Test and Training Enabling Architecture (TENA) Overview

Ryan Norman
TENA SDA Deputy Director for Technology Development
Test Resource Management Center
What is the Test Resource Management Center?

DASD(DT&E) / Director, TRMC
Dr. C. David Brown

Staff Director
COL Erik Webb
USA

Principal Deputy, DT&E
Dr. J Brian Hall
(SES)

Principal Deputy Director, TRMC
Mr. Derrick Hinton
(SES)

DT&E

- Monitor/ review DT&E activities of major defense acquisition programs
- Develop Policy and Guidance
- Assist Program Offices (Chief Developmental Testers) in T&E Planning
- Test & Evaluation Master Plan (TEMP) approval/disapproval
- Advocacy for Acquisition DT&E workforce
- Annual Report to Congress

TRMC

- Steward of the DoD test and evaluation (T&E) infrastructure
  - Major Range and Test Facility Base (MRTFB)
- Services T&E budget certification
- T&E Infrastructure Investments:
  - Central Test and Evaluation Investment Program (CTEIP)
  - T&E Science and Technology (S&T) Program
  - Joint Mission Environment Test Capability (JMETC) program offices
- Biannual Strategic Plan to Congress
A TRMC Perspective:
Vision for a Common Test and Training Infrastructure

Vision:
A highly flexible infrastructure that will allow us to conduct more operationally realistic testing and training.
Notable TRMC LVC Infrastructure Investments

- **Integration Architecture:** Test and Training Enabling Architecture (TENA)
- **Corporate MILS Network:** Joint Mission Environment Test Capability (JMETC)
- **Interface Standardization:** TENA Object Models
- **Common Tools:** JMETC Tools and TENA Utilities
- **Cross Domain Solutions:** Multi-Level Secure Joint / Coalition Network Environment (MLS-JCNE)
- **Cyberspace T&E Capabilities:** Cyber Infrastructure for T&E (CIT&E)
- **Range TSPI:** Common Range Integrated Instrumentation System (CRIIS)
- **Active TRMC strategic initiatives include:**
  - Big Data Analytics & Improved Knowledge Management
  - Interoperability T&E
  - Hypersonics test infrastructure
  - T&E of autonomous systems
  - Live Virtual & Constructive Test & Evaluation (LVCT&E)
What is an Architecture?

• An architecture is a bridge from requirements to design that defines for each component its:
  – Purpose
  – Function
  – Interfaces to other components / systems
  – Relationships to other components / systems
  – Guidelines for evolution over time

• Architectures put constraints on developers. These constraints make possible the achievement of higher level goals.
  – These higher-level goals are called the system’s driving requirements
Range System and Infrastructure Development Challenges

- General Development Challenges
  - Multiple Developers and Development Groups
  - Different Timelines and Delivery Dates
  - New Computing and Communication Technologies

- Range Specific Development Challenges
  - Multiple Sponsors and Funding Sources
  - Evolving Test and Training Requirements
  - Expansion of Inter-Range Connectivity
  - Information Assurance Policies and Procedures
  - Range Modernization Must Be Gradual

Challenges grow exponentially when you need to interoperate with other ranges.
Notional “Current State” of T&E Operations

DoD-wide Limitations:
- Limited Resource Sharing
- Unique Interfaces for the same assets located at different ranges
- “Single-point” solutions each with their own sustainment tail
- No Guarantee of Inter-Range Interoperability

Result: Inefficient, Non-interoperable “stove pipes”

Range Limitations:
- Single-point solutions each with their own sustainment tail
- Increased integration time
- No Guarantee of Intra-Range Interoperability

Limited commonality within and between ranges

Remote Operated LVC Range
Notional “Efficient State” of T&E Operations

DoD-wide Common Architecture Benefits:
- “Plug and Play” instrumentation across test ranges
- Common solutions shared and reused between ranges
- Shared sustainment burden
- Facilities sharing of range operators

Range Benefits:
- Reduced Range O&M costs
- Reduced test setup & re-configuration time
- “Data Contract” that assures Intra-Range Interoperability
The TRMC “Blueprint”: Putting Test Capabilities on the DoD Map

TENA is TRMC’s architecture for achieving its LVC interoperability vision

Defense Strategic Guidance
- Acquisition Process
- Service T&E Needs and Solutions Process

Strategic Plan for DoD T&E Resources
- Annual T&E Budget Certification
- TRMC Joint Investment Programs
  - (6.3 Funding)
- Risk mitigation needs
- Technology shortfalls
- Risk mitigation solutions
- Advanced development
- (6.4 Activity)

DT&E / TRMC Annual Report
- Requirements
- Capabilities
- (6.6 Funding)

Transition
- Service Modernization and Improvement Programs
- Acquisition Programs and Advanced Concept Technology Demonstrations
- T&E Multi-Service/Agency Capabilities
- DoD Corporate Distributed Test Capability
JMETC depends on TENA to support distributed testing

**Joint Operational Scenarios**

**Systems Under Test**

**Integrated Test Resources**

- Virtual Prototype
- Hardware in the Loop
- Installed Systems Test Facility
- Range
- Environment Generator
- Threat Systems

**TENA**

- Standard Interface Definitions
- Common Middleware

**JMETC Infrastructure on SDREN**

**Reuse Repository**

**Distributed Test Support Tools**

* TENA: Test and Training Enabling Architecture
Test and Training Enabling Architecture (TENA) at a Glance

TENA is DoD’s GOTS range integration architecture

● What does TENA enable?
  ● Interoperability between inter- and intra-range assets
  ● Elimination of proprietary interfaces to range instrumentation
  ● Efficient incremental upgrades to test and training capabilities
  ● Integration of Live, Virtual, and Constructive assets (locally or distributed)
  ● Sharing and reuse of common capabilities across existing and new investments

● What is included in the TENA architecture?
  ● Customizable “data contracts” that standardize repeatable information exchange
  ● Interoperability-enabling, auto-code generated software libraries
  ● A core set of tools that address common test and training requirements
  ● Collaboration mechanisms that facilitate sharing and reuse

● TENA has a plan for continued evolution and funding to execute this plan
Where TENA is Used

- **Any** situation where test and training data needs to be passed over Internet Protocol (IP) networks to include:
  - Interfacing two or more systems for information exchange
  - Across programming languages and computing platforms
  - Receiving system health & status information
  - Remote command & control of one or more systems
  - Real-time dissemination of instrumentation data
  - Communicating with web applications & browsers
  - Injecting virtual and/or constructive data with live assets and instrumentation

- **TENA is not intended to replace** messaging formats used in theater operations
  - Examples: LINK-16, Variable Messaging Format
Worldwide Use of TENA

TENA is used in 13 countries outside the US
What Makes TENA Unique?
Core Architectural Tenets

- **Promote Computer Enforceable System Interfaces**
  - For meaningful interoperability, systems should formally define their interfaces for the particular data produced or consumed and the services/algorithms provided or required.
  - Generic interfaces may look appealing, but significant costs exist with performance, interoperability, and maintenance that are overlooked with this perceived flexibility.

- **Utilize Auto-Code Generation to Raise the Abstraction Level**
  - Distributed programming is hard! Define higher level abstractions to automatically generate properly designed and tested source code for common distributed programming solutions—similar to comparison of modern programming languages to assembly code.

- **Let Computer Detect Interoperability Errors as Early as Possible**
  - When would you like to detect interoperability problems? Many system errors can be detected by the computer during the development phase, reducing overall expense.

- **Design the Middleware to Make it Hard to Use Wrong**
  - Middleware is defined from a defensive posture that minimizes the opportunity for improper usage and run-time anomalies.

- **Anticipate Better Techniques and Technologies**
  - Maintain separation between interfaces and implementations to simplify transition to improved techniques and technologies when appropriate.

- **Emphasize Live-Virtual-Constructive Interoperability**
  - Systems don’t have to use TENA Middleware natively in order to take advantage of some of TENA’s capabilities.
The Ways in Which TENA Applications Can Communicate

- TENA provides to the application developer a unification of several powerful inter-application communication paradigms:
  - **Publish/Subscribe**
    - Each application publishes certain types of information to which any other application can subscribe
    - Common algorithms can be shared among applications with optional enforcement to guarantee consistent implementation
  - **Remote Method Invocation (RMI)**
    - Each object that is published may have methods that can be remotely invoked by other applications
    - Similar to CORBA RMI or Java RMI
  - **Distributed Shared Memory (DSM)**
    - Applications read and write the state of objects as if they were local objects, even though they are remote objects
    - A very natural, easy to understand programming paradigm that projects the illusion of working on a shared memory machine onto a distributed computing system
  - **Messages**
    - Individual messages that can be sent from one application to other applications
TENA is an Open Architecture

- SEI defines an Open System as “a collection of interacting software, hardware, and human components designed to satisfy stated needs with interface specifications of its components that are fully defined, available to the public, maintained according to group consensus, in which the implementations of the components conform to the interface specifications.”
- TENA is maintained according to a consensus of its users assembled as the TENA Architecture Management Team (AMT)
  - TENA Architectural Specification is publicly defined and available on the web
  - TENA Middleware Specification (API) is publicly available on the web
  - TENA Object Model is publicly available and downloadable without restriction
    - An Event Designer can create or modify object models for a given event to satisfy their particular event requirements
- TENA Middleware exists and is being used to support real events
  - Built on open source software – CORBA ACE/TAO
  - Government owned, without proprietary software
  - Studying possible open source release
Architecture Management Team (TENA AMT)

Current AMT Members:
- 329 Armament Systems Group (329 ARSG)
- Aberdeen Test Center (ATC), Aberdeen Proving Ground, MD
- Air Armament Center (AAC), Eglin AFB, FL
- Air Force Flight Test Center (AFFTC), Edwards AFB, CA
- Alaska Training Range Evolution Plan (ATREP)
- Army Operational Test Command (OTC), Fort Hood, TX
- Common Training Instrumentation Architecture (CTIA)
- Common Range Integrated Instrumentation System (CRIIS)
- Dugway Proving Ground (DPG)
- Electronic Proving Ground (EPG)
- integrated Network Enhanced Telemetry (iNET)
- Interoperability Test and Evaluation Capability (InterTEC)
- Joint Fires Integration & Interoperability Team (JFIIT)
- Joint Mission Environment Test Capability (JMETC)
- Joint National Training Capability (JNTC)
- Naval Air Warfare Center – Aircraft Division
- NAWC – Weapons Division
- Naval Aviation Training Systems Program Office (PMA-205)
- Naval Undersea Warfare Center (NUWC)
- NAVSEA Warfare Center - Keyport
- P5 Combat Training System (P5CTS)
- Pacific Missile Range Facility (PMRF)
- Redstone Test Center (RTC)
- T&E/S&T Non-Intrusive & Advanced Instrumentation
- White Sands Missile Range (WSMR)
- Yuma Proving Ground (YPG)


Meetings every 3 months

Industry Advising Members
- Boeing
- Cubic Defense
- DRS
- Embedded Planet
- EMC
- General Dynamics – C4 Systems
- Kenetics
- MAK Technologies
- NetAcquire
- Raytheon
- Science Applications International Corp (SAIC)
- Scientific Research Corporation (SRC)
- Scientific Solutions, Inc. (SSI)
- Trusted Computer Solutions

International Participation
- Australia
- Denmark
- France
- Singapore
- Sweden
- United Kingdom
TENA Information Assurance (IA) Activities

- **Air Force Evaluated/Approved Product List (E/APL)**
  - Approved 11/18/2010, currently preparing test results for TENA Console

- **Navy Application & Database Management System (DADMS)**
  - Approved 6/27/2011

- **Army Certificate of Networthiness (CoN)**
  - Approved 10/8/2013 and covers TENA Software Suite 6.x (including TENA-enabled applications)

- **S/DREN (Secret/Defense Research and Engineering Network)**
  - TENA protocol and TENA-based applications approved for DREN and SDREN sites

- **NIPRnet**
  - JTTOCC (which uses TENA) obtained ATO 12/27/2012

- **DIACAP**
  - InterTEC tool suite (which includes TENA Middleware) currently in DIACAP testing (with AF 46TS)

- **Unified Cross Domain Management Office (UCDMO)**
  - TENA-enabled Cross Domain trusted guard SimShield v2.2.0.1 on baseline list
  - SPAWAR (Charleston) performed Security Analysis of TENA for use in a Cross Domain Solution to support future C&A activities related to CDS systems using TENA

**TENA project working with IA organizations to reduce cost and delays with ability to operate TENA applications**
How TENA is Currently Used Across Test and Training Facilities

- Common specifications for test and training data
- Data Dissemination across variable applications, platforms, programming languages, networks, and classification levels
- Data Collection and Playback
- Local and Remote Command and Control
- Health & Status Monitoring
- Real-Time simulations
- Stimulation of live sensors and instrumentation
- Connecting non-interoperable inter- and intra-range systems
- Eliminating proprietary interfaces to range instrumentation
- Sharing and reuse of common range tools and capabilities
- Online Collaboration and File Sharing

Examples provided in slide backups
How TENA Supports T&E: Notional Test Walkthrough

TENA enables efficiencies through inherent interoperability and reuse

1. Test Planning & Requirements Definition
2. Test Design
3. Event Construction, Setup and Rehearsal
4. Test Execution
5. Analysis & Reporting

Pre-Test

Test

Post-Test

TENA Repository

TENA Object Models

TENA Tools & Utilities

Test Execution Examples

TENA Data Collection System
Test Planning: TENA Website Services
https://www.tena-sda.org/

Currently 8,378 user accounts

206 separate activity groups

16.5 million page hits in 2014

Helpdesk cases resolved in 2014 was 2,452

Currently supporting 40 computer platforms

1,198 different object models

Repository software downloads of 2,877 in 2014

727 middleware development kits downloaded in 2014
Test Design: TENA Object Models

- Enables interoperability among range resource applications
- Provides the “common language” that all range resource applications use to communicate

Object Model Stages

- **User-Defined Objects** – objects defined solely for the purpose of a given logical range by TENA users
- **TENA Candidate Objects** – objects defined as potential standards, which are undergoing test and evaluation by the community prior to standardization
- **TENA Standard Objects** – objects developed and supported by the TENA SDA, which have been approved for standardization by the AMT
The Goal of the Block 1 MLS-JCNE implementation is to provide the RDT&E community with a persistent, interoperable, and reusable capability to exchange unclassified data between unclassified and classified enclaves.
Test Construction / Setup: TENA Tools

- Tools are applications, components, or utilities required to support a successful test execution

- The TENA SDA maintains a library of tools that address common test requirements
  - Common tools enable a consistent depiction of the test environment
  - All tools and supporting documentation available through the TENA Repository

- Some example tools include:
  - Collaboration and Sharing: TENA Repository
  - Help Desk and Troubleshooting: TENA Issue Tracking System
  - OM Design Support: MagicDraw UML-to-TDL Plugin
  - Legacy Test Asset Integration: TENA Adaptor
  - Test Event Management: TENA Console
  - 3D Visualization: SIMDIS TENA Plug-in
  - Video Sharing: TENA Video Distribution System
  - Data Logging: TENA Data Collection System
TENA enables JPARC to provide force-on-force (FOF) training capability that fully integrates and supports joint and coalition components for both air and ground training in live, virtual, and constructive (LVC) domains.

“TENA is the greatest thing that ever happened to us. We couldn’t be doing today with all these systems—and we couldn’t have all the participants that we do—if it weren’t for TENA”

Billy D. Smith
Chief of electronic combat training requirements for Red Flag at JPARC
1. TENA Capable Range Interface Unit (RIU) for Radars
2. TENA capable Telemetry Tracker pointing data interface – Mod of existing RIU
3. Persistent distributed TENA capability through IRCC

TENA SDA
Provides WSMR:
- TENA Training
- OM Design
- TENA Adaptor Software
- Common Tools
- Technical Support
Test Execution Example: End State at PMRF-NGRC&DD
Test Execution: TENA at Eglin Air Force Base

- TENA supports Eglin’s Joint Test and Training Operations Control Center (JTTOCC) in providing efficient, flexible real-time control of all resources required for safe air, land, and sea test and training 24x7 operations.

“TENA gave us a common environment that greatly simplified the efforts of our two non-co-located software development contractors. It also significantly aided in our ability to meet information assurance criteria, allowing us to move from requirements to fielding on the NIPRNet in under 18 months.”

Chris Short
JTTOCC Lead Systems Integration Engineer
Test Execution Example:
TENA Enabled TM Control

- TCS Antenna Control Unit (ACU) model M1 completing TENA interface
- Remote monitoring and control of telemetry antenna system using TENA is undergoing operational testing
- To be used on Yuma TM pedestals
Test Analysis / Reporting: Data Collection and Analysis Framework

- **Data Collector**
  - Using TENA object models, data collection software is automatically generated to record object and message attribute values in a persistent data store (currently SQLite and MySQL database representations)
  - Plan to provide add-on collection capability to allow publisher side collection, as well as subscriber side collection – which requires collection management capabilities

- **Data Analysis Support**
  - Extractor tool provided to convert data into format that can be used by Microsoft Excel
  - Analysis capabilities and tools are often highly specialized, and the intent of TENA is to provide a framework for user community to extend to support their unique data storage and analysis needs

- **Data Playback**
  - Automatically generated playback tool can be used to re-play collected data for various forms of testing and analysis
TENA Upgrade Support Offer

• The TENA team is available to offer advice and assist any organization looking to use TENA
  • Advice on overall design approach and trade-offs to consider
  • Recommended Object Models to reuse
  • Recommendations on how to design new Object Models
  • Implementation / Code Designs Reviews
  • Awareness of similar systems and lessons learned
  • Hands-on training classes on TENA capabilities
  • Contract language to help ensure TENA-enabled solutions

Opportunity to Get Assistance in Using TENA
E-mail request to: feedback@tena-sda.org
What is JMETC?

- **A corporate approach for linking distributed facilities**
  - Enables customers to efficiently evaluate their warfighting capabilities in a Joint context
  - Provides compatibility between test and training

- **A core, reusable, and easily reconfigurable infrastructure**
  - Consists of the following products:
    - Persistent connectivity
    - Middleware
    - Standard interface definitions and software algorithms
    - Distributed test support tools
    - Data management solutions
    - Reuse repository

- Provides customer support team for JMETC products and distributed testing
JMETC
Distributed Test Architecture

Joint Operational Scenarios

Systems Under Test

Integrated Test Resources

Virtual Prototype
Hardware in the Loop
Installed Systems Test Facility
Range
Environment Generator
Threat Systems

TENA: Test and Training Enabling Architecture

* TENA: Test and Training Enabling Architecture
## JMETC Network Options

JMETC is the DoD’s corporate approach to distributed testing

<table>
<thead>
<tr>
<th>Key Attributes</th>
<th>JMETC Secret Network (JSN)</th>
<th>JMETC MILS Network (JMN)</th>
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<tbody>
<tr>
<td>Access to Non-DoD Assets</td>
<td>Industry X</td>
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<td>Academia X</td>
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<td>Up to &amp; including TS/SCI X</td>
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<td>Enterprise Coalition Capability X</td>
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<td>Non-Standard Configurations</td>
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<td>Non-Routable IPs X</td>
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<td>Performance</td>
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<td>Cloud Services</td>
<td>Access to Regional Service Delivery Points (RSDP’s) X</td>
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<tr>
<td>Non-Destructive Cyber Test Environments</td>
<td>National Cyber Range X</td>
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JMETC SECRET Network (JSN)

- Functional Sites: 78
- New Sites Planned: 9
- Connection Points to Other Networks: 5

- Leverages the SECRET Defense Research and Engineering Network (SDREN) for connectivity
- Operates only at the SECRET classification
- Continuous monitoring, troubleshooting, and optimization of the end-to-end network infrastructure
- Capable of supporting numerous simultaneous test events

As of 07 Oct 2015

Sites in Hawaii
PMRF: Bldg 105
MHPCC

Sites in Alaska
Ft. Greely: CRTC

JSN Sites

Army
Joint
Air Force
Industry
Navy
Marines

Distribution A. Approved for public release: distribution unlimited.
How a Test Planner Should View JMETC

All linked by JMETEC
Regional Service Delivery Points (RSDPs)

- Provide enterprise resources to generate virtualized representative cyber environments
  - Comprised of computational and storage assets to host ~15K high fidelity virtual representations
  - Each is capable of supporting numerous events and varying classifications concurrently
  - Also serves as a platform for tools and services (e.g., traffic generation, instrumentation, visualization, integrated event management, collaboration)
  - Accessible via the JMN

- Designed to be adaptable, flexible, and cost-effective
  - Modular architecture can be expanded or reconfigured to meet evolving requirements
  - Geographically dispersed to minimize latency and maximize usability
  - Employs blade architecture for feasibility
Summary

- The Test and Training Enabling Architecture (TENA) is helping standardize integration of test systems to enable more efficient T&E
  - Government-owned, community managed software matured over 15+ years of development & real-world use
  - Auto-code generation that streamlines integration and modifications
  - Enables standard, repeatable Live Virtual Constructive (LVC) integration
  - Institutionally resourced for user support, maintenance, and improvements

- TENA provides value to programs conducting T&E
  - Reduced test setup and integration time
  - Government-owned interface to modeling & simulation capabilities
  - Efficient LVC integration
  - Extensive library of applications and source code available for reuse

Specifying use of TENA in the RFP enables benefits to be realized
Important Contact Information

- **Project Website:** [https://www.tena-sda.org/](https://www.tena-sda.org/)
  - Download TENA Middleware: [https://www.tena-sda.org/repository/](https://www.tena-sda.org/repository/)
  - Submit Helpdesk Case: [https://www.tena-sda.org/helpdesk/](https://www.tena-sda.org/helpdesk/)
  - Use for technical questions regarding TENA

- **TENA Feedback:** [feedback@tena-sda.org](mailto:feedback@tena-sda.org)
  - Provide technical feedback on TENA Architecture or Middleware
  - Ask non-technical questions regarding TENA
  - Provide responses to AMT action items
  - Request TENA training
Backup Slides

Additional Examples
Some Examples of TENA Usage

- InterTEC (C4ISR stim/sim/collection)
- JDAS (data archive)
- TVDS (video distribution)
- JIMITS (live range IR threat emulator)
- SIMDIS (range display)
- Starship (event control)
- Gateways (translators to DIS & HLA)
- CTIA (training instrumentation)
- ARDS (precision TSPI)
- CRIIS (next generation precision TSPI)
- P5 (precision TSPI / ACMI)
- NACTS (precision TSPI / ACMI)
- SimShield (trusted data guard)
- Reflect (data playback)
- MatLab (data analysis)
- Execution Manager GUI (event control)
- IVT (interface/network verification tools)
- JAAR (after action review)
- JIMM (constructive simulation)
- JSAF (constructive simulation)
- DCIT (distributed monitoring)
- Link-16 translator (Link-16 over WAN)

- PET (air picture data analysis system)
- JWinWAM (test assessment tool)
- Real-time Casualty Assessment System
- ICADS (individual combat aircrew dis. sys.)
- ATREP (training instrumentation)
- iNET (wireless networking)
- CRS-P (constructive simulation)
- AEA HWIL (airborne electr. attack lab)
- OT-TES (tactical engagement sys for OT)
- ADMAS (embedded vehicle instruments)
- HWIL RF threat injection system
- Radars (tracking, surveillance, miss-distance)
- Range optics (high fidelity remote control)
- Threat systems
- UAV remote control of sensors
- Range safety systems
- Embedded instrumentation
- Weather server (distribution of weather data)
- Player ID server (Unique ID for entities)
- Open air range acoustic sensors
- Undersea hydrophone instrumentation
- Live video – synthetic scene integration
Partial Listing of Recent Testing, Training, and Experiments Using TENA-Compliant Capabilities

**Test Events**
- Joint Distributed IRCM Ground-test System (JDIGS), Mar 10-Ongoing
- Interoperability Test and Evaluation Capability (InterTEC) Cyberspace Event, Nov 11
- Air-to-Ground Integrated Layer Exploration (AGILE) Fire III, IV, V, Jan-Nov 11
- Joint Track Manager Concept-Demonstration (JTMC-D), Jun-Sep 11
- Joint Integration Air & Missile Defense Office (JIAMDO) Joint Sensor Integration (JSI), Apr-Aug 11
- Air Force Systems Interoperability Test (AFSIT), Jun-Jul 11
- Joint Strike Fighter (JSF) Test, Jun 11
- JIAMDO Correlation / Decorrelation Interoperability Test (CDIT) United Kingdom, Oct 10, Mar 11
- JIAMDO CDIT CONUS, Sep 10-Jan 11
- JRTC Joint Interoperability Test (JIT) of Air Defense Systems, Sep-Nov 10
- Broad Aerial Maritime Surveillance (BAMS) Test Oct 09 and Oct 10
- Battlefield Airborne Communications Node (BACN) Joint Urgent Operational Need (JUON), Aug 10
- B-1B Link-16 Interoperability Testing, Mar-Apr 10
- Joint Electronic Warfare Assessment for Test and Evaluation, Sep 09

**Training Exercises**
- Daily Training, Eielson AFB
- Daily Training, Fallon AFB
- Unified Endeavor (UE) 11-3, May-June 11, UE 11-1 Phase 6, Aug-Sep 11
- Joint Close Air Support (JCAS) Distributed Test, Jun 10
- Red Flag Alaska (RFA), four times a year since 2008, Pacific Alaska Range Complex (PARC)
- JDEWR Cope Tiger 09, Mar 09, PARC
- RFA 09-2, April-May 09, PARC
- Distant Frontier, May-Jun 09, PARC
- Northern Edge 09, Jun 09, PARC
- Talisman Sabre 09 - Australian Army and US Army, Jul 09, Shoalwater Bay, Queensland Australia
- RFA 09-3, Jul-Aug 09, PARC
- JDEWR Talisman Sabre 09, Jul 09, PARC
- RFA 10-1, Oct 09; 10-2, Apr 10; 10-3 Aug 10
- Northern Edge, Jun 10

**Experiments**
- Joint Surface Warfare (JSuW) Joint Capabilities Technology Demonstration (JCTD), Oct 10
- Joint Expeditionary Force Experiment (JEFX) 09-1, 09-2, 09-3, Feb-Apr 09
- JEFX 09-4 B-2 Test (Spirit ICE), Aug 09
- JEFX 10-1, 10-2, 10-3, Jan-Apr 10
TENA at Joint Pacific Alaska Range Complex (JPARC)

- TENA enables JPARC to provide force-on-force (FOF) training capability that fully integrates and supports joint and coalition components for both air and ground training in live, virtual, and constructive (LVC) domains.

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Billy D. Smith
Chief of electronic combat training requirements for Red Flag at JPARC
RTC/ASE Architecture for Test & Evaluation of Hostile Fire (RATH)

“Applying TENA has been a leading contributor to making disparate efforts (M&S, Lab, Hangar, Range) leverage duplicate capabilities to form an overall better test capability”

Mac Lowry
Advanced Technology Office Chief, Redstone Test Center
Mobile Multi-Sensor TSPI System (MMTS) Project

- U.S. Army Program Executive Office (PEO) for Simulation, Training, and Instrumentation (STRI) awarded Photo-Sonics, Inc. a contract to build the Mobile Multi-Sensor Time-Space-Position-Information-System (MMTS)
- The MMTS consists of two high-performance optical tracking pedestals connected via fiber optics to a control van equipped with two remote control consoles, the system was designed to track and provide high accuracy Time-Space-Position-Information (TSPI) of high-speed weapons including hyper-velocity projectiles
- Functional testing and Final Site Acceptance Test completed at White Sands Missile Range (WSMR)
- Final system has been delivered and integrated via TENA Interface into Redstone Arsenal

System Characteristics
- Fully Integrated Pedestal and Sensor Control Software
- Radar provides a Single Station Solution
- High-Speed Auto Tracker (250 FPS)
- High Accuracy
- High Dynamics
- Automated Stellar and Turn & Dump Calibration
- Simulation System
- Range Interface Computer to calculate real-time 3D data
- Integrated Data-Reduction Software (six degrees of freedom)
- TENA Integration into RTC

“TENA architecture was instrumental in the development of the interoperability between the MMTS and the Integrated Test Range. Implementing the various TENA modules was simple, smooth, and straightforward with no major effort needed.”

Philip Kiel
President, Photo-Sonics
TENA specified in CRIIS acquisition program requirements for ground system communication

- TENA project providing port to Green Hills Real-Time Operating System, which is used in ground stations and air platforms
- TENA specified in RRRP acquisition program requirements for radar system communication with other range systems
  - TENA project supporting the design and evaluation of object models for these tracking radars that are planned to be deployed to WSMR, Yuma, Redstone, and Aberdeen ranges
Backup Slides

Not for presentation
TENA Mission

- Historically, range systems tend to be developed in isolation, focused on narrow requirements, and constrained by aging techniques/technologies.
- Range infrastructures have grown organically with minimal coordination or sharing, resulting in duplicated effort and many “stove-pipe” systems.

The purpose of TENA is to provide the necessary enterprise-wide architecture and the common software infrastructure to:

- **Enable interoperability** among range, C4ISR, and simulation systems used across ranges, HWIL facilities, and development laboratories.
- **Leverage range infrastructure investments** across the DoD to keep pace with test and training range requirements.
- **Foster reuse** of range assets and reduce cost of future developments.

**Working with the Range Community to Build the Foundation for Future Test and Training Range Infrastructure**
TENA is...

- An implemented architecture that many government organizations & vendors use to build interoperable systems
- A highly robust GOTS network data transport architecture
- A collection of developed systems that address common needs
- Fully controlled by the community of its users
- Built for “performance, performance, and performance”
- Available for a wide range of computer platforms and programming languages
- Streamlined for practical application via auto-code generation
- A mechanism used to promote range data standards
- Backwards Compatible (from Release 6 onwards)
- Revised and Improved based on user feedback and lessons learned from working software implementations
- 100% resourced for improvements and sustainment by US DoD
TENA Objects are Compiled In

● Why use compiled-in object definitions?
  ● **Strong type-checking**
    ● Don’t wait until runtime to find errors that a compiler could detect
  ● **Performance**
    ● Interpretation of methods/attributes has significant impact
  ● Ability to easily handle complex object relationships
  ● Conforms to current best software engineering practices

● How do you support compiled-in object definitions?
  ● Use a language like CORBA Interface Definition Language to define object interface and object state structure
  ● Use **code generation** to implement the required functionality

● Thus the concept of the TENA Definition Language (TDL) was created
  ● Very similar to IDL and C++
TelemetryAntennaControlSystem
Class Hierarchy Illustration

Documentation maintained in TENA Repository
Summary: Benefits of TENA

- TENA represents an enormous amount of practical experience focused on addressing common range infrastructure requirements
  - More than 8,000 registered users who have contributed to making TENA support their needs
  - More than 170,000 user downloads of middleware and object models used across the range community

- TENA’s technical approach emphasizes cost savings and reliability
  - The TENA software is hard to use wrong
  - TENA catches many user errors at compile time rather than run time
  - TENA tools provide unprecedented understanding of a distributed event

- TENA auto-code generation capability simplifies the creation of quality range infrastructure code
  - Auto-generated example applications mean you never start with a blank page
  - TIDE tool manages installation/configuration, upgrades, and maintenance
  - Rapid development of real-time, distributed, LVC applications
  - Auto-generated test programs make integration a snap

- TENA has many standard object models enhancing interoperability
  - Building blocks already exist for common data structures and algorithms
  - More than 750 user object models exist in the TENA Repository for reusability

- All TENA software and support is free to users
  - TENA is the most capable and sophisticated interoperability solution for the range community
  - TENA software is thoroughly tested and very reliable
  - The TENA web site/repository has extensive documentation, training, and collaboration capabilities

- TENA has a plan for continued evolution and funding to execute this plan!