TELEMETRY APPLICATIONS OF TENA

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I. INTRODUCTION

When the DoD initially developed their test and training ranges, they did so by creating what are now termed "stovepipe" systems, meaning they were individually built with different suites of sensors, networks, hardware and software. When the focus shifted toward a Joint initiative within the military, these stovepipe systems made interoperability incredibly difficult, and the need was identified for a common architecture that would provide for real-time software system interoperability as well as interface existing range assets, Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems, and simulations. This architecture, the Test and Training Enabling Architecture (TENA), which is government owned and free for anyone to use, allows for the most efficient use of current and future range resources via range resource integration. This integration fosters interoperability and reuse within the test and training communities, critical to validate system performance in a highly cost-effective manner.

TENA provides a middleware software component and can be used on any Internet Protocol (IP)-based network. Networks such as the Joint Mission Environment Test Capability (JMETC) networks and the Joint Staff (JS) J7 Deputy Director Joint Environment Joint Training Enterprise Network (JTEN). TENA enables and enhances distributed testing and training as well as range integration. Upgrading an existing range system to TENA can be achieved in drastically shorter time than traditional software integration efforts. Additional benefits include cost-effective replacement of unique range protocols, enhanced exchange of mission data, and organic TENA-compliant capabilities at sites, which can be leveraged for future events, enhancing both reuse and interoperability.

II. TENA AND THE TELEMETRY COMMUN ITY

As in the past, present telemetry (TM) support requires operators to be on location with the TM receive system or at a remote TM console (with a remote TM antenna control unit). This often results in temporary duty (TDY) for operators and potentially an insufficient number of operators to support all scheduled operations. The capability to remotely operate the telemetry system (i.e., perform status monitoring, data distribution, and / or command and control from a centrally-located, manned site) would greatly reduce operational costs of TDY to remote TM sites. A remote control capability could eliminate the existing requirement for personnel at both the local TM system antenna site as well as the TM control facility, alleviating previous manpower issues.

Efforts are currently underway at Patuxent River, MD (Pax River) Atlantic Test Range to develop and field an enterprise approach to remotely manage and operate all components of remote ground telemetry systems by utilizing TENA. This approach provides a common architecture interfacing to system components, regardless of system manufacturer. At completion, this effort will provide for single operator control of several remote TM systems, which reduces travel and manning requirements at remote sites. It will also allow TM status information, setup and control to be distributed to appropriate destinations for system verification and operations.

Recently, the Pacific Missile Range Facility (PMRF) upgraded their two Versatile Tracking Mounts (VTMs) to TENA. White Sands

Missile Range (WSMR) notified PMRF that a new, TENA-compliant Universal Video Tracking System (UVTS) had been developed and could be retrofitted in the PMRF VTMs. PMRF sent WSMR three new computers to implement the UVTS, and the instrument port of the Sourse Integration Sensor (SIS) on PMRF's instrumentation Network (iNet) was made TENA-compliant. The UVTS were successfully installed in August 2015 with their first mission support in October of the same year.

III. TENA OFFERS INTEROPERABILITY AND RESOURCE REUSE

Being successful in the development of any Joint testing capability requires a supporting and guiding activity, and in December 2005, the JMETC program element was formed. JMETC, the DoD corporate approach for linking distributed facilities, is a distributed live, virtual, and constructive (LVC) testing capability developed to support the acquisition community during program development, Developmental Testing (DT), Operational Testing (OT), interoperability certification, including demonstration of Net Ready Key Performance Parameters (KPP) requirements in a customer-specific Joint Mission Environment (JME). JMETC provides readily available connectivity to the Services' distributed test capabilities and simulations, as well as Industry test resources. Although a testing capability, JMETC is also aligned with and complemented by the Joint Chiefs of Staff (JCS) J7 integration solutions to foster test, training, and experimental collaboration. JMETC uses a hybrid network architecture. The JMETC Secret Network (JSN), which leverages the Secret Defense Research and Engineering Network (SDREN) for connectivity, is the T&E enterprise network solution for secret testing. The JMETC Multiple Independent Levels of Security (MILS) Network (JMN) is the T&E enterprise network solution to support higher classifications and cyber testing. The JMETC program has used TENA to improve testing support infrastructure. TENA, as the live range instrumentation architecture for test organizations, and field-proven in exercises and numerous distributed test events since 2002, provides JMETC a technology already deployed in the DoD. TENA provides the middleware and software component while the persistent JMETC networks provide the connectivity for distributed testing.

Interoperability is the characteristic of an independently developed software element that enables it to work together with other elements toward a common goal by focusing on what is common among them. Reuse is the ability to use a software element in a context for which it was not originally designed, in essence focusing on the multiple uses of a single element and often requiring well-documented interfaces. In order to achieve interoperability, a common architecture, an ability to meaningfully communicate (including a common language and a common communication mechanism), and a common context (including the environment and time) must be present. To bring the efficiency and economic advantages of interoperability and reuse to the DoD test and training ranges, TENA was developed. The initial interoperability and reuse efforts were completed in early Fiscal Year 2005, and the continuing interoperability and reuse refinement of TENA is managed by the TENA Software Development Activity (SDA).

The TENA architecture is a technical blueprint for achieving an interoperable, composable set (composibility is defined as the ability to rapidly assemble, initialize, test, and execute a system from members of a pool of reusable, interoperable elements) of geographically distributed range resources – some live, some simulated – that can be rapidly combined to meet new testing and training missions in a realistic manner. TENA is made up of several components, including a domain-specific object model that supports information transfer throughout the event lifecycle, common real-time and non-real-time software infrastructures for manipulating objects, as well as standards, protocols, rules, supporting software, and other key components.

The TENA Middleware combines distributed anonymous publish-subscribe, and model-driven distributed object-oriented programming paradigms into a single distributed middleware system. This unique combination of high-level programming abstractions yields a powerful middleware system that enables the middleware users to rapidly develop complex yet reliable distributed applications. The TENA Middleware (currently at Release 6.0.4.2) is US Government owned and available for free download at the TENA SDA web site https://www.tena-sda.org/.

The TENA object model consists of those object / data definitions, derived from range instrumentation or other sources, which are used in a given execution to meet the immediate needs and requirements of a specific user for a specific range event. The object model is shared by all TENA resource applications in an execution. It may contain elements of the standard TENA object model although it is not required to do so. Each execution is semantically bound together by its object model.

Therefore, defining an object model for a particular execution is the most important task to be performed to integrate the separate range resource applications into a single event. In order to support the formal definition of TENA object models, a standard metamodel has been developed to specify the modeling constructs that are supported by TENA. This model is formally specified by the Extensible Markup Language (XML) Metadata Interchange standard and can be represented by Universal Markup Language (UML). Standards for representing metamodels are being developed under the Object Management Group Model Driven Architecture activities. The TENA Object Model Compiler is based on the formal representation of this metamodel, and TENA user-submitted object models are verified against the metamodel. However, it is important to recognize the difference between the TENA metamodel and a particular TENA object model. The object captures the formal definition of the particular object/data elements that are shared between TENA applications participating in a particular execution while the object model is constrained by the features supported by the metamodel.

A significant benefit for TENA users is auto-code generation. The TENA Middleware is designed to enable the rapid development of distributed applications that exchange data using the publish-subscribe paradigm. While many publish-subscribe systems exist, few possess the high-level programming abstractions presented by the TENA Middleware. The TENA Middleware provides these high-level abstractions by using auto-code generation to create complex applications. Although using the Common Object Request Broker Architecture (CORBA), the TENA Middleware offers programming abstractions not present in CORBA. TENA provides a strongly-type-checked framework interface that is much less error-prone than the existing CORBA Application Programming Interface (API). These higher-level programming abstractions combined with a framework designed to reduce programming errors enable users to quickly and correctly express the concepts of their applications. Re-usable standardized object interfaces and implementations further simplify the application development process.

Through the use of auto code generation, other utilities, and a growing number of common tools, TENA also provides an enhanced capability to accomplish the routine tasks which are performed on the test and training ranges in support of exercises. The steps in many of the tasks are automated, and the information flow is streamlined between tools and the common infrastructure components through the enhanced software interoperability provided by TENA. TENA utilities facilitate the creation of TENA-compliant software and the installing, integrating, and testing of the software at each designated range. This complex task falls to the Logical Range Developer, which, in this phase, performs the detailed activities described in the requirement definitions and event planning, and the event construction, setup, and rehearsal activities of the Logical Range Concept of Operations. While some manual exercise and event setup is required at ranges, TENA tools, as they are developed and become accepted across the range community, making exercise pre-event management easier.

IV. SUPPORT FOR TENA USERS

The TENA SDA has developed a website that provides a wide range of support for the TENA user, including an easy process to download the middleware, free of charge. The website also offers a help desk and user forums that will address any problems with the Middleware download and implementation. The TENA SDA is very aware of the need to inform range managers and train TENA users, and the TENA SDA presents regular training classes that are designed to meet the attendees' needs, from an overview of TENA to a technical introduction of TENA, all the way to a hands-on, computer lab class for the TENA Middleware.

TENA's continuing evolution in its support of the test and training range community is managed by an organization of users and developers. This collection of TENA stakeholders, called the Architecture Management Team (AMT), meets several times a year to be updated on TENA usage, problems, and advancements. The agenda involves briefings and is open to wide ranging discussions, ensuring the users' concerns and inputs are understood, recorded, and action items are made if necessary. Of equal importance, TENA developers and management has had a long and mutually beneficial relationship with the Range Commanders Council.

V. CONCLUSION

Although it was a technological and software evolution that was the impetus for TENA's growth in its enabling of range interoperability and resource reuse, the Middleware found its needed validation on the DoD test and training ranges. On those ranges, the U.S. Military evaluates the warfighting equipment, personnel, and concepts that are deployed in support of ongoing missions around the globe. Unfortunately, test and training events only provide the opportunity for evaluation. It is the data collection and analysis that determines the war worthiness of the equipment or concept; it can quickly and definitively illuminate any necessary improvements needed to ensure effective and safe weapon system operation and training.

TENA and JMETC are time-tested, proven, integral parts of that equation. JMETC reduces the time and cost to plan and prepare for distributed events by providing a persistent, readily-available network, including the necessary networking tools to connect all associated sites. TENA is the common integration software, easily integrated into telemetry environments and applications. With TENA-enabled systems and events run over the JMETC network, Test Directors can put their focus back where it needs to be – on the warfighter and the task at hand.

For more information about TENA and JMETC, contact Ryan Norman, TENA SDA Deputy Director – Technology Development, or AJ Pathmanathan, JMETC Lead Engineer, E-mail: feedback@tena-sda.org or feedback@jmetc.org or go to the TENA Web Site: https://www.tena-sda.org or JMETC Web Site: https://www.jmetc.org.