 USING TENA AND JMETC TO ENABLE INTEGRATED TESTING AND TRAINING

Gene Hudgins, Keith Poch, and Juana Secondine
TENA Software Development Activity (SDA), Ft. Walton Beach, FL, 32548

ABSTRACT

The Test and Training Enabling Architecture enables interoperability among ranges, facilities, and simulations in a timely and cost-efficient manner and fosters reuse of range assets and future software systems. TENA is a common architecture, providing for real-time software system interoperability using the TENA Middleware, as well as interfacing to existing range assets, C4ISR systems, and simulations. The Middleware, currently at Release 6.0.1, has been used by the range community for testing, evaluation, and feedback in many major exercises since 2002, and has been selected for use in the Joint Mission Environment Test Capability prototyping demonstrations and distributed testing.

I. INTRODUCTION

Due to the necessity of the continuous evolution of the warfighter, equipment, and concepts being deployed in support of missions around the globe, the United States Department of Defense (DoD) developed geographically dispersed ranges on which to conduct crucial test and training events. The test and training events carried out at these facilities are varied in nature and range anywhere from individual systems under test to large-scale Joint exercises spread across numerous ranges where live, virtual, and constructive (LVC) systems are blended to enact representative scenarios. While highly capable, these DoD ranges were initially developed with “stovepipe” systems, individually built with different suites of sensors, networks, hardware and software making interoperability difficult. The focus is now shifting to allow 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 weapon system performance, such as the Joint Strike Fighter (JSF), in a more cost-effective manner.

The Test and Training Enabling Architecture (TENA) is the DoD corporate approach for interoperability of distributed range facilities with an LVC capability. This includes the Services as well as Industry resources. TENA provides real-time software system interoperability by interfacing to existing live range assets, plus Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems, and simulations.

TENA provides the middleware software component and can be used on any network such as the Joint Mission Environment Test Capability (JMETC) Network and the US Joint Forces Command Joint National Test Capability Joint Training and Experimentation 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 re-use and interoperability.

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 LVC testing capability developed to support the acquisition community during program development, developmental testing, operational testing, 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 Joint National Training Capability (JNTC) integration solutions to foster test, training, and experimental collaboration.

The JMETC program has used TENA to prototype a new testing support infrastructure. TENA, as the live range instrumentation architecture for test organizations and JNTC, and field-proven in major field exercises as well as 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 network provides the hardware connectivity. This is accomplished through the utilization of the existing Secure Defense Research and Engineering Network (SDREN) and Defense Research and Engineering Network (DREN) infrastructure. As each node is brought online the JMETC network, the JMETC team uses NUTTCP, Mping, and the JMETC Interface Verification Tool (IVT) as its network testing tools. NUTTCP, which requires a Unix operating system, is a Transmission Control Protocol (TCP)/User Datagram Protocol (UDP) network performance tool, and Mping, available from Microsoft and requiring Windows XP, is used to test multicast capability between JMETC sites. NUTTCP and Mping must reside in the lab participating in the testing event. IVT is used to test the JMETC network with TENA and/or other data protocols.

Prior to an event, operational testing is performed by the User Support Team to verify the network can operationally support TENA and/or other data protocols. The testing is conducted after the network infrastructure tests have been successfully performed by the JMETC network System Control (SYSCON) and will ensure the backbone of the JMETC network from the site Service Delivery Point (SDP) to other sites’ SDP and the end-user site local network infrastructures are configured for proper and efficient TENA operations. Operational testing is executed in two phases. Phase 1 consists of a one-on-one with each new or updated JMETC site; Phase 2 is a full mesh with all sites participating in a particular event/exercise.

The JMETC Team’s network goal was to complete a network infrastructure of approximately 46 connected nodes during 2010. By the end of FY10 this number had reached 55 functional sites, with 7 planned and 4 peering connection points. As of the second quarter of FY11, these numbers now stand at 61 functional sites with 9 new sites in the works and 5 connection points to other networks. Based on the customer’s needs and the potential for reuse, a dedicated and trusted network is provided on the SDREN, which is part of the Global Information Grid (GIG). The JMETC sites, encrypted for Secret, also include numerous sites at Defense industrial facilities. This infrastructure can be connected to one of two JNTC-sponsored Network Aggregators to
further increase the network capability by bridging to sites on other classified networks to include the JNTC Joint Test and Experimentation Network (JTEN), Defense Information System Network (DISN) networks, and potentially, other classified enclaves.

Together, the TENA and JMETC complement enables and enhances distributed testing and training. While JMETC is a relatively new presence for the test and training community, TENA has evolved since the late 1990s when it was brought into play to solve an old problem that restricted range effectiveness. Many of the early range data collection and analysis systems were part of a vertical “stovepipe” growth of the instrumentation and instrumentation suites, and not able to utilize the advantages found in the concepts of range interoperability and range resource reuse. These concepts allowed for taking easy advantage of the growth in modeling and simulation and its revolutionary application to training, forwarded in the late 1990s by the Foundation Initiative 2010 (FI 2010) project, sponsored by the Office of the Secretary of Defense (OSD) Central Test and Evaluation Investment Program (CTEIP).

Utilizing TENA, JMETC enabled several initial prototype demonstrations: an Air Combat example (a Data Link Messages Test Environment), Technical Alignment with JNTC events (test and training collaboration), a Land Combat example (Future Combat System (FCS) test environment), and an Information Operations example (IO Range integration). In August 2007, JMETC supported its “Stand Up” event, Integral Fire 07.

Integral Fire 07 (IF07), an Air Force – Integrated Collaborative Environment (AF-ICE) event, was a distributed test event involving all the military services and the U.S. Joint Forces Command (JFCOM). JMETC supported the event by providing test infrastructure and technical support.

Administered by the Simulation and Analysis Facility (SIMAF) at Wright-Patterson Air Force Base, Ohio, IF07 had three distinct customers: JFCOM’s Joint Systems Interoperability Command (JSIC), the DoD Joint Test and Evaluation Methodology (JTEM) Joint Test & Evaluation (JT&E) program, and the Warplan-Warfighter Forwarder (WWF) initiative, sponsored by the United States Air Force (USAF) Command and Control Intelligence, Surveillance and Reconnaissance Battle-lab.

TENA was successfully used to exchange simulation or instrumentation data between sites. Specifically within their laboratories, nine sites used the Distributed Interactive Simulation (DIS) Protocol. At each of these local DIS sites, data was converted to TENA using the DIS-TENA Gateway device prior to the data being sent to another site, mitigating configuration challenges of using DIS over wide-area networks. These DIS-TENA Gateways operated satisfactory and all test objectives were met during the Integral Fire 07 test event.

II. RECENT AND ONGOING TEST AND TRAINING EVENTS INVOLVING THE UNITED STATES MILITARY USING JMETC/TENA

A. Pacific Alaska Range Complex (PARC)

Pacific Alaska Range Complex (PARC), the largest instrumented air, ground, and electronic combat training range in the world, has integrated their systems to include TENA Middleware to
support the operational mission and requirements of Joint Red Flag – Alaska (JRF-A). PARC is conditionally Accredited and Certified (A&C) as a JNTC venue and is the first live training range to receive JNTC A&C.

PARC’s emphasis is on Joint and Coalition warfighting capabilities, training the warfighter and providing near real experience of first 8-10 combat sorties. Three to four Joint and Coalition force exercises are executed per year. Each warfighter exercise is a two week Joint air and ground war including relevant, real-world combat scenarios with realistic threats and targets. For combat sorties, PARC provides realistic integrated air defense threats, target arrays, and adversaries, providing realistic and relevant scenarios that also improve Joint and Coalition interoperability. Training venues supported include:

- JRF-A exercises;
- Northern Edge (NE) – Pacific Command (PACOM) sponsored, theater-wide;
- Joint Expeditionary Force Experiment (JEFX);
- Unit level training – Distant Frontier.

Many platforms have trained at PARC, including fighters, bombers, tankers, Command and Control (C2), ground, and C4ISR. Training missions include air-to-air, air-to-ground, Offensive Counter Air (OCA), Defensive Counter Air (DCA), Close Air Support (CAS), Electronic Warfare (EW), Suppression of Enemy Air Defense (SEAD), and Active Array Radar (AAR), as well as Personnel Recovery (PR)/Combat Search and Recovery (CSAR), insertion/extraction, special ops, and tactical airlift.

Essentially PARC has created both a black TENA network and red TENA network. Systems on either side publish and subscribe TENA objects and messages as needed/required; SimShield provides multi-level security as a cross domain solution by allowing these two networks to communicate seamlessly at near real time.

B. Interoperability Test and Evaluation Capability (InterTEC)

The Joint Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (JC4ISR) Interoperability Test and Evaluation Capability (InterTEC) is an integrated test solution for scalable, extensible, and operationally relevant interoperability test and evaluation and is using TENA in its employment. The performance objective of InterTEC is to field an accredited test system for the conduct of Joint interoperability certification testing that integrates existing interoperability testing tools and adds new capabilities in accordance with DoD policy for Joint Service interoperability and net readiness assessments of C4ISR networks-of-systems.

The first spiral focused on developing and fielding an accredited, integrated C4ISR interoperability test capability for the tactical data link protocols of the Joint Data Network (Variable Message Format--VMF, Link 11, and Link 16). In the JMETC prototype event, InterTEC demonstrated extensibility and reuse through the rapid integration of an additional live range environment including live aircraft from the Air Force Flight Test Center at Edwards AFB, California, a virtual F-15E from Eglin AFB, Florida, and additional constructive entities generated from the Air Combat Environment Test & Evaluation Facility (ACETEF) at Patuxent River,
Maryland. These sites were combined with existing Spiral 1 sites to perform a Joint air combat event, and constituted the InterTEC Initial Operational Capability (IOC). Using InterTEC in the JMETC event provided a significant capability addition to InterTEC. Both the Navy Sea Range and Air Force Flight Test Center were able to perform Joint Interoperability testing between Navy and Air Force live entities in a distributed Joint LVC battlespace environment. TENA acted as the key enabler of the reuse demonstration.

Spiral 2, extended the capability of Spiral 1 to include an integrated test capability for the Joint Planning Network protocols, to include United States Message Text Formatting (USMTF) and Over The Horizon Targeting-Gold (OTH-G). Spiral 3 will focus on intelligence, surveillance, and reconnaissance systems/protocols, as well as supporting the test processes associated with the Net Ready Key Performance Parameter (NR-KPP).

C. Joint Expeditionary Force Experiment (JEFX)

Since the JEFX pre-event, Persistent Fire (PF) 09-1, JMETC has been involved in the continued planning and execution of JEFX events, a series of experiments that combines LVC forces to assess the ability of selected initiatives to provide needed capabilities to warfighters. The focus is on live fly communication and airborne data links. The events are conducted over the JMETC network. The USJFCOM JNTC Aggregation Router is also being utilized for connection to the VIP briefing facility in the Pentagon; the Warfighter Capability Demonstration Center (WARCAP). The main sites are the Combined Air Operations Center (CAOC-N) Nellis AFB, 505th Command and Control Wing (CCW) Hurlburt Field (also a training venue), both of which have been funded by the users to connect to the JMETC network. Also included are Electronic Systems Command (ESC) Hanscom AFB, SIMAF Wright-Patterson AFB, GCIC Langley AFB, GWEF Eglin AFB, and C2TF – DTF Eglin AFB. Supporting sites are JMETC SYSCON Pax River and DTCC Huntsville. The TENA Team has provided TENA-DIS gateways to sites for simulation data and live fly data.

D. Joint Surface Warfare (JSuW)

Through the ongoing JSuW Joint Capability Technology Demonstration (JCTD), JMETC has again demonstrated that its current distributed infrastructure is highly suitable for testing in a rapidly evolving experimental, developmental, and operational LVC testing environment. JMETC’s expert support team and availability of its persistent network enabled the JSuW team to quickly move from idea to execution. JSuW perceived the risk of using the JMETC infrastructure to be so low that JSuW was able to execute runs for record with as little as 3 weeks’ notice to JMETC. The JSuW JCTD leverages maturing weapon data link network technologies to demonstrate the integration of multiple Intelligence, Surveillance, and Reconnaissance (ISR) and launch platforms with existing stand-off weapons. The program enables variable ISR assets such as Joint Surveillance and Target Attack Radar System (JSTARS) and P-3 Littoral Surveillance Radar System (LSRS) in order to provide initial targeting data and in-flight target updates for multiple weapons, referred to as third party targeting. JSuW provides multiple comprehensive Joint kill chain threads to the Combatant Commander, significantly increasing operational agility. Additionally, JSuW increases probability of target kill in adverse weather conditions and at extended ranges, while minimizing launch platform threat exposure. To that end, the program provides both new data-link messages and the associated Concept of Operations (CONOPS) for third party targeting.
The network connectivity necessary to execute the JSuW JCTD Simulation Exercise (SIMEX) 09-2 required a unique connection between two disparate Wide Area Network (WAN) architectures – the JMETC network on the SDREN and the Defense Information System Network - Leading Edge Services (DISN-LES). JMETC facilitated a temporary peering solution between the JMETC network and the DISN-LES by providing guidance and assistance for design of the integrated network architectures, assistance in getting the connectivity approved through the Defense Information Assurance Security Accreditation Working Group (DSAWG), troubleshooting the standup of connection and continued support through event execution. JMETC SYSCON was instrumental in ensuring the connectivity was in place in time for event integration and execution. The end result of the peered network architectures was the ability of the JSuW JCTD SIMEX 09-2 team to focus on their test objectives while allowing the JMETC and Defense Information Systems Agency (DISA) teams to handle the infrastructure, resulting in the successful execution of the event. Based on the successes of SIMEX 09-2, JMETC has continued to provide persistent network support to JSuW for the 2.22a series of interoperability test events.

In order to expedite delivery of much needed capabilities to the warfighter, JSuW desired to execute multiple successive test events on a demanding schedule throughout 2010. Quite simply, this would not have been possible without the persistent infrastructure provided by JMETC. With a persistent infrastructure readily available, the JSuW team was able to focus on the testing and assessment of their much needed initiatives. Time and time again, through various distributed Joint test and training events JMETC has been able to demonstrate that its current distributed infrastructure is highly suitable for testing in a rapidly evolving experimental, developmental, and operational LVC testing environment.

E. Joint Close Air Support (JCAS) Distributed Test

Another 2010 event held using the JMETC infrastructure was the JCAS Distributed Test event executed the week of June 14-17 during Test Week 2010. USJFCOM J89, as the sponsor of the test, intended to gather baseline data and gain distributed test planning knowledge in preparation for Digitally-Aided CAS (DACAS) Block 2 activities. USJFCOM J892 provided the Joint Test Threads (JTT) to add a realistic operational context in order to accomplish this objective. Each JTT had mission Measures of Effectiveness (MoE), task measures, functional measures, and data elements to address the assessment objectives. The JCAS Distributed Test scenario provided an operationally relevant environment via a mix of Joint LVC test resources available through JMETC sites at Eglin Air Force Base 46TS, Redstone Test Center (RTC), Ft. Hood Central Technical Support Facility (CTSF), Camp Pendleton Marine Corps Tactical Systems Support Activity (MCTSSA), and NAVAIR Pt Mugu. Participation at Test Week also included Wright-Patterson SIMAF and NAVAIR Patuxent River. The InterTEC funded C4ISR Mobile Instrumentation System (CMIS) van was moved from the Joint Interoperability Test Command (JITC) in Fort Huachuca, AZ to Huntsville, AL and served as the Test Control Center for this distributed test.

Utilizing the World Class Network Services readily available through JMETC’s persistent connectivity, USJFCOM was not only able to save time and expense, but was ultimately afforded the luxury of turning its focus primarily to its test assessment objectives. Follow-on testing will occur as-needed to assess improvements and changes to the processes and systems that are a part of Close Air Support missions.
F. Air Ground Integrated Layer Exploration (AGILE) Fire

AGILE Fire is an AF-ICE event providing an LVC environment designed to actively support the Secretary of the Air Force Chief of Warfighting Integration Modeling and Simulation investment for maturing existing data links, as well as emerging command and control capabilities; focus on the interoperability within and between air and ground communication layers; and to capture requirements for emerging technologies and interfaces to existing force structure.

Both the AGILE Fire Phase I and II events leveraged the persistent JMETC infrastructure to integrate facilities, labs and resources. Fourteen sites were involved in the events including one new site: Northrop Grumman Corporation B-2 Aircraft Lab, El Segundo, CA, brought up on short notice.

JMETC tools were used extensively, such as TENA gateways for data transfer among sites, InterTEC tools for data link analysis, the IVT to check-out and verify the operation of both JMETC connectivity and TENA applications, and Voice over Internet Protocol (VoIP). Of particular note was the first time use of JMETC chat services for event team collaboration, and Secure File Transfer Protocol (SFTP) services for file transfer; both very successfully.

JMETC met the infrastructure requirements of AGILE Fire. The event team was very pleased with the infrastructure and technical support provided by JMETC. They reported they were able to collect significant data of value to the warfighter concerning their specific objectives. The event team also strongly felt the AGILE Fire event reaffirmed the value of distributed testing and are continuing with AGILE Fire III and IV.

III. TENA OFFERS INTEROPERABILITY AND RESOURCE REUSE

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, FI 2010 developed TENA. The FI 2010 program completed the initial interoperability and reuse efforts in early Fiscal Year 2005, and the continuing interoperability and reuse refinement of TENA is now 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 shared memory, 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 6.0.1) is US Government owned and available for free download at the TENA SDA web site https://www.tena-sda.com.

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 a complex Common Object Request Broker Architecture (CORBA) application. As such, the TENA Middleware offers programming abstractions not present in CORBA and 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 quickly and correctly to 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, will make exercise pre-event management easier.

IV. EMERGING RANGE SYSTEMS AND THE USE TENA

The rapid growth in Net-Centric warfare, coupled with the increasing need for interoperability among test ranges and sites, has led to a great diversity in the DoD testing infrastructure and the networks supporting it. The primary challenge of enabling interoperability for systems under test in a mission-level context in a distributed LVC dynamic Joint Net-Centric Operations (JNO) environment is being met by adopting TENA. For TENA to service the entire mission area, it must be able to function in this diverse, resource-constrained environment. Therefore, the OSD Test Resource Management Center (TRMC) Test and Evaluation (T&E) / Science and Technology (S&T) Program is sponsoring the TENA in Resource Constrained Environments (TRCE) approach. TRCE will improve the TENA Middleware’s operation and performance in resource-constrained environments by developing technologies that support a broad range of variable quality networks, including wireless networks, and provide native TENA support for handheld & embedded computing platforms. TRCE will enhance the TENA Middleware to support these types of networks and platforms to provide a common and robust interoperability architecture.

The TRCE project is focused on developing capabilities to extend the use of the TENA Middleware to remote and potentially tactical edge instrumentation and systems under test. Two key aspects of the program focus on developing reliable communication with performance constrained links (related to variable quality and low data rate networks) and operation on constrained hardware devices (related to low power, reduced CPU and reduced memory). Examples of constrained link types may be wireless, cellular, acoustic, SATCOM, and other RF communications. Furthermore, hardware constraints exist in the form of low power & small form factor computers, embedded instrumentation, and mobile internet devices (MID) such as computers on module, smartphones, and tablet computers. This variability and unpredictability in the overall test environment presents significant challenges in achieving interoperability; TRCE technologies are being developed in order improve the reliability and robustness of the TENA middleware in these types of environments.
V. 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 ranges community is managed by an organization of users and developers. This collection of TENA stakeholders, called the Architecture Management Team (AMT), several times a year to be updated on TENA usage, problems, and advancements. The agenda involves briefings and open 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.

VI. 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 the ongoing missions around the globe. However, 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. Now paired with JMETC to prove connectivity as well as interoperability and reuse, TENA is commonly accepted as an important part of the equation. TENA and JMETC reduce the cost and time to plan and prepare for distributed Joint events by providing a readily-available, common integration software for linking sites, plus test tools; putting the focus back on the event itself.

For more information about JMETC and TENA, contact George Rumford, JMETC Senior Technical Advisor / TENA Software Development Activity (SDA) Director, or Ryan Norman, JMETC Systems Engineer, E-mail: feedback@jmetc.org or feedback@tena-sda.org or go to the JMETC Web Site: https://www.jmetc.org or TENA Web Site: https://www.tena-sda.org.