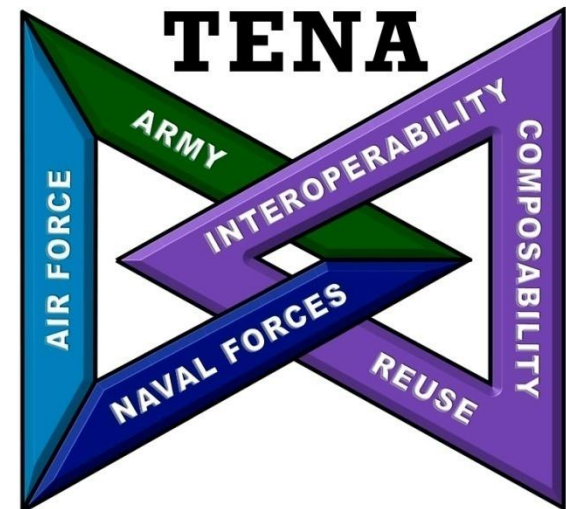


Improving Distributed Test & Evaluation with JMETC & TENA



Keith Poch

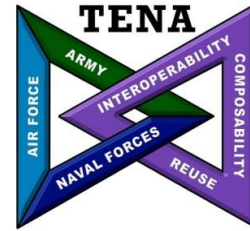
TRMC JMETC / TENA User Support Team, JSN Connectivity Team

KBRwyle, Acquisition Engineering, Niceville, FL

Keith.Poch@tena-sda.org



T&E at a Crossroads

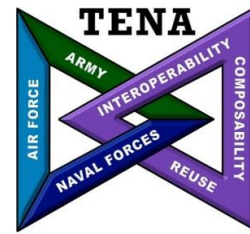


- **Live-Virtual-Constructive distributed T&E mitigates today's biggest testing limitations:**
 - We aren't challenging current generation acquisition systems with complex enough test environments
 - We have limited high priority / low availability assets to go around
 - Testing with multiple security levels / boundaries is too resource-intensive to be viable
 - Information Assurance & Cybersecurity is equal parts necessary and frustrating
 - "Traditional" T&E model not relevant in an agile acquisition world
- **The Problem: Distributed T&E is still "hard" so it isn't a critical part of every program's day-to-day test activities**
 - Connecting disparate lab & range networks needs to be easier & faster
 - Effort needs to shift from environment construction and test execution to improving data analysis capabilities
 - Cooperation & collaboration between facilities needs to be the norm rather than the exception
- **Vision: We must make distributed T&E routine**
 - **Before JMETC:** Months / Years to plan, execute, & analyze
 - **With JMETC Now:** Weeks / Months to plan, execute, & analyze
 - **Our Need:** Hours / Days to plan, execute, & analyze

T&E risks irrelevance if we don't address these limitations



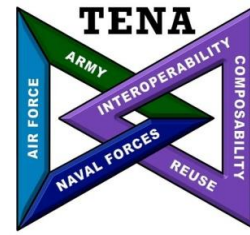
Joint Mission Environment Test Capability (JMETC) Program



- **Distributed Testing (Events, Tools, etc.)**
- **JMETC Secret Network (JSN)**
- **Test & Training Enabling Architecture (TENA)**
 - TENA Object Models
 - TENA Web Services
 - TENA Software Repository
 - TENA Tools
- **Big Data / Knowledge Management Initiative**
- **National Cyber Range Complex (NCRC)**
 - National Cyber Range (NCR)
 - Regional Service Delivery Points (RSDPs)
 - NCR Expansion (Service Sites)
- **JMETC MILS Network (JMN)**
- **Executive Agent (EA) for Cyber Test Ranges**



Distributed T&E Ingredients Supporting the Vision



- **Connectivity: “Persistent MILS Network”**

- Common network practices & procedures that reduce test execution risk
- Shared Cross Domain Solutions (CDS) that reduce cost to use & maintain
- Proactive monitoring & troubleshooting when things gone wrong

- **Analysis Capabilities: “Bring Big Data Analytics to T&E”**

- Connections to physically disparate data sources
- Automated analysis and reporting capabilities
- Empower analysts to ask questions they never thought possible to ask

- **Information Assurance / Cybersecurity: “Balancing security & mission”**

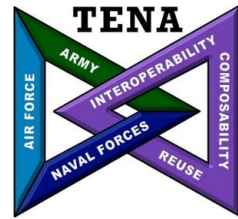
- Pre-negotiated security agreements with reciprocity across disparate domains
- Common Risk Management Framework (RMF) Overlay for RDT&E Networks
- Shared software certifications for common tools

- **Subject Matter Expertise: “JMETC is its people”**

- Seasoned team with decades of hands-on distributed T&E experience
- “Walking Encyclopedias” of available test assets & best practices



JMETC Benefits Acquisition Programs, Testers, & Evaluators

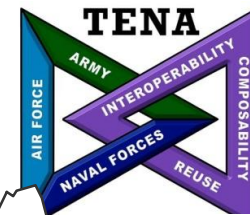


- Enables early verification that systems work in a Joint Environment
 - Test whether systems work well together
- Supports all aspects of testing
 - Rapid acquisition, Developmental Test, Operational Test, Interoperability Certification, Net-Ready Key Performance Parameters testing, Joint Mission Capability Portfolio testing
- Helps find problems early in acquisition – when they are less costly to fix
 - Customers have run as many as 20 independent test runs in a day and fixed interoperability issues overnight
- Reduces acquisition time and cost
 - Readily-available, persistent connectivity with standing network security agreements
 - Common integration software for linking sites
 - Accredited test tools for distributed testing
- Support to Acquisition Programs
 - Expertise to integrate distributed test facilities

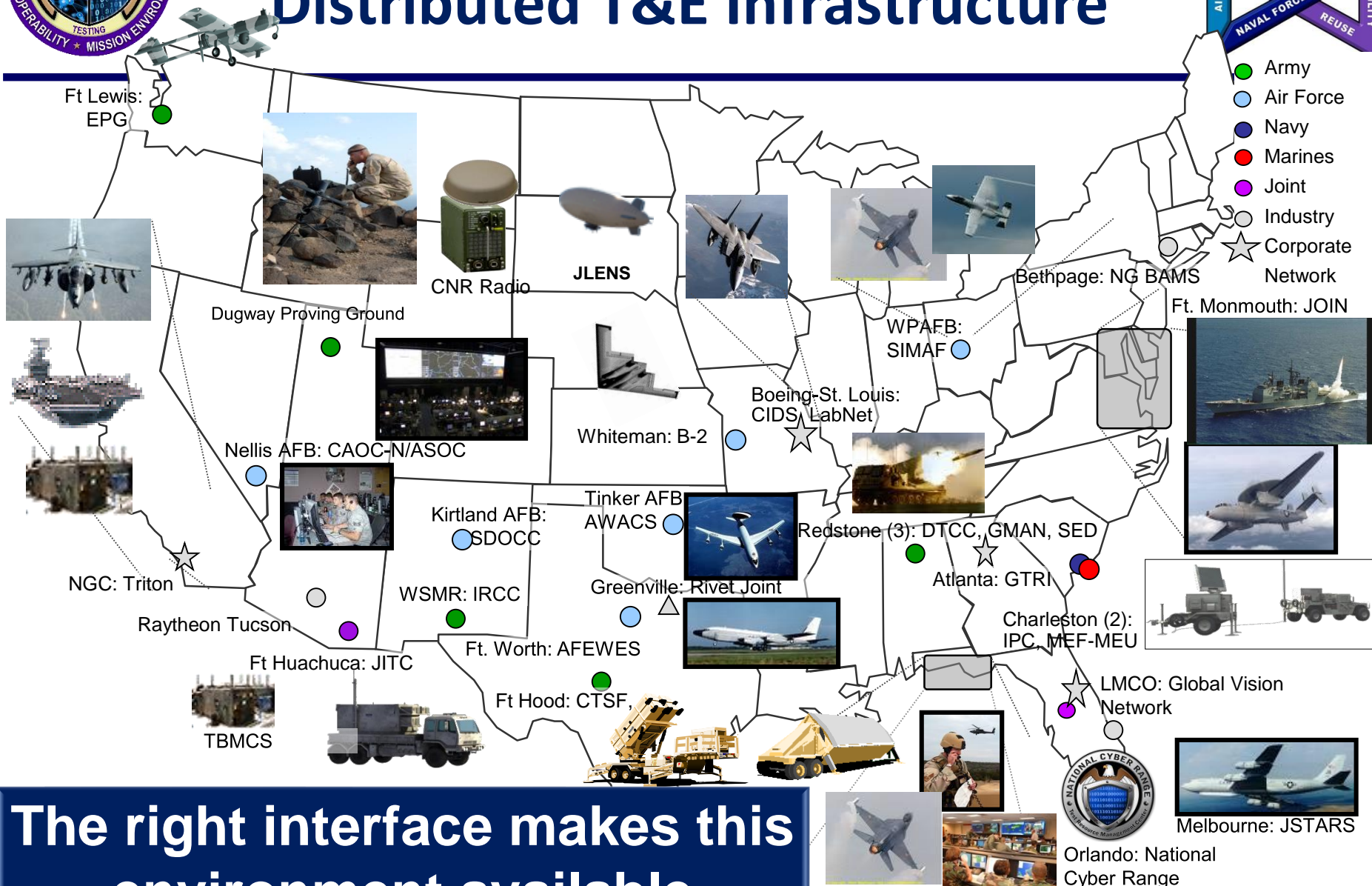
JMETC is identified in T&E Master Plans (TEMPs) as the distributed infrastructure to be used to conduct Joint testing



Example Assets Available Through Distributed T&E Infrastructure



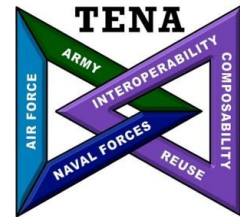
- Army
- Air Force
- Navy
- Marines
- Joint
- Industry
- ★ Corporate Network



The right interface makes this environment available

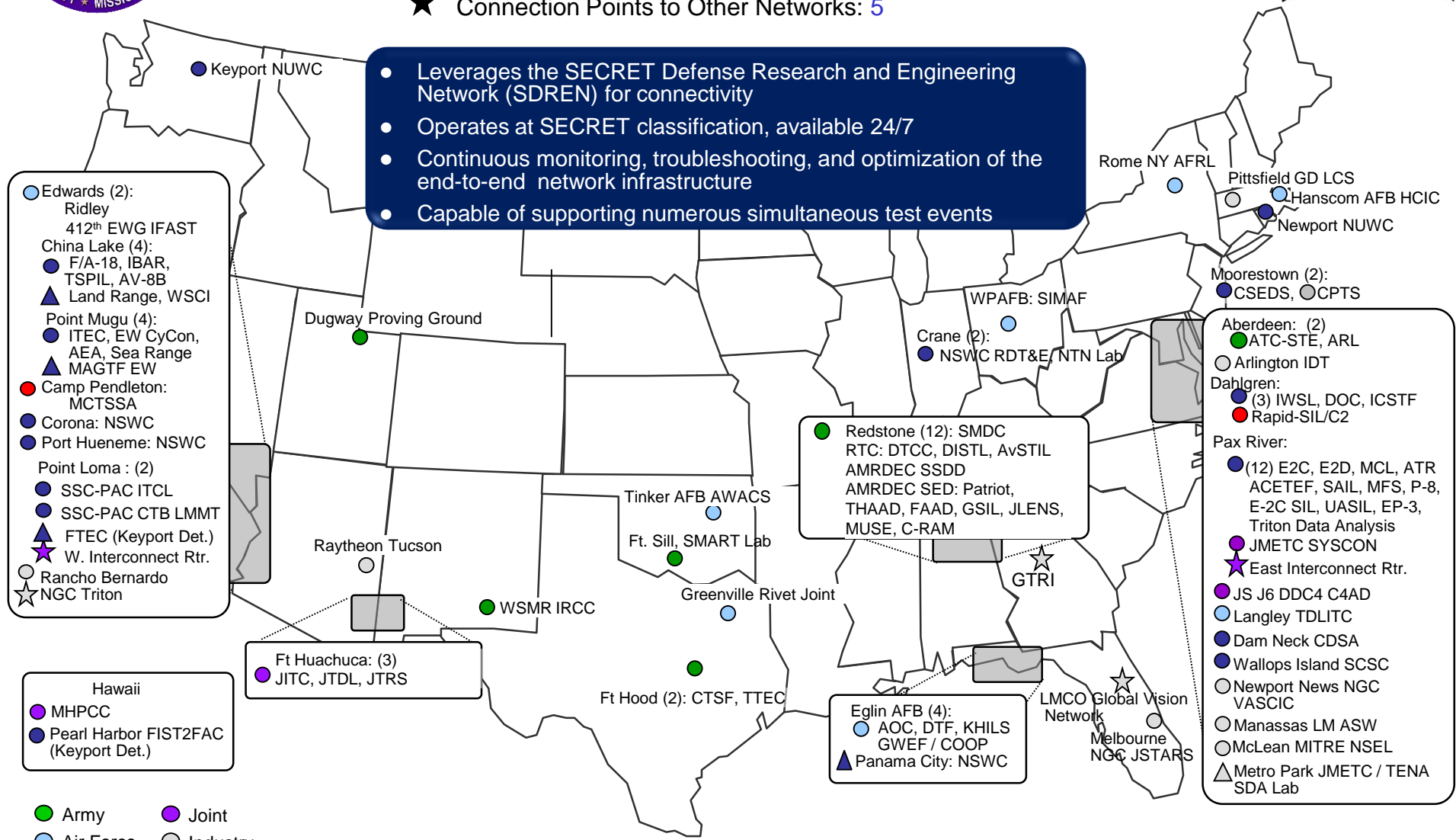


JMETC SECRET Network (JSN) Site Map



- Functional JSN Locations: 49 (access to 82 labs/facilities)
- ▲ Planned JSN Locations: 6
- ★ Connection Points to Other Networks: 5

- Leverages the SECRET Defense Research and Engineering Network (SDREN) for connectivity
- Operates at SECRET classification, available 24/7
- Continuous monitoring, troubleshooting, and optimization of the end-to-end network infrastructure
- Capable of supporting numerous simultaneous test events



- Edwards (2):
Ridley
412th EWG IFAST
- China Lake (4):
F/A-18, IBAR,
TSPIL, AV-8B
- ▲ Land Range, WSCI
- Point Mugu (4):
ITEC, EW CyCon,
AEA, Sea Range
▲ MAGTF EW
- Camp Pendleton:
MCTSSA
- Corona: NSWC
- Port Hueneme: NSWC
- Point Loma : (2)
- SSC-PAC ITCL
- SSC-PAC CTB LMMT
- ▲ FTEC (Keyport Det.)
- ★ W. Interconnect Rtr.
- Rancho Bernardo
- ★ NGC Triton

- Hawaii
- MHPCC
- Pearl Harbor FIST2FAC
(Keyport Det.)

- Army
- Air Force
- Navy
- Marines
- Joint
- Industry

- Ft Huachuca: (3)
JITC, JTDL, JTRS

- Redstone (12): SMDC
RTC: DTCC, DISTL, AvSTIL
AMRDEC SSDD
AMRDEC SED: Patriot,
THAAD, FAAD, GSIL, JLENS,
MUSE, C-RAM

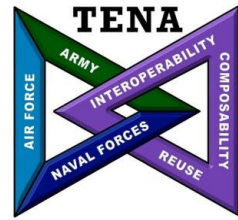
- Eglin AFB (4):
AOC, DTF, KHILS
GWEF / COOP
- ▲ Panama City: NSWC

- Aberdeen: (2)
ATC-STE, ARL
- Arlington IDT
- Dahlgren:
(3) IWSL, DOC, ICSTF
● Rapid-SIL/C2
- Pax River:
● (12) E2C, E2D, MCL, ATR
ACETEF, SAIL, MFS, P-8,
E-2C SIL, UASIL, EP-3,
Triton Data Analysis
- ★ JMETC SYSCON
- ★ East Interconnect Rtr.
- JS J6 DDC4 C4AD
- Langley TDLITC
- Dam Neck CDSA
- Wallops Island SCSC
- Newport News NGC
VASCIC
- Manassas LM ASW
- McLean MITRE NSEL
- ▲ Metro Park JMETC / TENA
SDA Lab

As of 25 Apr 2018



JMETC SECRET Network (JSN) Teams

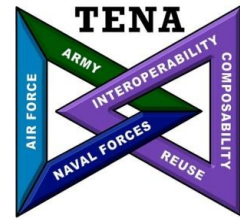


JMETC teams provide direct onsite or remote test activity support regarding test requirements, planning / design, execution, and post-test lessons learned and infrastructure gaps / limitations as needed

- **JSN SYSCON** – Tier 1 help desk, full mesh network characterization testing, proactive troubleshooting, test event collaborative systems (VoIP, Adobe Connect, chat, file server), security patches
- **JSN Connectivity Team** – Tier 2 network support, network characterization and analysis, walk-the-wire trouble resolution, assistance with new site Connection Approval Process (CAP), site installation, PPS (ports, protocols and services) management, Cybersecurity
- **User Support Team** – Test requirements, planning, test event support tools, Test and Training Enabling Architecture (TENA), test execution, on-site event assistance



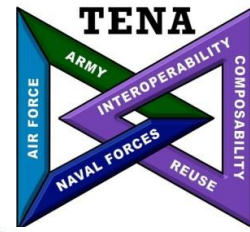
JSN SYSCON Services



- **Cisco Unified Call Manager Cluster** -- Redundant VoIP Telephone and Voice Conferencing servicing JSN Sites
- **Adobe Connect**
 - Used for event team collaboration / event control on JSN / SDREN
 - Similar capability as DCS with desktop sharing, file sharing, whiteboard sharing, video, and chat
 - Valuable for event teams to view briefings, schedules, test points, hotwashes
 - Adobe Connect User Guide posted on JMETC website
- **Extensible Messaging and Presence Protocol (XMPP) Chat**
 - Used for tactical chat
- **Secure File Transfer Protocol (SFTP) Server**
 - Used extensively for file transfer
- **Domain Name Service (DNS)**
- **YUM (Yellowdog Updater, Modified) Server**
 - Used to update Linux (CentOS)
- **Windows Server Update Services (WSUS) and AV updates (McAfee & Symantec) at SDREN NOC**

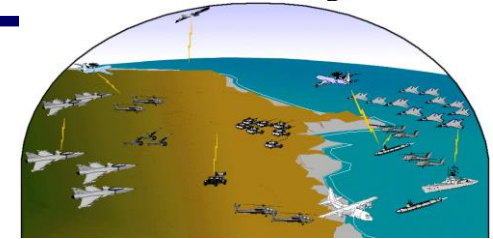
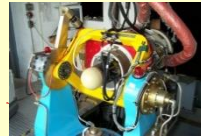


JMETC Uses TENA as its Distributed Test Architecture



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 Standard Interface Definitions

TENA Standard Interface Definitions

TENA Standard Interface Definitions

TENA Standard Interface Definitions

TENA Standard Interface Definitions

TENA Standard Interface Definitions

TENA Common Middleware

TENA Common Middleware

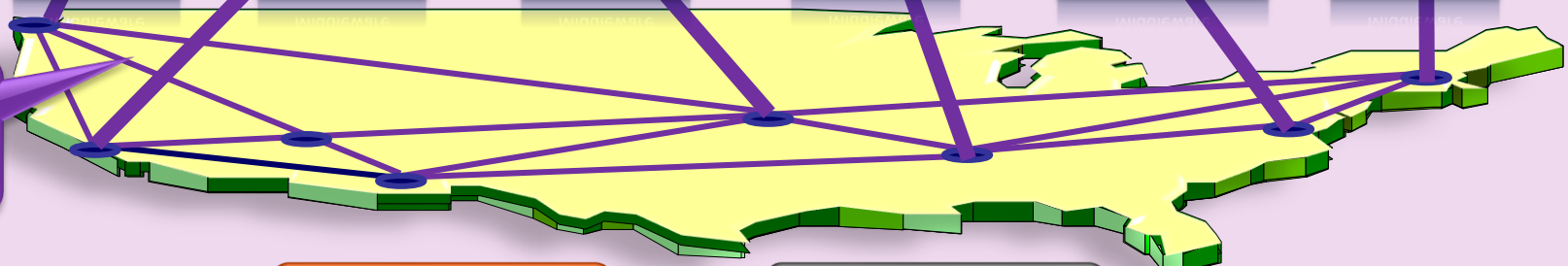
TENA Common Middleware

TENA Common Middleware

TENA Common Middleware

TENA Common Middleware

JMETC Infrastructure on DREN



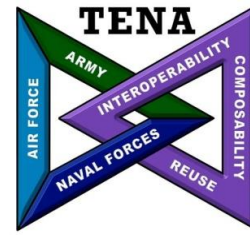
Reuse Repository

Distributed Test Support Tools

* TENA: Test and Training Enabling Architecture



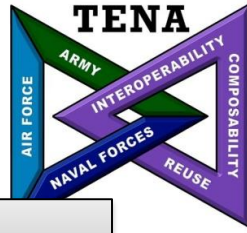
Enterprise Software Ingredients Supporting the Vision



- **System Integration Tools: “LVC Interoperability is our mission”**
 - Software that reduces test setup & design costs in a mixed architecture environment
 - Cross Domain Solutions that bridge classification levels and/or security boundaries
 - Adapters that enable communication without changing existing systems’ behaviors
- **Common Tools: “Build once, use everywhere”**
 - Community tools readily available for download and use
 - Event Planning tools that simplify event integration and setup
 - Event Management tools that enable total awareness
 - Post-Test Event Analysis tools that embrace big data analytics techniques
- **Collaboration Tools: “The sum is better than the parts”**
 - Community-wide and DoD-only event collaboration
 - Community-wide and DoD-only source code collaboration
- **Cloud Services: “Embrace Testing as a Service (TaaS)”**
 - Immersive constructive environments available “on demand”
 - Re-hosted acquisition system software readily available for use (e.g. JSF system software)
 - Reduce local software footprint to mitigate Information Assurance headaches



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?

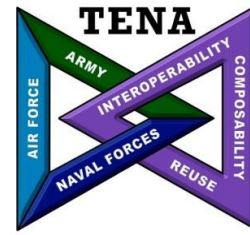
- Customizable “data contracts” that standardize repeatable information exchange
- Interoperability-enabling, auto-code generated software libraries
- A core set of tools that address common test and training requirements
- Collaboration mechanisms that facilitate sharing and reuse

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





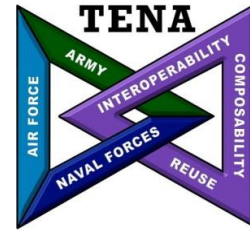
TENA SDA Current Focus Areas



- Supporting capabilities development at ranges & labs
- Enabling TENA use in TRMC CTEIP and T&E S&T projects
- Expanding a GOTS library of range systems adapters
- Standardizing instrumentation remote monitoring and control
- Updating Object Models to better mix Virtual-Constructive with Live
- Improving enterprise tools & utilities
- Enhancing TENA Website Services
- Prototyping Enterprise Software Sharing Repository
- Exploring Software as a Service (SaaS) in the cloud
- Preparing for an enterprise Knowledge Management / Big Data Analytics capability
- Developing a “common language” for cyber T&E and training



JMETC / TENA Support Offer



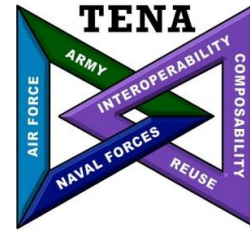
- **The JMETC / TENA team is available to offer advice and assist any organization looking to use TENA**
 - Advice on overall design approach and trade-offs to consider
 - Recommended Object Models to reuse
 - Recommendations on how to design new Object Models
 - Implementation / Code Designs Reviews
 - Awareness of similar systems and lessons learned
 - Hands-on Training classes on TENA capabilities
 - Contract language to help ensure TENA-enabled solutions
 - Network connectivity to CONUS & OCONUS labs / ranges / facilities
 - Distributed event subject matter expertise

Need Assistance?

E-mail request to: feedback@trmc.osd.mil



Summary



- **Vision: An agile Test & Evaluation Infrastructure that support acquisition requirements**
 - Robust, Immersive, Easy-to-Construct Live-Virtual-Constructive Test Environments
 - Agility that supports rapid acquisition & experimentation along with traditional DT / OT
- **TENA provides the architecture and enterprise software foundation to achieve the vision**
- **JMETC provides the network and LVC expertise to achieve the vision**
- **The JMETC / TENA SDA Team is here to help**
 - TENA Upgrade support offer
 - Distributed Test Event Subject Matter Experts (SMEs)
 - Knowledge Management and Big Data Analytics support
 - Information Assurance / Cybersecurity assistance



JMETC Points of Contact



TENA Software Development Activity (SDA) Director

Ryan Norman
(571) 372-2725

ryan.t.norman.civ@mail.mil

Event Scheduling / Event Questions

Interoperability Events

Keith Poch
(850) 389-6044

keith.poch@tena-sda.org

Distributed Tests

Linking Sites

Cyber Events

Lizann Messerschmidt
(571) 451-4295

lizann@mitre.org

NCR Events

RSDP Events

JMETC Program Manager

George Rumford
(571) 372-2724

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NCRC Expansion / Site Questions

NCRC, Deputy Director

Rob Tamburello
(501) 372-2753

robert.n.tamburello.civ@mail.mil

TENA Products / Software Repository

TENA Software Development Manager

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(703) 253-1068

steve.bachinsky@tena-sda.org

National Cyber Range Complex (NCRC) Director

AJ Pathmanathan
(571) 372-2702

arjuna.pathmanathan.civ@mail.mil

Connectivity / Network Questions

JMETC Secret Network (JSN)

Jeff Braget
(850) 389-6031

jeff.braget@tena-sda.org

Secret Only

Always Connected

JMETC MILS Network (JMN)

Ben Wilson
(757) 492-7621

bennett.wilson@navy.mil

Above Secret (TS/SCI/SAP)

Connected Only During Event

Miscellaneous Questions

For JMETC questions: feedback@jmetc.org

For TENA questions: feedback@tena-sda.org

Websites

Unclassified, FOUO, DoD-Restricted (CAC required): <https://www.trmc.osd.mil>

Distribution A, Industry, non-DoD (username/password required): <https://www.tena-sda.org>

Help Desk

Action Items, Questions, Tasks, Software Needs, Bug Reports: <https://www.tena-sda.org/helpdesk>



Backup Event Charts



Backup Event Charts

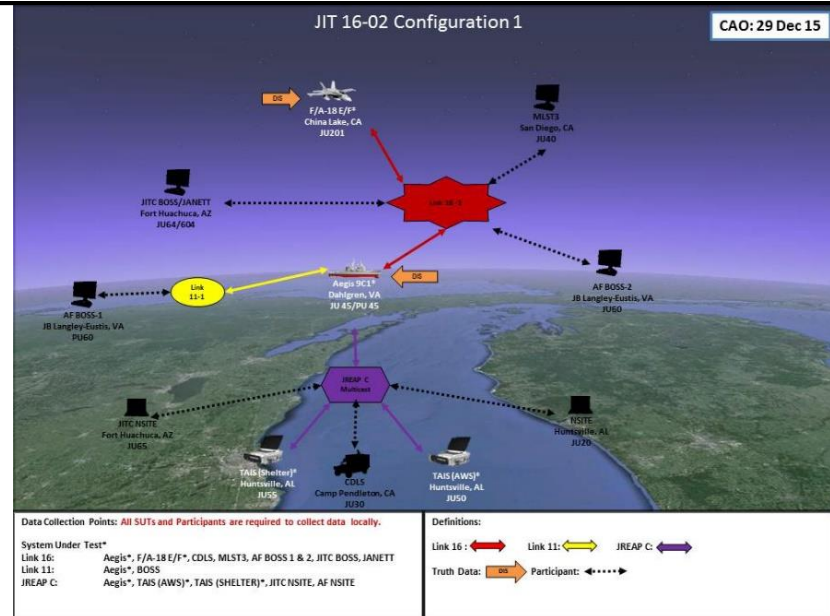


Joint Interoperability Tests (JITs)



Program Overview

The Joint Interoperability Test Command (JITC) Joint Tactical Data Link (TDL) Branch is responsible for ensuring systems that implement TDLs (Link-11/11B/16), Joint Range Extension Application Protocol (JREAP), Variable Message Format (VMF), and United States Message Text Formatting (USMTF) are interoperable and comply with the applicable Joint standards. The JITC accomplishes this mission by conducting tests, called JITs. JMETC provides the network infrastructure, event support tools, and event planning and execution support for multiple Joint Interoperability Tests for JITC each year. JITs have been executing 4-5 times per year on the JMETC persistent infrastructure since FY10.



JMETC Tools

JMETC provides JITs with a persistent, robust infrastructure: the JMETC Secret Network (JSN), integration software -- the Test and Training Enabling Architecture (TENA), tools, reuse repository, and the technical expertise to integrate live, virtual, and constructive (LVC) systems for test and evaluation in Joint systems-of-systems and cyber environments. TENA is used to exchange simulation data between sites and monitor the applications and network. The JSN Systems Control (SYSCON) services included network troubleshooting, Ports and Protocol (PPS) for firewall setup, Voice over Internet Protocol (VoIP), and Secure File Transfer Protocol (SFTP) Server.

Impact

JMETC provides a venue for TDL interoperability testing with its persistent infrastructure capabilities. JMETC enables readily available tactical systems and infrastructure at little or no cost to JITC and the Program Offices, as well as rapid scalability for extended participation of sites and systems as needed. The JITs benefit from the JMETC persistent test infrastructure, resulting in significant reduction in test time and allowing system-specific follow-on testing, when necessary, with little or no notice or setup. In FY17, JITC has already tested 16 systems under test (SUTs) and are scheduled for one more test event in the Summer of 2017.



US Navy (NAVSEA) Interoperability Development & Certification Testing (IDCT) Distributed Integrated Interoperability Assessment Capability (DIIAC)

Program Overview

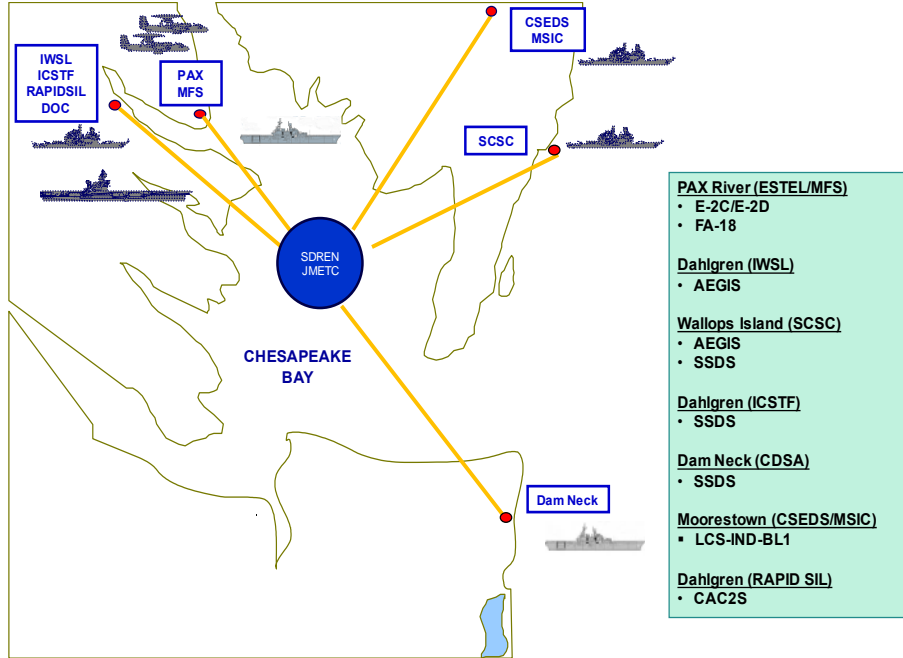
IDCT testing is for the purpose of conducting interoperability testing and analysis for new / updated system software for use in the Naval Warfare Systems Certification Process (NWSCP) interoperability certification decision.

DIIAC testing verifies that the test bed for IDCT is able to support all test objectives outlined for a given event from a Simulation and Stimulation (SIM/STIM) perspective and performs Verification and Validation (V&V) on new capabilities intended to be tested in upcoming IDCTs.

JMETC Tools / Services

JMETC provides the infrastructure (network, tools, and reuse repository) and technical expertise to support the U.S. Navy systems interoperability, development, and certification effort in a distributed test environment. JMETC personnel provide direct on-site and remote test activity support for IDCT events on a daily basis. The JMETC Secret Network (JSN) Systems Control (SYSCON) and event support team work closely with the Navy team to resolve connectivity, tools, firewall, and/or security issues.

The key tools used during IDCT and DIIAC events are ClearPath (used to verify multicast connectivity), the SYSCON-provided Voice over Internet Protocol (VoIP) and the Secure File Transfer Protocol (SFTP) Server. The Test and Training Enabling Architecture (TENA) is used for over the wire simulation protocol via the DISGW (TENA-DIS Gateway) while tactical messaging retains its native formatting.



Impact

The Navy has achieved a 66% reduction in network costs upon moving to the JSN. The move also allows the Navy to focus on the task of fleet software certifications.

The persistent nature of the JSN is essential to the recurring set of development and certification tests allowing the Navy to efficiently and effectively test when needed and resolve interoperability anomalies in an effective and comprehensive manner.



Air Force System Interoperability Test (AFSIT)



Program Overview

The Air Force System Interoperability Test is a U.S. Air Force series of tests that provide system-level interoperability testing to validate compliance to tactical data link (TDL) standards, and to verify compatibility and interoperability with participating systems. The emphasis of each AFSIT is to use actual hardware-in-the-loop (HWIL) communications assets to confirm interoperability of hardware / software modifications and / or upgrades.

Approach

- The focus of AFSIT is to “immerse” systems under test (SUTs) into a simulated battle theater to validate compliance to TDL standards, as well as verifying compatibility and interoperability with participating systems
- Research, evaluate, and coordinate test objectives with A5/JI (USAF participating Test Unit Coordinator)
- Perform formal, highly structured, rigorous MIL-STD conformance testing
- Make continuous improvements to testing methodologies
- Maintain Test Center to current and emerging standards
- Provide detailed, concise reports to the bit level on each / every AF tactical data link platform
- Assist all AF platforms through Joint certification testing, provide connectivity, defend system performance parameters at the Joint Analysis Review Panel (JARP)



Recurring Systems Under Test



Airborne C2
E-3, JSTARS, Rivet Joint, Senior Scout



Airborne non-C2

F-15C/D, F-15E, F-16 (Link 16), F-16 (SADL), F-22, B-2, B-2 BLOS, B-1 FIDL, AC-130H/U, C-130J, CV-22, HH-60, A-10C, SDB II (WEAPON), MAF DRC



Ground-based C2

BCS-F, NCR-IADS, BC3-T, MSCT, JADSI (AOC), TACP (C2), BAO Kit, C2 JRE, CRC's OM Mod

Gateways

JADSI, LAK, Pocket-J, ROBE, JRE, JTEP, BACN



Impact

The AFSIT Event leverages the persistent JMETC Secret Network (JSN) infrastructure to integrate facilities, labs, and JSN Systems Control (SYSCON) services; to include network troubleshooting and Voice over Internet Protocol (VoIP). In addition, AFSIT uses the Test and Training Enabling Architecture (TENA) for the distribution of Distributed Interactive Simulation (DIS) data.

SUTs are evaluated performing mission threads in a simulated environment that includes real AF command and control (C2) and weapons platforms. Due to such rigorous testing, superior TDL platforms are delivered to the Warfighter, operating per MIL-STD specifications.



U.S. Naval Air Systems (NAVAIR) MQ-4C TRITON

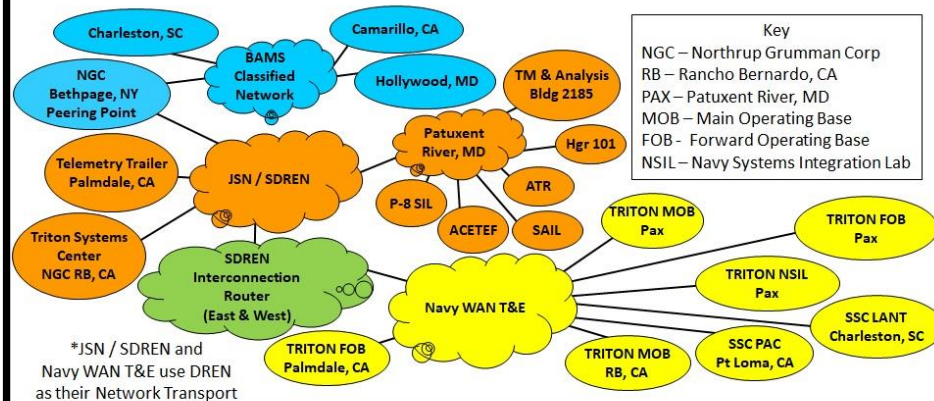
Program Overview

- The TRITON program uses a variety of communication links for an operationally-realistic test infrastructure; connectivity was accomplished by peering three networks.
- JMETC assisted NAVAIR and Northrup Grumman Corp. (NGC) engineers in the development of the Navy Wide Area Network Test and Evaluation Network (NWTE).
- This new network was then connected to both the JMETC Secret Network (JSN) over the Secret Defense Research and Engineering Network (SDREN) and the Northrup Grumman Corporation (NGC) Broad Area Maritime Systems (BAMS) Classified Network (BCN), providing all three networks to TRITON engineers to utilize for project testing.
- The NWTE network is peered at Patuxent River and San Diego SDREN Interconnection Points, while the BCN is peered at NGC Rancho Bernardo, California.

JMETC Tools

- JSN is used for test control (non-production Internal Communication System [ICS], file transfers, Voice over Internet Protocol [VoIP], etc.)
- The JMETC Secure File Transfer Protocol (SFTP) server is the primary method used to disseminate the huge amounts of data collected each day. Data is transferred to the JMETC SFTP server where it is accessed by engineers who pull down the data sets they need for analysis.
- Triton is currently working on a near-real time distribution of data where the data is pushed to the JMETC SFTP server at specified intervals during testing

TRITON Test Network Environment



"...the TRITON Test Network has been an integral part of the TRITON program for well over 2 years, supporting not only flight test, but ground test, and much lab work (often 24/7)." Jeff Sappington (TRITON Navy Lead Test Engineer in email comments FY15)

Impact

- JMETC recently expanded support to TRITON by executing a Cyber Table Top (CTT) exercise and supporting their addition to other test events including Interoperability Development and Certification Testing (IDCT) and Joint Interoperability Tests (JITs).**
- Flight and ground tests between the UAS and ground stations are conducted daily; relying on persistent connectivity.**
- As of January 11, 2018, the MQ-4C TRITON reports Total Development and Operational Test Hours of 167 Flights with over 1,114 Flight Hours; and over 2,500 hours of Ground Tests**



Joint Strike Fighter (JSF) Record and Playback



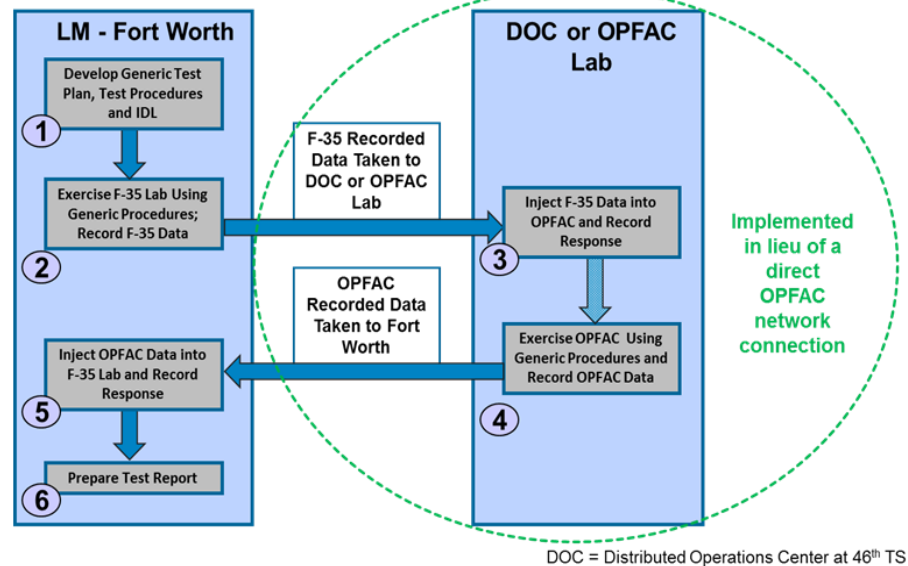
Overview

Issue: Unable to connect F-35 Hardware (HW) / Software (SW)-in-the-loop missions systems labs to various Operational Facility (OPFAC) labs due to concerns that real-time interface(s) could not be implemented consistent with F-35 security requirements

Goal: Establish repeatable (portable) processes to evaluate F-35 Data Link Information Exchange Requirements (IERs) not verifiable through laboratory testing

Sites: Air Force: Eglin, Greenville Rivet Joint, Tinker. Navy: China Lake, Dahlgren, Dam Neck, Pax River, Pt. Mugu

Systems: FA-18, Aegis, Landing Helicopter Deck (LHD), F-15, F-16, Joint Surveillance Targeting and Attack Radar System (JSTARS), E2-C, EP-3, EA-6B, and Airborne Warning and Control System (AWACS)



Solution

- Adopted Record / Playback Approach
- Connected F-35 HW / SW-in-the-loop Mission systems labs to various OPFAC Labs via JMETC Secret Network (JSN) on the Secret Defense Research and Engineering Network (SDREN)
- Used F-15 OPFAC instance as F-35 surrogate to expand interactions with Command and Control (C2) platforms and increase number of messages that could be tested
- Added dedicated Cooperative Avionics Test Bed (CATB) vs. OPFAC flight test at end of System Development and Demonstration (SDD) to verify high value / dynamic IERs

Impact

- Reduces execution costs and total event time span
- Leverages test planning / execution expertise at 46th Test Squadron (TS) at Eglin AFB
- Potential to use similar approach in the United Kingdom (UK) for future Coalition events

JSF Program Office (JPO) Estimated Cost Savings: 90%

Small Diameter Bomb (SDB) Increment II

SDB II Tests

- Capability to remotely observe live missile telemetry data from the Eglin Range
- Capability to perform real-time data analysis and reduction
- JMETC connects Eglin AFB Central Control Facility (CCF) to Raytheon Tucson via the 46 Test Squadron Air Operations Center (AOC) lab

Benefits

- Distributed data collection and analysis using data transfer on JMETC infrastructure eliminates the need to mail or hand carry the data
- Reduced the travel cost for 12 engineers needing to travel to observe the flight test mission
- Risk reduction for future developmental testing (DT) and operational testing (OT)

