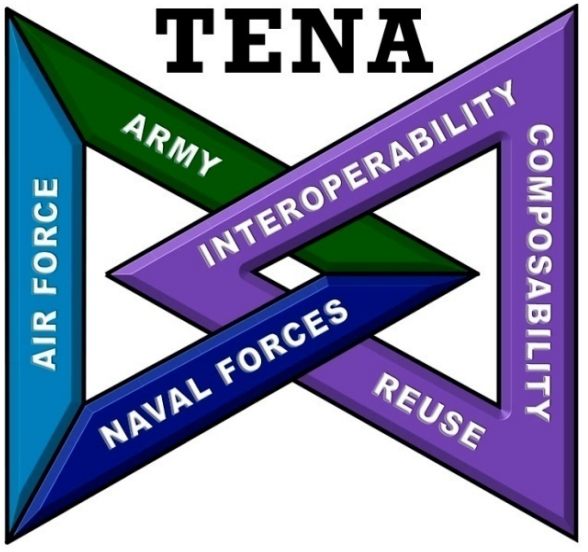
Successful Distributed and Cyber Testing with TENA and JMETC



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TENA and JMETC User Support Team Lead

Test Resource Management Center

March 8, 2017

TRMC Supports Live Virtual Constructive (LVC) Test and Training

TRMC maintains an implemented architecture and network for Red and Blue Live Virtual Constructive (LVC) T&E:

- **Mature, continuously improved software architecture (15+ years)**
- **Mature, continuously improved network infrastructure (8+ years)**
- **Standard interface definitions for integrating Red and Blue systems**

- **Proven tools suite to rapidly integrate and operate LVC-DE**
- **Existing TRMC subject matter expertise**
- **Integration of cyberspace T&E via National Cyber Range (NCR)**
- **Architecture enables integration of emerging Red/Blue capabilities**
- **Used to support over 250 distributed test events since 2007**

The right interface makes this environment available

TENA Mission

- Historically, range systems tend to be developed in isolation, focused on specific requirements, and often constrained by aging distributed computing technologies
- Range infrastructures have grown organically with minimal coordination or sharing, resulting in duplicative efforts 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 a Common Test and Training Range Infrastructure

Test and Training Enabling Architecture (TENA) at a Glance

TENA is DoD's GOTS range integration architecture

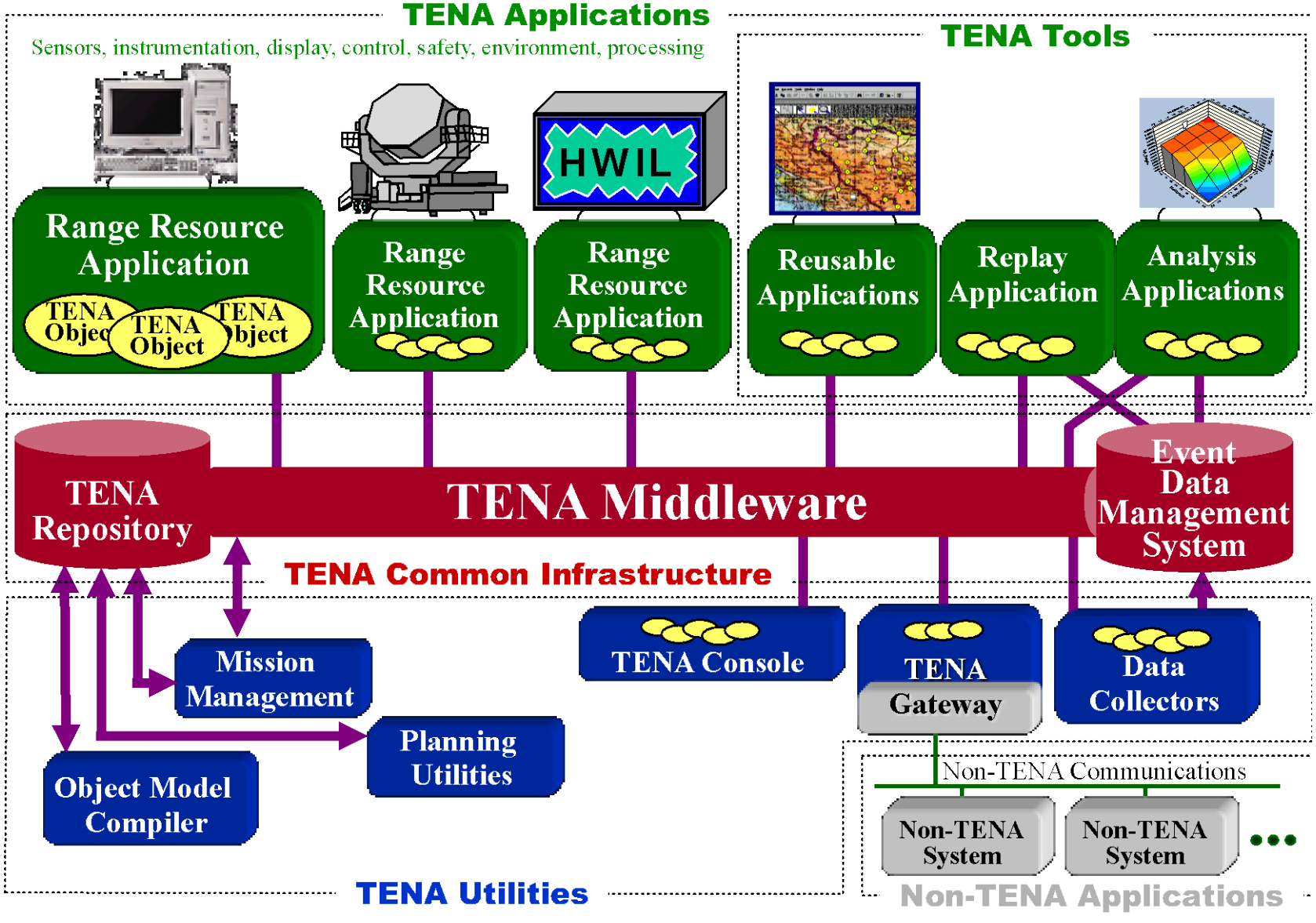
- **What does TENA enable?**
  - Interoperability between inter- and intra-range assets
  - Elimination of proprietary interfaces to range instrumentation
  - Efficient incremental upgrades to test and training capabilities
  - Integration of Live, Virtual, and Constructive assets (locally or distributed)
  - 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**

TENA ENABLED
Test and Training Enabling Architecture

TENA Architecture



TENA is an Open and Evolving Architecture

- **Software Engineering Institute (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 Models are publicly available and downloadable without restriction
    - Range system interface standards developed with community to support remote monitoring and control from a vendor agnostic manner
    - Users can create, modify, or extend object models for a given organization or event to satisfy unique distributed communication interface requirements
- **TENA Products evolved in response to range needs and technology changes**
  - TENA software products continue to evaluate and use open source software – ACE/TAO, Boost, Qt, SEDRIS, and others
  - Government owned, without any proprietary software
  - Source code collaboration services supported for various products
  - Standard interfaces emphasized to enable implementation technology changes

How TENA is Currently Used Across Test and Training Ranges & 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

Data Management

Event Management

LVC Integration

Sharing & Reuse

TENA Object Models

- **TENA uses Object Models to define system interfaces**
  - Used to formally define the data and method interfaces of a range system
  - Rich meta-model available with automatic code generation of properly designed, tested, and IA scanned software code to support common range system needs
  - Object models are properly versioned and support specialization when needed
- **TENA SDA provides Repository for Object Model definitions created by the user community to promote interoperability and reuse**
  - Provides the authoritative source and archive for range system interfaces
  - Website used to generate interface dependent software for various capabilities across 50+ different computer platform configurations used by range community

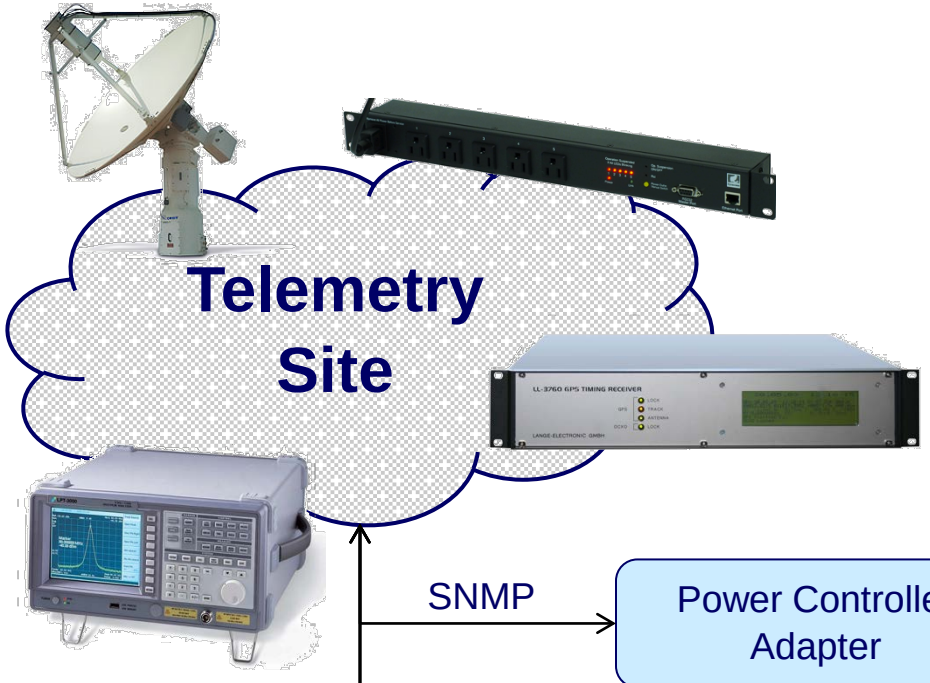
TENA Object Models provide a common interface for your LVC system

How do we integrate TENA into an existing environment?

- **Gradual and Overlapping Deployment**
  - TENA can be introduced into an existing environment in a gradual manner in which an initial set (two or more) of systems are enhanced with TENA functionality
  - These existing systems will typically require Adapters to bridge between TENA and the existing distributed communication protocols and systems
- **Adapters for Existing Protocols and Systems**
  - TENA Adapters are built in a collaborative manner following a common software framework (with code generation) to create a library of adapters that are maintained for the range community (source code versioned, built, IA scanned, tested, etc.)
  - Adapters allow the range system information and services to be available using common system interfaces and distributed communication infrastructure without changing the code to the existing systems
- **Utilize Redundancy during Testing**
  - Since existing range systems are not modified, the use of adapters permits side-by-side initial testing and operational deployment to minimize risk

TENA can be introduced to a range gradually and unobtrusively using Protocol and System Adapters

Adapter Illustration



SNMP → Power Controller Adapter

VISA → Spectrum Analyzer Adapter

TCP proprietary → Telemetry Antenna Controller Adapter

VISA → Telemetry Receiver Adapter

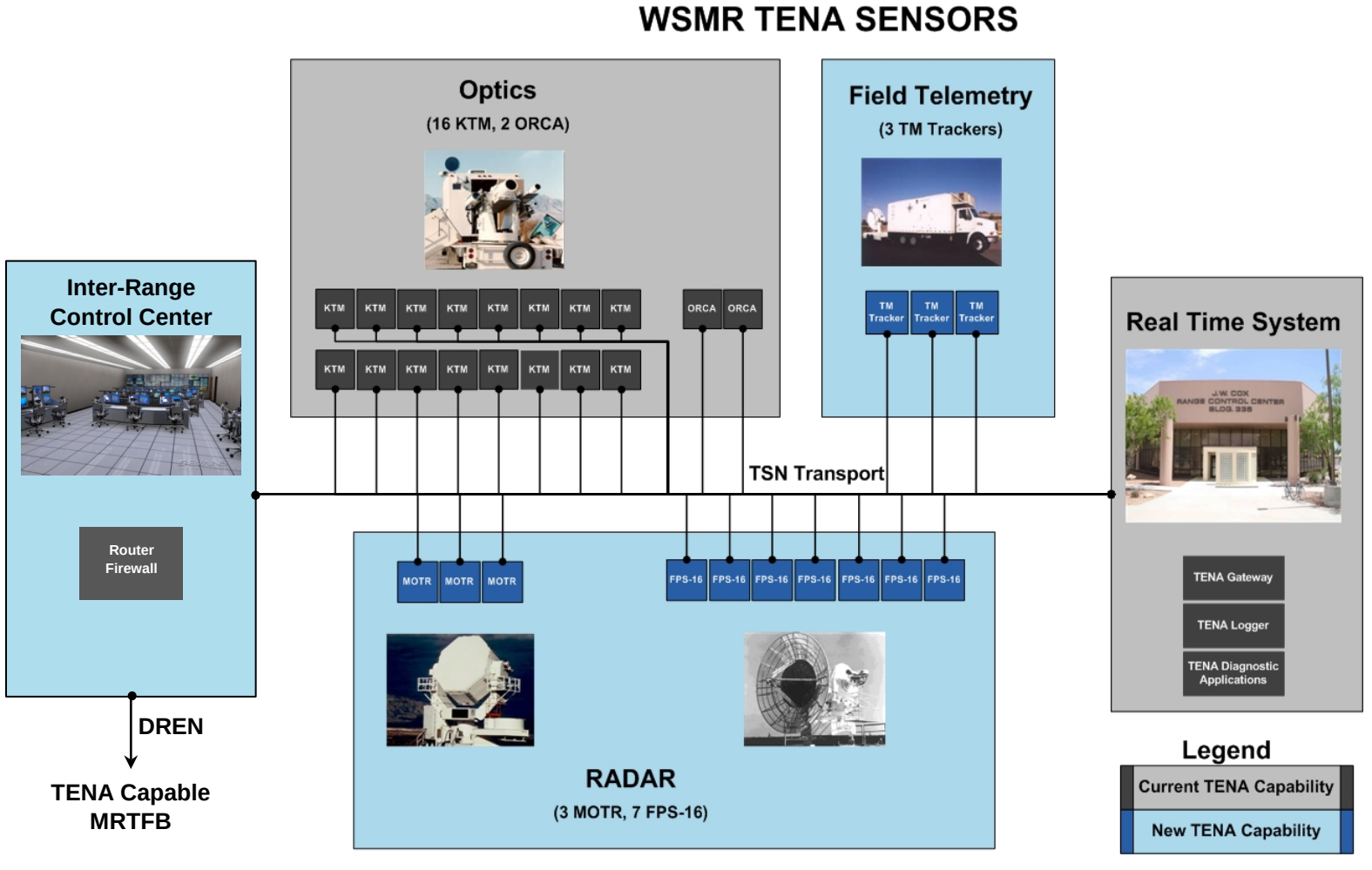
■ ■ ■

Range Instrumentation Network

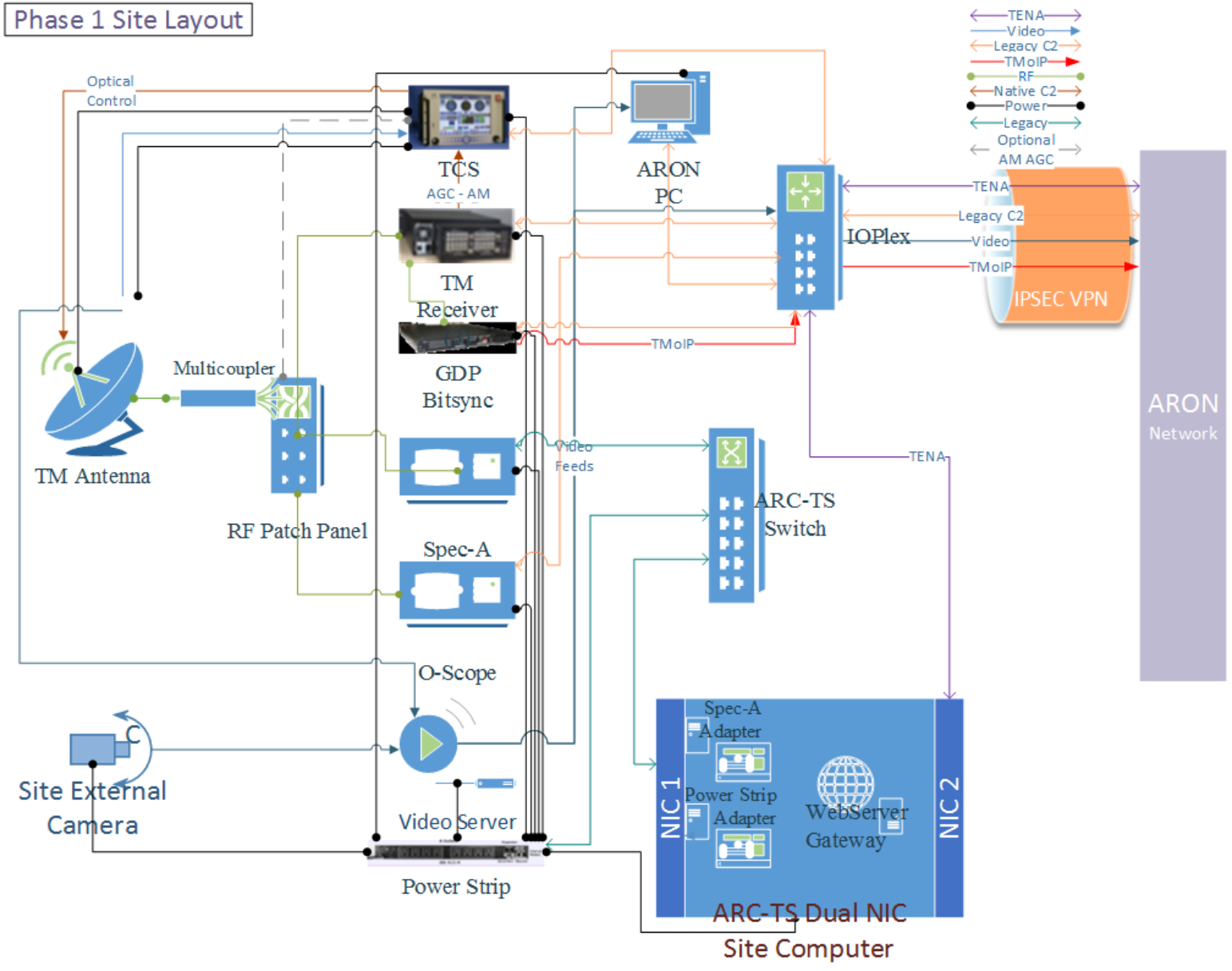
- Event Management Tools
- Remote Configuration Control
- Remote Operator Station(s)
- Range Supervisor Station(s)
- Data Collection, Analysis, & Playback
- Data Visualization Tools

WSMR Distributed Instrumentation Control Enterprise (DICE)

- Establishing common communication architecture that operates in parallel with the different functional group protocols

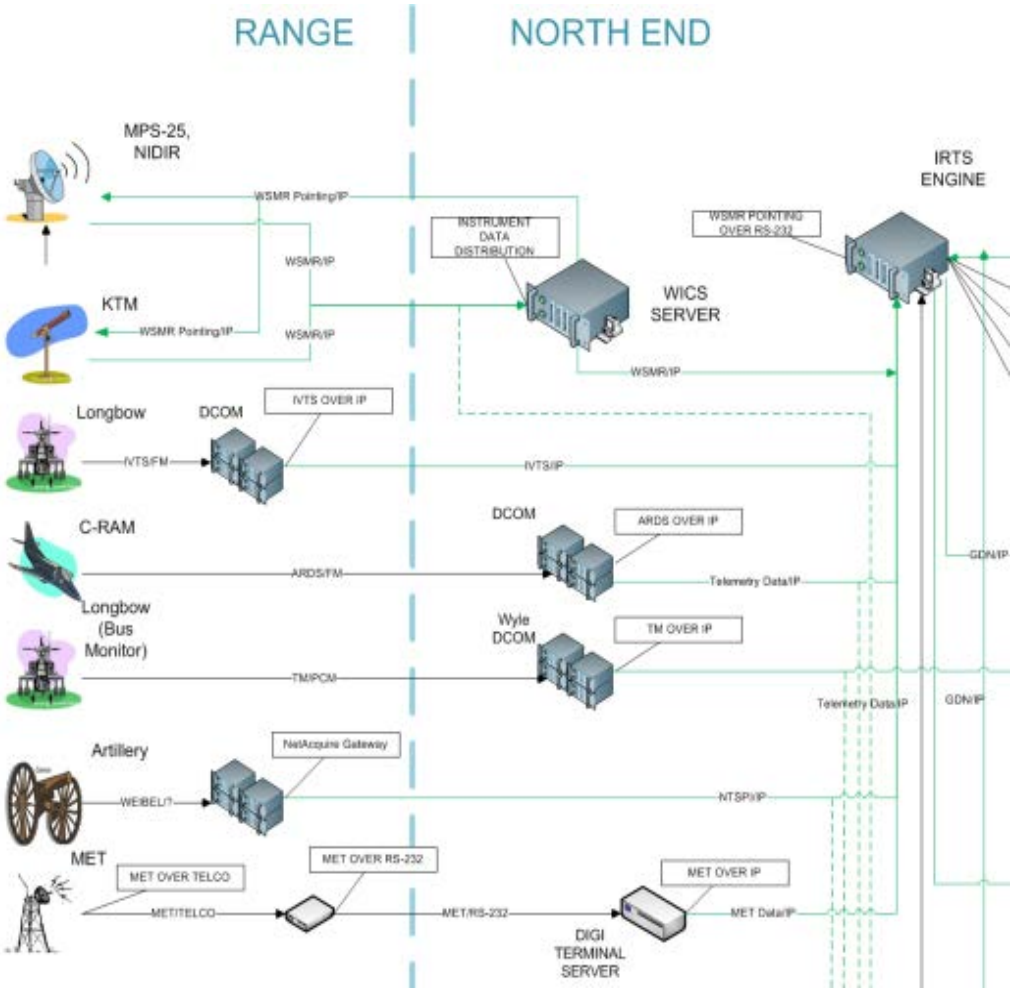


NAVAIR ATR
Advanced Remote Controlled Telemetry System (ARC-TS)



Yuma Proving Ground Range System Distributed Communication Modernization

- **YPG initiated "RealTime TENA Adoption Plan" in 2013**
  - Initial phase successfully demonstrated passive pointing of telemetry antenna control system by real-time tracking system
- **Collaborative Adapter Development**
  - MPS-25 Radar Adapter
  - TCS M1L Telemetry Antenna Control System Adapter
  - Integrated Range Tracking System (IRTS) Adapter
  - Plan to integrate Weibel radar Adapters and MRTE (Modular Real-Time Enterprise) Adapter



JMETC's Mission

JMETC provides the robust **distributed infrastructure** (network, enterprise resources, integration software, tools, reuse repository) and **technical expertise** to integrate Live, Virtual, and Constructive (LVC) systems for test and evaluation in Joint Systems-of-Systems and Cyber environments.

JMETC Benefits Acquisition Programs, Testers, & Evaluators

- Enables **early verification** that systems work in Joint and Cyber contested environments
  - Test whether systems work well together
  - Test whether systems are resilient to cyber threats
  - Identify issues early when they are less costly to fix
- Provides access to **high-demand, low availability systems**
  - Supplements number of live Systems Under Test (SUTs), threats, or “supporting cast” to create a realistic environment
  - Feasible alternative to Live testing in early DT and risk reduction for OT
- Provides access to **cyber ranges**
  - Ability to conduct unconstrained but nondestructive cyber activities in representative environments
- Provides a **collaborative engineering environment**
  - Gives SMEs an opportunity for collaboration without leaving home station
- Supports all aspects of **testing across the acquisition lifecycle**
  - Interoperability, cybersecurity, rapid fielding, DT, OT, etc.

Reduce Acquisition Cost, Schedule and Risk

JMETC SECRET Network (JSN)

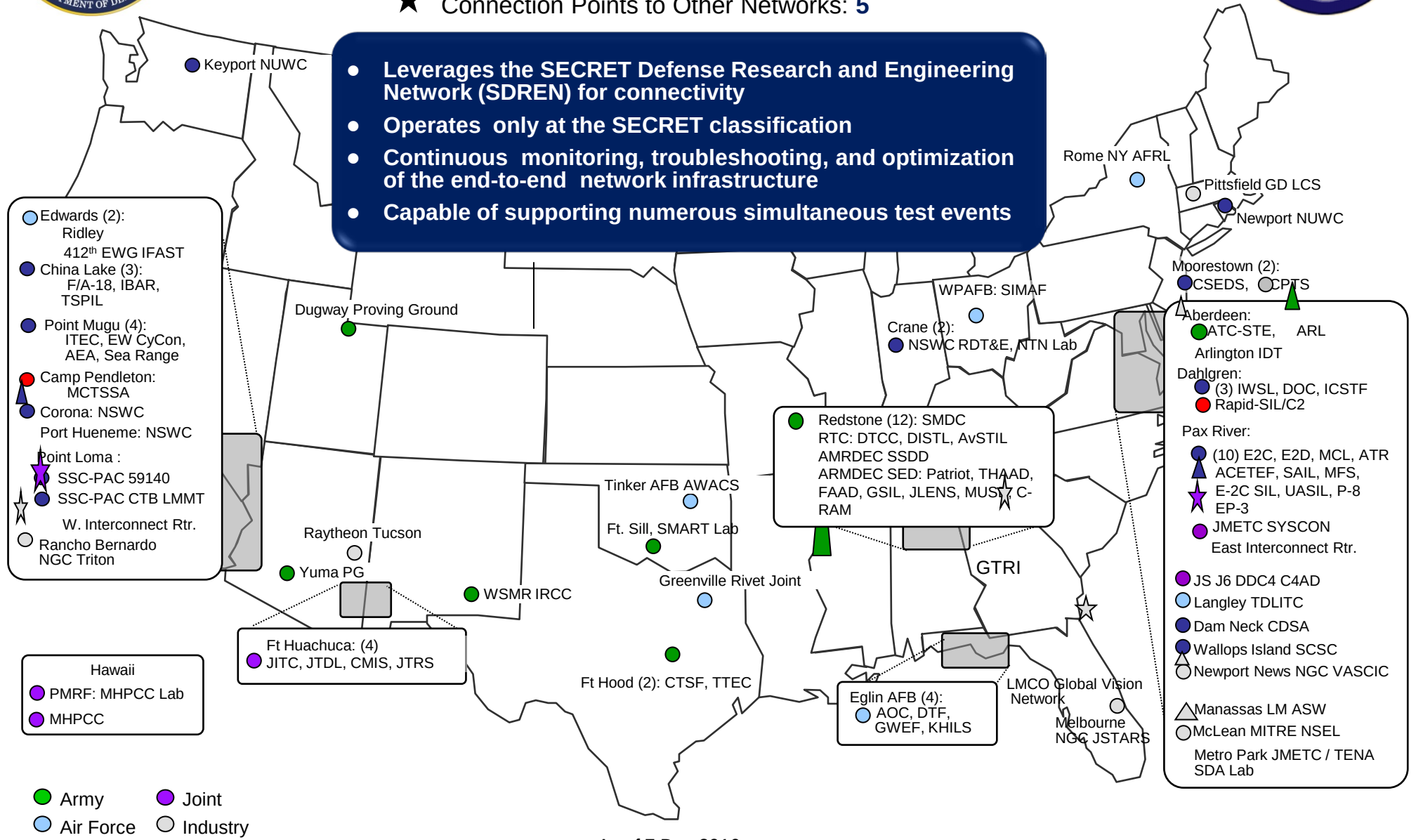
- Focus is on **persistent connectivity**
  - Standing Agreements
    - All sites have valid Authority to Operate (ATO) and Authority to Connect (ATC)
  - Daily full mesh, end-to-end network characterization ensure optimized performance
  - On demand usage with little to no coordination necessary
    - MOAs in place to authorize connections between all sites
- Persistency enables user to…
  - Test capabilities early and often
  - Execute unscheduled/unplanned testing whenever needed
  - Focus on the test rather than the network
- Operates at **SECRET Collateral**
  - Leverages SECRET Defense Research & Engineering Network (SDREN) for connectivity
  - Functional and growing since 2007

Customer time and dollars not spent on infrastructure by leveraging JMETC

JMETC SECRET Network (JSN) Site Map

- Functional JSN Locations: **45 (access to 76 labs/facilities)**
- Planned JSN Locations: **6**
- 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 7 Dec 2016

Sampling of Assets Available on JSN

JSN Event Support Services

- **Pre-Test / Test Integration Emphasis**
  - Test Development/Design - help users leverage JSN capabilities and services to meet with infrastructure solutions
  - Network Engineering - designs, configures, establishes, and baselines connectivity solutions for test customers
  - Cybersecurity Engineering - support site/user accreditation efforts
  - User Support - ensures JMETC sites have the knowledge, skills, abilities, and site-specific examples to address test resource interoperability issues

- **Test Execution Emphasis**
  - JMETC SYSCON - verifies infrastructure readiness and proactively troubleshoots problems as they are discovered
  - Event Support - provides direct support to customer test activities on an as-needed basis

- **Post Test Emphasis**
  - Capture Lessons Learned and Infrastructure Gaps/Limitations
  - Data dissemination and distributed analysis

JSN Connectivity Services

- **JSN Systems Control (SYSCON)**
  - JMETC Personnel available to test, monitor, and troubleshoot network connectivity
  - Web-Based Help Desk and Phone Support
  - Assistance with site Ports, Protocols & Services management
  - Assistance with site device configuration
  - 9x5 and after hours support as necessary
- **Inter-Site Collaboration**
  - VoIP Call Manager
  - Chat Server (XMPP)
  - Secure File Transfer Protocol (SFTP) Server
  - Adobe Connect
- **Information Assurance Compliance**
  - Linux and Windows Patches (YUM and WSUS)
  - Anti-virus (McAfee, Symantec, TrendMicro)
  - Scan/STIG tools (SRR, Gold Disk, Retina, etc.)

Continue to expand services offered based on community requirements

Major JSN Events Supported

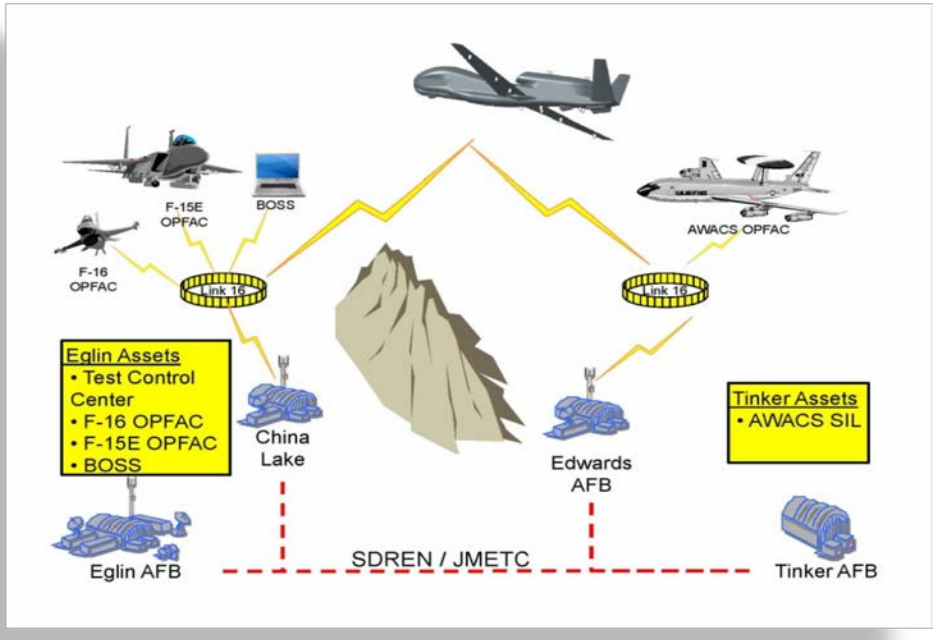
(December 2015 – November 2016)

Customer	Event	Execution Dates	Onsite Support
Navy	MQ-4C Triton	Ongoing	-
Air Force	Small Diameter Bombs II (SDB) Live Fly Testing	Ongoing	-
Air Force	Air Force System Interoperability Test (AFSIT)	Multiple	-
Joint	Joint Simulation Environment (JSE) Meeting on Adobe Connect	Dec-15	-
Air Force	Simulation Exercise (SIMEX)	Dec-15	**Yes**
Navy	NAVAIR Captive Carry Testing	Jan-16	-
Joint	Joint Interoperability Test Command (JITC) Joint Interoperability Tests (JIT)	Jan-16, Mar-16, Jul-16, Oct-16	**Yes**
Navy	Distributed Integration & Interoperability Assessment Capability (DIIAC) V&V	Feb-16, Apr-16, Jun-16, Sep-16	**Yes**
Navy	Interoperability Development and Certification Testing (IDCT)	Mar-16, Aug-16, Nov-16	**Yes**
Navy	Common Connectivity Device (CCD) Cooperative Engagement Capability (CEC) Multi-Site Interoperability Testing	Mar-16	-
Navy	Integrated Warfare Systems (IWS) Interoperability Configuration Verification	May-16	**Yes**
Joint	Air Ground Integrated Layer Exploration (AGILE) Fire IX	Apr-16, Jun-16, Aug-16	**Yes**
Joint	Joint Distributed IRCM Ground-test System (JDIGS)	Jun-16	-
Joint	Navy Integrated Fires	Jun-16, Nov-16	**Yes**
Joint	F-35 Joint Strike Fighter Record & Playback	Aug-16	**Yes**
Navy	Alpha Omega Live Virtual Constructive (LVC) Event	Sep-16	-

JSN Event Examples

Battlefield Airborne Communication Node (BACN) Joint Urgent Operational Need

- Integration of BACN payload onto multiple platforms for solution to urgent in-theater need :
  - Combat requirement for beyond line-of-sight comm
  - Relay, bridge, and range extension for ground forces and supporting aircraft
- Distributed Testing included Live-fly, DT, and Operational Utility Evaluation



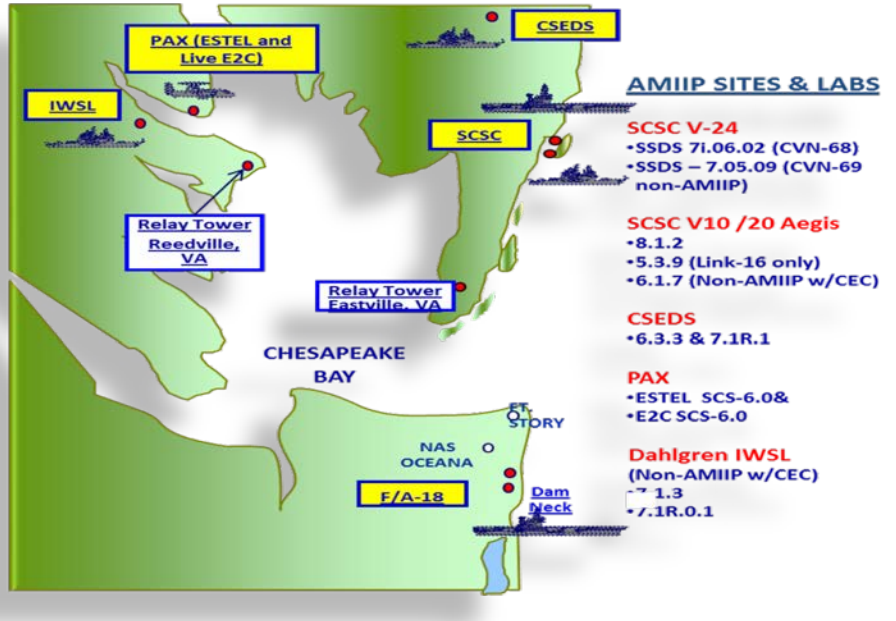
IMPACT

- Efficient integration of DT and OT
- Testing successfully completed without need for live assets to be co-located
- Distributed Testing saved “~$1.2M” (OTA)
- Urgent capability fielded-quickly

JSN Event Examples

Aegis "Accelerated Mid-Term Interoperability Improvement Project" (AMIIP)

- Assessment of Interoperability improvements between Aegis and cooperative platforms
- Aegis Ship Self Defense Ship (SSDS) and Hawkeye E-2C Live Hardware-In-the-Loop systems in a full Cooperative Engagement Capability (CEC) net for a representative Battle Group environment.
- Addresses 4 of the "Big 6" Fleet interoperability issues
    1. **Track ID / IFF**
    2. **Link Track Correlation**
    3. **TDL Filtering**
    4. **Link 16 / Link 11 Pairings**
    5. Digital Air Control
    6. IFF Mode 5 Fielding
- 5 Sites, 9 Labs, 10 HWILs, Live Fly includes E-2C and F/A-18s
- JMETC supported distributed testing of systems is verified in follow-on live Sea Tests.



IMPACT

- Provided "unprecedented environment for Strike Group like testing"
- Testing efficiency, reduced risk & minimized costs to find/fix problems
- True "Test-Build-Test" rapid turnaround
- Moved data to the analyst versus moving analyst to the data

JSN Event Examples

Joint Interoperability Tests (JITS)

- Sponsored by the Joint Interoperability Test Command (JITC)
- JITC conducts interoperability assessments, standards conformance, and interoperability certification testing of joint tactical data links in HWIL and operationally realistic environments to validate the implementation of approved standards in a Joint environment.
- Supports NR-KPP Assessment
- Typically 4-5 large events annually

IMPACT

- Joint Interoperability could not be evaluated on this scale without a distributed LVC environment
- The Joint Tactical Data Link Community of Interest (COI) moved to JMETC in 2010 due to cost savings and increase flexibility

Why Do We Need Cyber Ranges?

- To assess advanced cyberspace technologies or exercise tactics, techniques, and procedures (TTPs) that require **isolated environments** of complex networked systems (e.g., movement on the Internet)
- To **conduct activities that cannot occur on operational networks** due to potential catastrophic consequences (e.g., releasing self-propagating malware)
- To **rapidly and realistically represent cyber contested environments** at different levels of security, fidelity, and/or scale (e.g., Blue [friendly] force, Red [adversary] force, and Gray [neutral] networks)
- For **precise control of the event environment** that allows for rapid reconstitution to a baseline checkpoint, reconfiguration, and repeat of complex use cases (e.g., rapidly running variation of conditions to quickly evaluate hundreds of scenarios)

Requirement Drivers for Additional Cyber Range Capabilities

- Need increased virtualization **capacity to meet expected demand** but must be…
  - cost effective to scale efficiently
  - remotely accessible to support distributed activities
  - interoperable with other “cyber range” capabilities
  - able to support multiple security classifications (including coalition)
  - able to support unconstrained activities

These Virtual Ranges Can Also Be Utilized To Meet More Traditional Requirements

Integrated Solution

Multi-classification Network

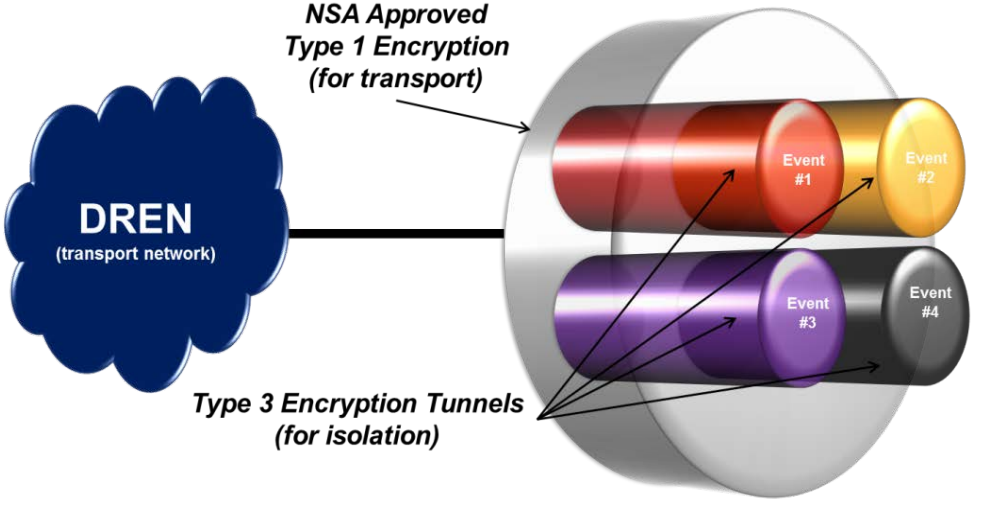
Distributed Cloud Computing Environment

Tools and Services

Technical Support Team

JMETC MILS Network (JMN)

- Focus is on providing **secure distributed testbeds** to support unconstrained cyber activities and users access to **enterprise resources at multiple classifications**
- Employs **Multiple Independent Levels of Security** (MILS) architecture
  - Allows for segregation of data streams by protocol, system, event, COI, etc.
    - Capable of supporting multiple simultaneous events at multiple classifications concurrently
    - Ability to create isolated "sandboxes"
  - Accredited by Defense Intelligence Agency (DIA) to **operate from Unclassified up to TS//SCI**
    - Included NSA Red Team assessment



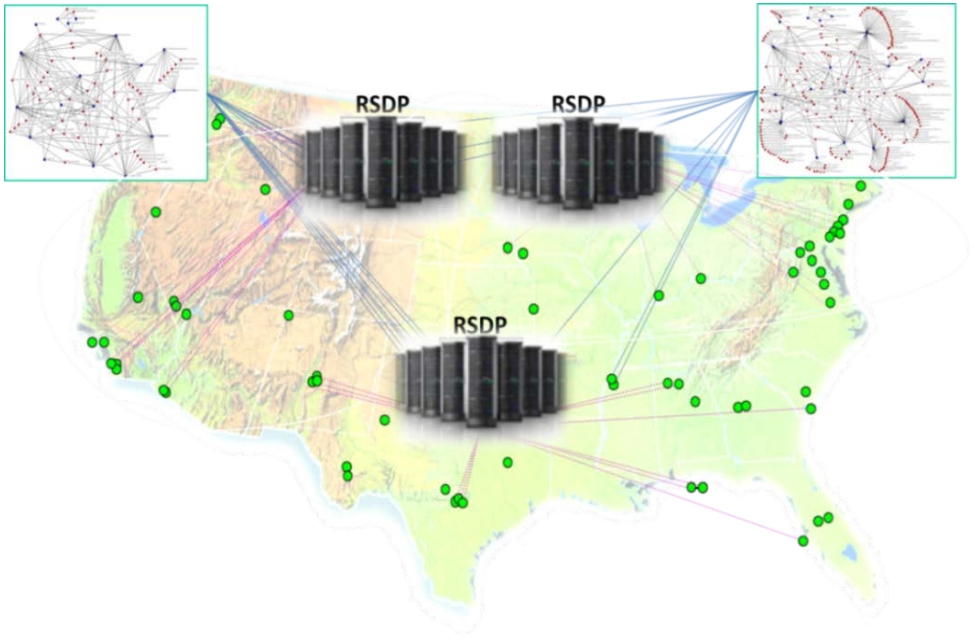
JMN Connectivity Services

- JMN NOSC
  - Manage, optimize and troubleshoot network connectivity
  - Help Desk
  - Provide pre-event checkouts as requested
  - Local infrastructure assistance as requested
  - 10x5 with after hours support as necessary
- Inter-Site Collaboration
  - VoIP
  - Chat Server
  - Secure File Transfer Protocol (SFTP) Server

Continue to expand tools & services offered based on user requirements

Regional Service Delivery Points (RSDPs)

- Provide enterprise resources to **rapidly generate virtualized representative cyber environments**
  - Comprised of computational and storage resources to host 1000s of high fidelity virtual representations
    - Large, integrated Red-Blue-Gray environments
    - Platform specific high-fidelity representations
    - Tailored, independent student classrooms
  - Automated provisioning to minimize deployment time
  - Each is capable of supporting numerous events and varying classifications concurrently
  - Serves as a platform for tools and services
  - Geographically dispersed to minimize latency and maximize usability
  - Designed to be cost-effective and adaptable
  - Also supports more conventional types of testing

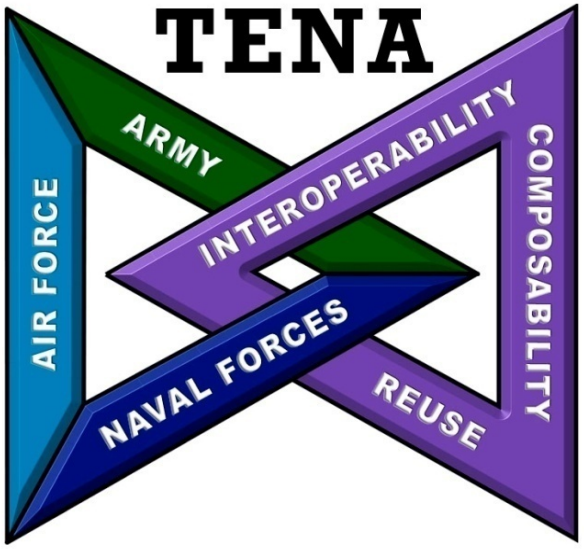


Important Contact Information

- **TENA Website: http://www.tena-sda.org**
  - Download TENA Middleware
  - Submit Helpdesk Case (http://www.tena-sda.org/helpdesk)
    - Use for all questions about the Middleware

- **JMETC Program Office Contact:**
  - E-mail: jmetc-feedback@jmetc.org
  - Telephone: (571) 372-2699
  - JMETC Website: http://www.jmetc.org

- **TENA Feedback: feedback@tena-sda.org**
  - Provide technical feedback on TENA Architecture or Middleware
  - Ask technical questions regarding the TENA architecture or project
  - Provide responses to AMT action items
  - Request TENA training


TENA
ARMY
INTEROPERABILITY
AIR FORCE
COMPOSABILITY
NAVAL FORCES
REUSE


ENABLING JOINT DISTRIBUTED TESTING
JMETC
OSD