin, Richard Crutchfield, Rob Wittman, Sean Barie

MITRE Corporation

Orlando, FL

bgrippin@mitre.org, crutchfield@mitre.org, rwittman@mitre.org, sbarie@mitre.org

ABSTRACT

This paper describes the Live Synthetic Training and Test & Evaluation Infrastructure Architecture (LS TTE IA) prototype. The LS TTE IA was funded by PEO STRI and AMSO in FY14 with the intent of providing a technology insertion into LVC-IA, replacing the existing infrastructure with a cloud-enabled service-oriented architecture (SOA). This SOA infrastructure is being developed with the expressed goal of supporting both the Training domain and the Test & Evaluation community. It will be compliant with the Common Operating Environment (COE) and suitable for hosting within the COE Data Center/Cloud Computing Environment. The prototype architecture was developed in collaboration with Johns Hopkins University's LS TTE Enterprise Architecture (LS TTE EA) research which explored the business case and governance strategy for managing a SOA environment. The LS TTE EA is described, as well as the relationship of the LS TTE IA to the reference architecture of the LS TTE EA.

This paper explains the SOA prototype layered architecture, and the initial services developed in FY14. Two concurrent projects under development in FY14 developed services that operate on the LS TTE IA infrastructure. This paper will briefly discuss those projects and their successful use of the infrastructure. Finally, the paper will discuss the planned FY15 infrastructure improvements and the forward looking implementation strategy.

ABOUT THE AUTHORS

Paul Dumanoir is the Chief Engineer for the United States Army Product Manager for Warrior Training Integration (PdM WTI) under the Project Manager for Integrated Training Environment (PM ITE) at PEO STRI. He is currently the PM ITE Risk Reduction Test Bed project manager and has 26+ years of experience working in Army and DoD simulation and training programs as Product Manager, Project Director, and Systems / Software Engineer. His current interests include component-based product-line engineering, enterprise architectures, and system of system integration and interoperability. He earned his B.S. in Electrical Engineering from the University of South Alabama in 1987 and his M.S. in Computer Systems from the University of Central Florida in 1991.

Mr. Michael Willoughby is the Chief Engineer of the US Army Project Manager for Instrumentation, Targets, and Threat Simulators (PM ITTS) Instrumentation Management Office. He has over 26 years of service as a Department of the Army Civilian with over 20 years of acquisition experience. Previous assignments include PM for Rapid Data Generation and Deputy Director for the Joint Training Integration and Evaluation Center. Mr. Willoughby received his BS and MS degrees in Industrial Engineering from Auburn University and Texas A&M University.

Burt Grippin is a Lead M&S Engineer for the MITRE Corporation in Orlando, FL. He has 20 years of M&S and systems engineering (SE) experience working with U.S. Department of Defense (DoD) programs. He is currently the project leader supporting the U.S. Army Program Executive Office for Simulation, Training and Instrumentation (PEO STRI) for the Integrated Training Environment (ITE). He holds a B.T. in Electrical Engineering Technologies from Binghamton Univ.

Richard Crutchfield is the Group Leader of the Army Training & Learning Technologies Group at the MITRE Corporation in Orlando, FL. He has been part of the U.S. DoD M&S community since 1992 and supported on Combat Services Support Training Simulation System (CSSTSS) II, Advanced Distributed Simulation Technologies (ADST) II, Fire Support Combined Arms Tactical Trainer (FSCATT), Warfighter Simulation (WARSIM), Army Constructive Training Federation (ACTF), Joint Land Component Constructive Training Capability (JLCCTC), and other M&S activities. He is currently the MITRE Project Lead for the Analysis of Alternative for the Army Training Information System. He holds a B.S. in Mathematics with a minor in Computer Science from Columbus State University of Georgia.

Robert L. Wittman Jr. currently works for the MITRE Corporation as the Simulation Engineering Department Head. He has been part of the U.S. DoD M&S community since 1990 and with MITRE since 1992 starting out as a graphical user interface programmer and system analyst for the TACWAR aggregate analytical simulation system. He has worked as systems analyst, chief software engineer, and software architect on Joint and Army training and analytical simulations systems including: TACWAR, the Joint Theater Level Simulation System (JTLS), the Joint Simulation System (JSIMS), OneSAF, and Joint Urban Test Capability. He holds a B.S. in Computer Science from Washington State University, a M.S. in Software Engineering from the University of West Florida, and a Ph.D. in Industrial Engineering from the University of Central Florida.

Sean Barie is a Senior Software Engineer for The MITRE Corporation in Orlando, FL. He has 10 years of software development experience in Modeling and Simulation working with U.S. Department of Defense (DoD) programs. He is currently the software lead supporting the U.S. Army Program Executive Office for Simulation, Training and Instrumentation (PEO STRI) for the Live Synthetic Training and Test & Evaluation Infrastructure Architecture (LS TTE IA). He holds a B.S. in Computer Science from Plattsburgh State Univ.

Live Synthetic Training and Test & Evaluation Infrastructure Architecture (LS TTE IA) Prototype

Paul Dumanoir, Mike Willoughby

U.S. Army PEO STRI
Orlando, FL
paul.h.dumanoir.civ@mail.mil,
michael.b.willoughby.civ@mail.mil

Burt Grippin, Richard Crutchfield,
Rob Wittman, Sean Barie
MITRE Corporation
Orlando, FL
bgrippin@mitre.org,
crutchfield@mitre.org,
rwittman@mitre.org,
sbarie@mitre.org

BACKGROUND

The Integrated Training Environment (ITE) is a system of systems that, by design, combines and connects key training enablers in a persistent and consistent manner to accurately train Mission Command (MC) according to the Commander's training objectives within the appropriate operational environment. The Army is currently evolving the ITE system of systems and it is comprised of a growing number of programs of record (POR). These PORs include the Live, Virtual, Constructive Integrating Architecture (LCV-IA) which is the infrastructure software and supporting standards, and various PORs for live, virtual, constructive, and gaming Training Aids, Devices, Simulators, and Simulations (TADSS).

In parallel, the Army is proposing a new approach to delivering training called the Synthetic Training Environment (STE). While the STE concept is in its infancy, the Deputy Commanding General, Combined Arms Center – Training (DCG CAC-T) has defined key attributes of it in a recent Memorandum for the Record (Lundy, 2014). Some of the key attributes include a single synthetic environment integrated with the live environment that is accessible anywhere using fewer resources.

Also in parallel, the US Army Operational Test Command generated a requirement for new capabilities necessary to conduct operational testing called the Integrated Live Virtual Constructive Test Environment (ILTE). Operational Test Command, and its Materiel Developer, Program Executive Office, Simulation, Training, and Instrumentation (PEO STRI), envision ILTE as a system of systems with many similarities and commonality with ITE and STE. The proposed ILTE acquisition strategy includes leveraging existing and emerging Army TADSS to the greatest extent practical.

PEO STRI faces the technical challenge of how to migrate from the current ITE to the STE, and at the same time accommodate the needs of the testing community. PEO STRI and MITRE believe that a key to meeting this challenge is the establishment of a new infrastructure that includes cloud or data center delivery combined with a service oriented architecture (SOA) and a web framework that uses commercial technologies.

This paper describes the Live Synthetic Training and Test & Evaluation Infrastructure Architecture (LS TTE IA) prototype. PEO STRI and the Army Modeling and Simulation Office (AMSO) in FY14 funded the LS TTE IA with the intent of providing a technology insertion into LVC-IA, replacing the existing infrastructure with a cloud-enabled SOA. This SOA infrastructure is being developed with the expressed goal of supporting both the Training community and the Test & Evaluation community. It will be compliant with the Common Operating Environment (COE) and suitable for hosting within the COE Data Center/Cloud Computing Environment (ASA(ALT), 2013). The prototype architecture was developed in collaboration with John Hopkins University's LS TTE Enterprise Architecture (LS TTE EA) research that explored the business case and governance strategy for managing a SOA environment. The LS TTE EA is described, as well as the relationship of the LS TTE IA to the Reference Architecture of the LS TTE EA.

OPERATING CONCEPT

The use of the LS TTE IA constitutes a paradigm shift in many fundamental ways from the past use of Army Live Virtual and Constructive simulation. This paradigm shift is away from a user intense system through all phases of use, to include hardware and software installation, configuration, execution, and breakdown. This shift is supported by two concepts: the promise of Software as a Service (SaaS) and the power of process modeling. The LS TTE IA is designed to allow for agile development of new solutions and capabilities to rapidly support new uses as they are defined and discovered. The following subsections provide a few notional use cases contrasted against normal use of LVC simulations in Army training today.

Software as a Service

The LS TTE IA is architected to deliver its capability via SaaS. The current process of physically emplacing and installing hardware is a relic of the past; now deprecated by the capabilities of the virtual data center. The LS TTE IA uses a standard Application Program Interface (API) to provision the computational resources required to deliver the simulation services to the appropriate audience. Information technology (IT) automation tools replace the role of the technician to install the operating system, supporting platforms, and applications. IT automation tools load the appropriately configured operating system, install and configure the supporting platform, and install the necessary applications. In the past, this effort to get a "blank slate" installation in place might take two full time technicians 10 days to complete. With IT automation, it is completed without human error in tens of minutes. The effort to make this a reality is not a trivial undertaking in up front development costs – however, the return on investment over the life of the system justifies the expense. The components of the LS TTE IA supporting the auto provisioning capability will be further described in the high level design section of this document.

Technical Control

The role of technical control, also known as tech control, is far-reaching and pervasive in today's Army training environment. The role is responsible for ensuring that all aspects of the information technology that supports an exercise are available during execution of a training exercise. The design and implementation of today's flagship training systems drives the need for this role. The LS TTE IA seeks to minimize this need for a highly trained tech control staff through process automation. The technical control functions, such as scenario generation, simulation control, and technical after action review, are captured in process models for standard execution. This reduces the cost via a reduced tech control staff. Considerable effort is required to capture the technical knowledge required to properly support the execution of an exercise. However, embedding this knowledge in executable process models will result in a return on investment over the lifecycle of the system.

Notional Scenario Generation Process

The Scenario Generation process commonly used today involves considerable effort and interaction with military training experts, exercise control experts, and tech control operators. The process model below, which is documented using the standard Business Process Model Notation (BPMN) version 2.0, shows two notional workflows for scenario generation. The first shows a more manual flow for generating a scenario as is commonly accomplished today. The second identifies automation that can be accomplished in the LS TTE IA. The same automation could be accomplished without the LS TTE IA; however, it can be more easily accomplished with the LS TTE IA capabilities.

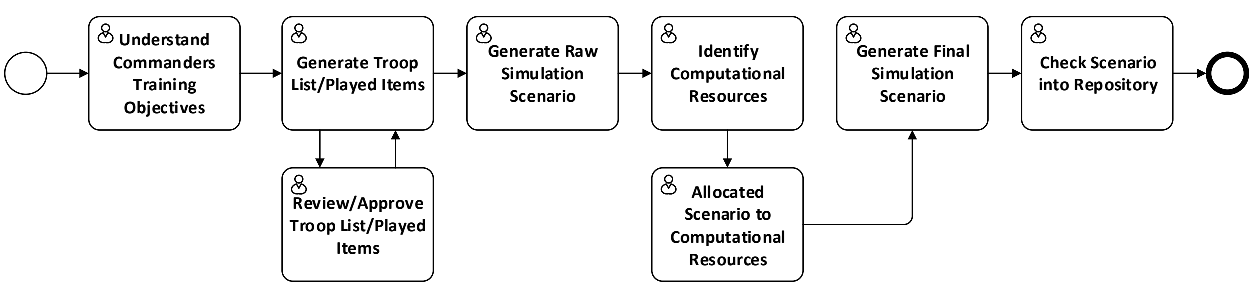

Figure 1 – Manual Scenario Generation

The manual scenario generation process in Figure 1 shows each task with a human actor icon in the upper left corner of the box. This is meant to signify the human is primarily responsible for accomplishing the given task. The automated scenario generation process in Figure 2 describes the same process with automation incorporated into the work flow, as depicted by a gear or data file icon in the upper left corner of the box. While not optimal, the latter can be viewed as an incremental step toward automating a manually intense process. The user is still primarily responsible for the first few tasks. Thereafter, full automation can generate the scenario and place it in the repository after the troop list and played items are approved. To explain better the automated flow, a 'gear' icon indicates a service in the LS TTE IA performs this task. In our example, the system would automatically generate a raw scenario and pass it to the next step in the process after approval of the Troop List/Played Items. The next step shows a 'table' to indicate business rules are accomplishing this task. For example, the business rules may limit the number of computational resources allocated for the virtual data center pool based on funding or other constraints. The remaining tasks are fully automated using services managed by the LS TTE process modeling capability.

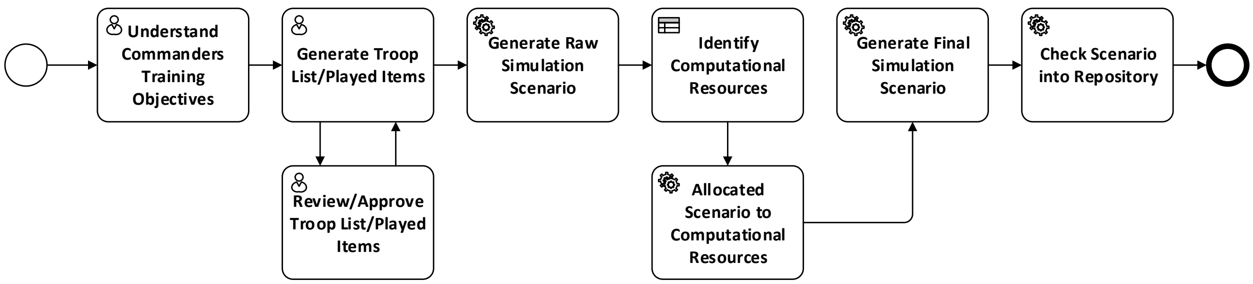

Figure 2 – Automated Scenario Generation

We contend that the use of an executable process model also provides a means of allowing domain experts to capture domain knowledge for future execution. It removes the requirement for the information technology expert to interpret, translate, and codify the domain experts' knowledge. The potential cost savings of this approach are tremendous.

ENTERPRISE ARCHITECTURE

The sponsor requested Johns Hopkins University (JHU) to conduct a parallel research effort to explore and refine aspects of the Enterprise Architecture (e.g., Business Model, Return on Investment, Governance) and the Reference Architecture of the LS TTE. The JHU research would explore the feasibility of an enterprise wide SOA-based system meeting the combined needs of the Army training and Test & Evaluation communities. The live training community has already embarked upon a journey to implement a SOA based system, the Live Training Transformation (LT2) Common Training Instrumentation Architecture (CTIA) Objective Architecture (Live Training Transformation, 2013). Based on the initial success of the live community, a derivation of this architecture was used by the sponsor to define a starting point for the LS TTE EA. The final LS TTE EA developed by JHU is shown in Figure 3.

Reference Architecture

The LS TTE IA effort was directed to focus on the information technology aspects of the LS TTE EA, which is reflected in the Reference Architecture aspect of the Enterprise Architecture**.** The Open Group Technical Standard for SOA Reference Architecture (The Open Group, 2011) defines a common vocabulary and best practices to implement a SOA. The standard has nine layers to group important considerations and responsibilities that are typically considered when designing a SOA-based solution. We used each of these layers and their associated capabilities and architectural building blocks to derive a domain specific SOA implementation. The architectural design developed during this research effort was communicated to JHU for synchronization with the Reference Architecture.

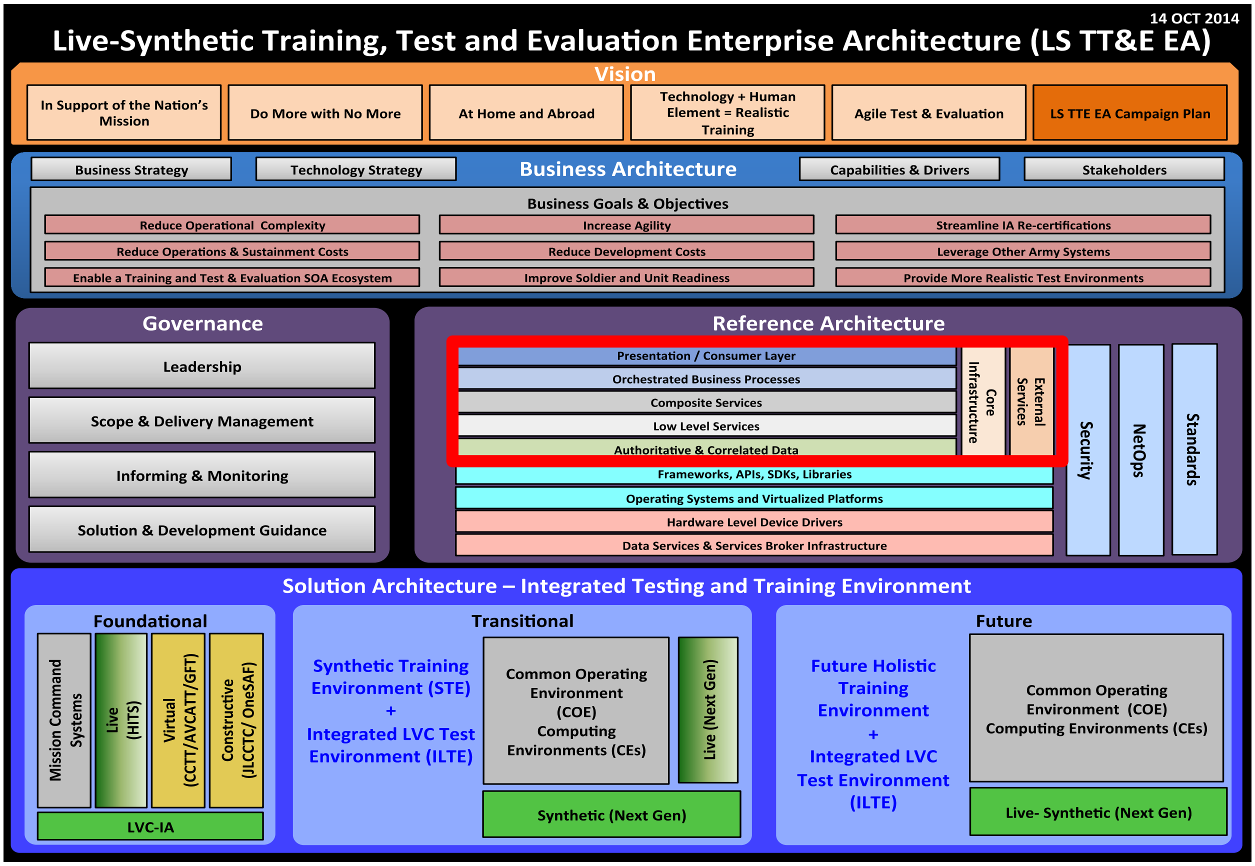

Figure 3 – LS TTE-Enterprise Architecture

INFRASTRUCTURE ARCHITECTURE

The LS TTE IA prototype is the initial implementation of the LS TTE Reference Architecture. The application layers within the red box in Figure 3 are implemented by the LS TTE IA prototype. The COE Data Center environment provides the surrounding layers of the Reference Architecture.

Layered Architecture

The LS TTE IA prototype is a domain specific implementation of the SOA Reference Architecture. The high level architectural design of the prototype is depicted in Figure 4. Five horizontal layers, two vertical layers, and an external layer representing existing systems represent the architecture. These logical layers act as a separation of concerns so a more loosely coupled system is achieved. In general, communication between layers is accomplished only with directly adjacent layers. This rule is relaxed as a constraint on a case-by-case basis primarily to address potential performance concerns. The following subsections describe each layer and their relationships.

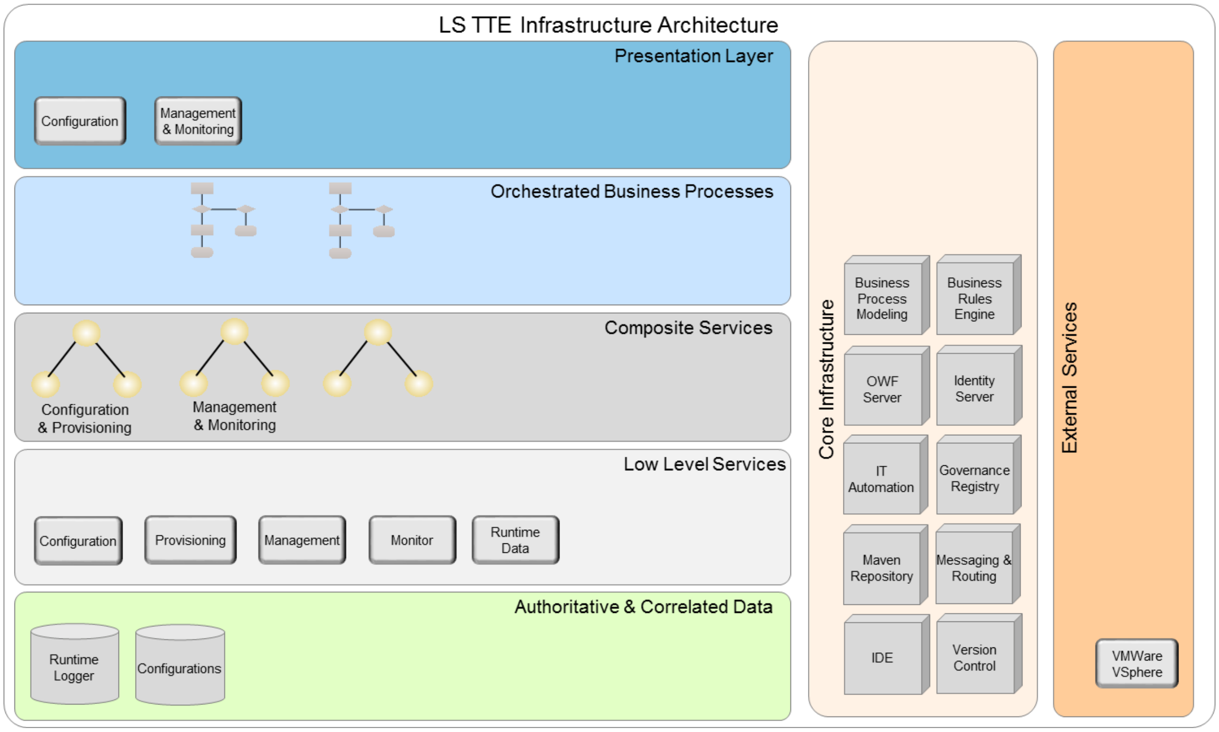

Figure 4 – LS TTE IA Domain Specific Architecture

Core Infrastructure Layer

The Core Infrastructure Layer provides many of the architectural building blocks required to realize a SOA. While the particular product and/or application used in the prototype to provide the core infrastructure capabilities is not necessary, one would expect to see similar capabilities in any SOA solution. The following subsections provide a brief description of the capabilities of the core infrastructure items.

Integrated Development Environment

The integrated development environment (IDE) is important to assist the developers in defining and developing services, composite services, process models, and other artifacts of the system. In conjunction with the governance registry, the artifacts can be exposed with IDE generated industry standard descriptions such as Web Services Description Language (WSDL) or Web Application Description Language (WADL). The prototype made use of the Eclipse IDE.

Version Control

The use of a version control system is an industry best practice. It is used as a developer tool in managing the source code baseline, supporting multiple service definitions, and other configuration management tasks. The Apache Subversion was used in the prototype (also note that it is fully integrated with the Eclipse IDE).

Maven Repository

The open source community maintains a central Maven Repository with ready packaged, versioned releases of popular open sources artifacts. The LS TTE IA added a repository manager, Artifactory, to act as a proxy to and to cache artifacts from the central maven repository. This also allowed the developers to share readily locally developed, ready packed artifacts. Moreover, even though not implemented in the initial prototype, this local Maven Repository manager helps support a continuous integration practice in the future. This is a component of an agile build environment.

Information Technology Automation

The IT automation has several key functions in the LS TTE IA. The IT automation component is a configuration management tool that interfaces with the virtual data center's APIs. These APIs are used to provision the computational resources and configure new machines (i.e., Operating Systems) and platforms (i.e., LAMP Stack, Apache Service Mix) necessary to support the LS TTE system. This capability covers the initial boot strap of the system as well as the dynamic provisioning to provide transient capabilities. The Chef product was used to support this capability in the LS TTE IA prototype.

Ozone Widget Framework Server

The Ozone Widget Framework (OWF) "is a web application that allows users to easily access their online tools from one location" (Ozone Widget Framework, n.d.). Among others, it serves as a capability for developing dashboards to support the SOA (i.e., Monitoring Metric Tools). It is fully integrated with the identify server to manage users' authentication and authorization based on defined roles. While there are other products and applications that can provide this capability, we were influenced to explore its use by three factors:

- The COE Data Center Computing Element Compliance document has a guideline (G-6) to use OWF hosted in the cloud.
- The US Congress mandated the framework be released to the public as open source (National Defense, 2012).
- The US Army mission command systems are using the framework.

Governance Registry

The governance registry is a central component of any SOA. It is where the service contract and descriptions are published in a standards-compliant manner to support both the developer at design-time and also the system at runtime. As the SOA implementation matures, it also provides for virtualizing runtime service access. While a common standard for registries is Universal Description, Discovery and Integration (UDDI), we have selected the WSO2 Governance registry that supports UDDI and other standards that are in use in industry today.

Identity Server

The proper security measures are essential to successfully providing an enterprise SOA solution. The WSO2 Identity Server fills this role in the LS TTE by providing security and identity management for web applications, services, and APIs. The server provides industry standard role-based access control (RBAC), fine-grained policy based access control, and Single Sign-on (SSO) bridging. While we have not taken full advantage of all of the capabilities provided, the design lends itself to supporting additional security measures. The Identity Server has been integrated with the OWF as the initial entry point for users of the LS TTE.

Messaging and Routing

The Message and Routing capability is primarily used to implement the industry best practice of Enterprise Integration Patterns (EIP). This provides agility and flexibility in communicating between services and applications in the architecture. Apache Service Mix (ASM) was chosen to implement this capability within LS TTE IA.

Business Process Modeling

The SOA enables business process modeling. Business process modeling defines an orderly execution of activities to achieve a well-defined objective. The processes can use the services provided by the SOA to help achieve the objective. These processes can be quickly modified to adapt to changes and optimize efficiency. This capability allows the capture of domain knowledge in an executable format. jBPM, which can execute business processes defined in BPMN 2.0, was chosen to implement this capability within LS TTE.

Business Rules Engine

The business rules engine allows the definition of rules to dictate how the system works at runtime. The rules can be used to manage policy, enforce operational constraints, or implement decisions. The business rules are integrated into the business process execution. For example, when a user attempts to approve a scenario as part of the scenario generation process, a rule may be evaluated to determine if all prerequisite criteria has been met prior to allowing. The LS TTE identified Drools as the business rules engine to implement this capability. This capability has not been brought into the current implementation of the LS TTE IA prototype.

External Services Layer

It is expected that the LS TTE IA will exist within a greater enterprise environment that offers enterprise services. Some of these services may be required or strongly recommended. Some of the external service one might expect to see is messaging and routing. It may be required for communication with other services and applications outside of the LS TTE IA enterprise. Security services may be required or leveraged. The intent of this layer is to expose and encourage the use of external services when available to meet needs of the LS TTE.

VMWare VSphere

VSphere is VMWare's cloud computing virtualization operating system. It provides the capability to abstract away server hardware resources and make them shareable by multiple Virtual Machines. LS TTE is leveraging this capability for the dynamic creation of Virtual Machines during the provisioning process.

Authoritative and Correlated Data Layer

The Authoritative and Correlated Data layer is meant to contain a source of trusted, accurate, and related data to be used by the system and its users. Many system architects believe the data layer should be behind services. We enforce this constraint for access to data from all but the Low Level Service layer. In the interest of performance, the Low Level services layer can use Java Persistence API (JPA), Java Database Connectivity (JDBC), Open Database Connectivity (ODBC), or similar standards based technology to interface with the Authoritative and Correlated Data layer. However, the Low Level Service layer is encouraged to access data through other services when performance requirements can be met.

Runtime Logger

The Runtime Logger database provides a common repository for service diagnostic and informational messages. Apache Service Mix, provides a runtime logger and LS TTE exposes it to all services built on the infrastructure. Logging level can be changed dynamically at runtime, which is beneficial when debugging issues.

Configurations

The Configuration database contains one or more configurations of the infrastructure. A configuration defines an instance of the infrastructure including all services deployed with that instance.

Low Level Services Layer

The Low Level Services layer is meant to contain services components. Each service component realizes one or more services and provides a functional and technical specification of the service. Generally, at this layer we do not expect any choreographing and/or orchestration of services. The services are registered in the Open Service Gateway initiative (OSGi) container's service registry for discovery by other services and component services. The service description is generally in the form of an interface definition. Though not the norm, services at this layer may also be registered as "outward facing" services in the SOA Governance Registry for direct external use.

Configuration Service

The Configuration Service manages configurations within the infrastructure. It provides the capability to create, modify, delete, and launch configurations within the Infrastructure. It is accessible via the Event Configuration web page within LS TTE.

Provisioning Service

The Provisioning Service creates and configures the Virtual Machines (VMs) required to support a given configuration. It creates the VMs from templates provided by the COE Data Center Computing Environment (DC CE). It installs the infrastructure software and all software required to support the services identified for the configuration. Once finished it launches the Virtual Machine(s) and the software contained within it.

Management Service

The management service is used by LS TTE to start and stop all services in the infrastructure. It is accessible via the Service Monitoring web page within LS TTE.

Monitor Service

The Monitor Service monitors the health of all services running within the infrastructure. This service gathers performance metrics including number of requests, average response time, and number of failed requests. It is accessible via the Service Monitoring web page within LS TTE.

Runtime Data Service

The Runtime Data Service maintains a cache of the last-published state of all objects active within the infrastructure. Provides publication and subscription support for all services that would send or receive data through the infrastructure. This service provides a single-point of subscription/publication, and routes published messages to all subscribing services.

Composite Services Layer

The Composite Services layer is meant to contain Composite Services, which are composed of multiple services from either the Low Level Service or the Composite Service layer. Generally, services at this layer will be composed using choreographed execution of other services without the use of an orchestrator. Another general characteristic of this layer is short lived execution. Similar to the Low Level Service layer, the Composite Services may be registered in the OSGi container's registry for discovery and are often exposed as forward facing services registered in the SOA Governance Registry for description, discovery, and integration.

Orchestrated Business Processes Layer

The Orchestrated Business Process Layer is meant to contain business process flows. The process flow is described using the BPMN and is decoupled from the underlying services used. These process flows are characterized by services being orchestrated by controller. They can include external business rules to customize and control the execution of the process flow. They can also be viewed as services and can support execution over a long period. This layer is where we get a clear separation of concern between the business and the information technology domains. The business analysis and experts can define the process using graphical tools with little or no programming expertise in a Domain Specific Language (DLS). Standardization of rule language is immature at this time though there are several initiatives in this area such as W3C's Rule Interchange Format (RIF), Object Management Group's (OMG) Production Rule Representation (PRR), and Haley Systems proposed rule language standard called RML.

Presentation Layer

The Presentation Layer is primarily used to allow interaction with the SOA. It is the point of entry of interactive consumers to include humans and other applications and external services. The intent of this layer is to provide multiple client-independent channels to deliver functionality to be consumed and rendered on client platforms and devices. End user applications can be supported through standard web interfaces (HTML5, JavaScript) or native applications. The following prototype user interfaces

Event Configuration

Front end web client that provides access to the capabilities provided by the Configuration Service. More specifically, the ability to create, modify, delete, and launch configurations.

Management & Monitoring

Front end web client that provides access to the capabilities provided by the Monitoring and Management Services. More specifically, the ability to start, stop, and monitor all services within the infrastructure.

PROTOTYPE SOLUTIONS

During the FY14 development of the LS TTE IA prototype, there were two Solution Development Teams (SDTs) that were working with the LS TTE IA. SDTs build services on LS TTE IA that provide solutions for their prospective users. Both of those efforts will continue in FY15 along with additional SDTs further broadening the LS TTE IA user community of interest.

JLCCTC Insight

Insight is a consolidated set of services built on the LS TTE IA that will replace a set of independent legacy tools that were used by the Joint Land Component Constructive Training Capability (JLCCTC) for federation management and control.

Enterprise After Action Review (EAAR)

EAAR delivers a COE compliant AAR prototype for use across PM ConSim & PM Mission Command (MC) products. EAAR is built as services that run on the LS TTE IA infrastructure, on the Command Post Computing Environment (CP CE) C2 IVM, or concurrently on both collecting into a single common database. This is possible through use of common standard software. EAAR is intended to replace multiple AAR products that exist on various PEO STRI programs of record in support of the common product line goal.

WAY FORWARD

LVC-IA Enhanced Capabilities

The LS TTE IA infrastructure is the government-owned implementation of the Reference Architecture component of the LS TTE Enterprise Architecture. By the end of 2015, the LS TTE IA prototype is expected to have implemented low level services that support data mediation to the core systems interfacing through LVC-IA. As such, it will provide a baseline implementation that could be introduced to LVC-IA as a technology enhancement, only requiring that LVC-IA Exercise Control tools be adapted to operate through the LS TTE IA. The LS TTE IA source code will be offered as Government Furnished Information to the LVC-IA contractor. Enhancing LVC-IA with the LS TTE IA will provide the users with significant usability enhancements resulting from the workflow automation capabilities that will encapsulate many manual activities into automated processes. It will also support the eventual move of the infrastructure to a COE Data Center.

STE Development & Test Environment

This LS TTE IA will provide a single baseline architecture upon which prototype services can be developed to address future needs of the STE. As STE technical gaps are identified, divergent organizations (Industry, Academia, Government, etc.) can develop prototype solutions on this common architecture. As additional solutions are identified and developed, the infrastructure itself will be updated to support evolving capability needs.

ILTE

LS TTE IA is postured to be the foundational architecture for ILTE. The service-oriented architecture of LS TTE IA supports the composability required to combine services and tools required for the Operational Test Command to conduct operational testing of Army weapon and information technology system. The LS TTE IA also enables the test community to leverage training community capabilities built upon the LS TTE IA. Test community use of LS TTE IA will also benefit the training community. While test and training often have similar requirements, the test community usually requires capability to conduct testing of a weapon system well before those capabilities are required for training. Therefore, capabilities developed on the LS TTE IA for testing are available to be leveraged for training applications.

Other Potential Use Cases

The service-oriented nature of the LS TTE IA sets the stage for supporting much more than just the Training and Test & Evaluation communities. Other communities including Experimentation, Acquisition, Intelligence, etc. could take advantage of the flexibility and composability of the LS TTE IA to support their needs. Other Services could also consider LS TTE IA as they are looking to evolve their modeling and simulation capabilities.

CONCLUSION

The LS TTE IA is an enterprise approach to providing capabilities to both the training and the test & evaluations communities. The just-in-time, dynamic provisioning of resources and capabilities to meet needs is new and innovative to both the Army training and the test & evaluations communities. As the Federal government initiatives are driving all applications to modernize and/or migrate to a data center environment, the LS TTE IA is looking to optimize the resource utilization in that environment. All capabilities fitting within this LSTTE framework are to be dynamically provisioned to support requirements and released upon satisfying that need. This work sets the stage for realizing a promise of cloud computing – an economy of scale for computational resource needs. The use of Business Process Modeling Notation (BPMN) will encapsulate the entrenched use of experts into codified rules sets. Being able to separate domain expertise from information technology expertise is a great leap forward. This has a huge potential for return on investment when compared to the Status Quo.

The challenge of supporting both the Training and Test & Evaluation communities with a single architecture is mitigated by the SOA implementation. Services can be built upon the architecture which support the existing capabilities and protocols in use today (e.g. TENA, HLA), while new capabilities and services can be developed more tightly coupled to the architecture to take full advantage of the power of the infrastructure. Governance of the architecture by a body of stakeholders representing both the Training and Test & Evaluation community's interests will ensure that competing requirements are resolved such that the infrastructure can meet the needs of both communities.

The prototype developers took a straightforward approach of mapping open source applications and technologies to satisfy the architecture building blocks defined in the Open Group's SOA Reference Architecture. These open source applications are being leveraged, integrated, and extended to implement a domain specific architecture. While this architecture is incomplete, occasional demonstrations throughout the continued development will provide PEO STRI with opportunities to envision the advantages the LS TTE IA can provide. The periodic demonstrations highlight key aspects of the technology used to implement LS TTE in a domain specific context, and demonstrate infrastructure support for emerging solutions as they are developed.

Demonstrations conducted to date suggest that LS TTE IA supports the LS TTE EA vision and business goals & objectives. Specifically, the LS TTE IA demonstrates potential to reduce operational complexity, reduce operation and sustainment costs, reduce development costs, streamline information assurance re-certifications and ultimately improve Soldier/Unit Readiness and provide more realistic test environments. Further development of the architecture and additional demonstrations of the LS TTE IA for specific use cases are necessary to confirm LS TTE IA will achieve the LS TTE EA goals and objectives.

REFERENCES

ASA(ALT). (2013). Common Operating Environment Data Center/Cloud Computing Environment Architecture Compliance. Version 2.0.

Live Training Transformation (LT2). (2013). Objective Architecture Vision. Revised February 12, 2013

Lundy, M.. (2014). "DCG-CAC-T Description of the Complex Training Operational Environment (Version 26) and updated implementing guidance" [Memorandum]. Department of the Army, U.S. Army Combined Arms Center and Fort Leavenworth

National Defense Authorization Act for Fiscal Year 2012. (2012). Section Sec. 924. Ozone Widget Framework. Retrieved from http://www.gpo.gov/fdsys/pkg/PLAW-112publ81/pdf/PLAW-112publ81.pdf

Ozone Widget Framework. (n.d.) Retrieved from http://www.ozoneplatform.org/

The Open Group. (2011). SOA Reference Architecture. Technical Standard (C119).

Under Secretary of the Army, (2014). Migration of Army Enterprise Systems/Applications to Core Data Centers [Memorandum]. Department of the Army.