TENA and JMETC, Enabling Integrated Distributed Testing

Briefing for:

ITEA Test Instrumentation Workshop

May 17th, 2012

TRMC (Test Resource Management Center) Investment Programs Overview

T&E/S&T

- Established in FY2002
- Develops technologies required to test future warfighting capabilities
- 6.3 RDT&E funds
- ~$100M / year
- 8 current Tech areas
  - Directed Energy
  - Hypersonics
  - Netcentric Systems
  - Unmanned Systems
  - Non-intrusive Instruments
  - Spectrum Efficiencies
  - Electronic Warfare
  - Cyberspace Test

CTEIP

- Established in FY1991
- Develops or improves test capabilities that have multi-Service utility
- 6.4 RDT&E funds
- ~$140M / year
- 51 current projects
  - 25 projects developing core Joint capabilities
    - 2 projects improving interoperability test cap.
  - 8 projects improving threat representations used in testing
  - 14 projects addressing near-term OT shortfalls

JMETC

- Established in FY2007
- Provides corporate infrastructure for distributed Joint testing
- 6.5 RDT&E funds
- ~$20M / year
- 69 current sites
  - Expanding to 70 sites
- Maintains
  - Network connections
  - Security agreements
  - Integration software
  - Interface definitions
  - Distributed test tools
  - Reuse repository

TENA Mission

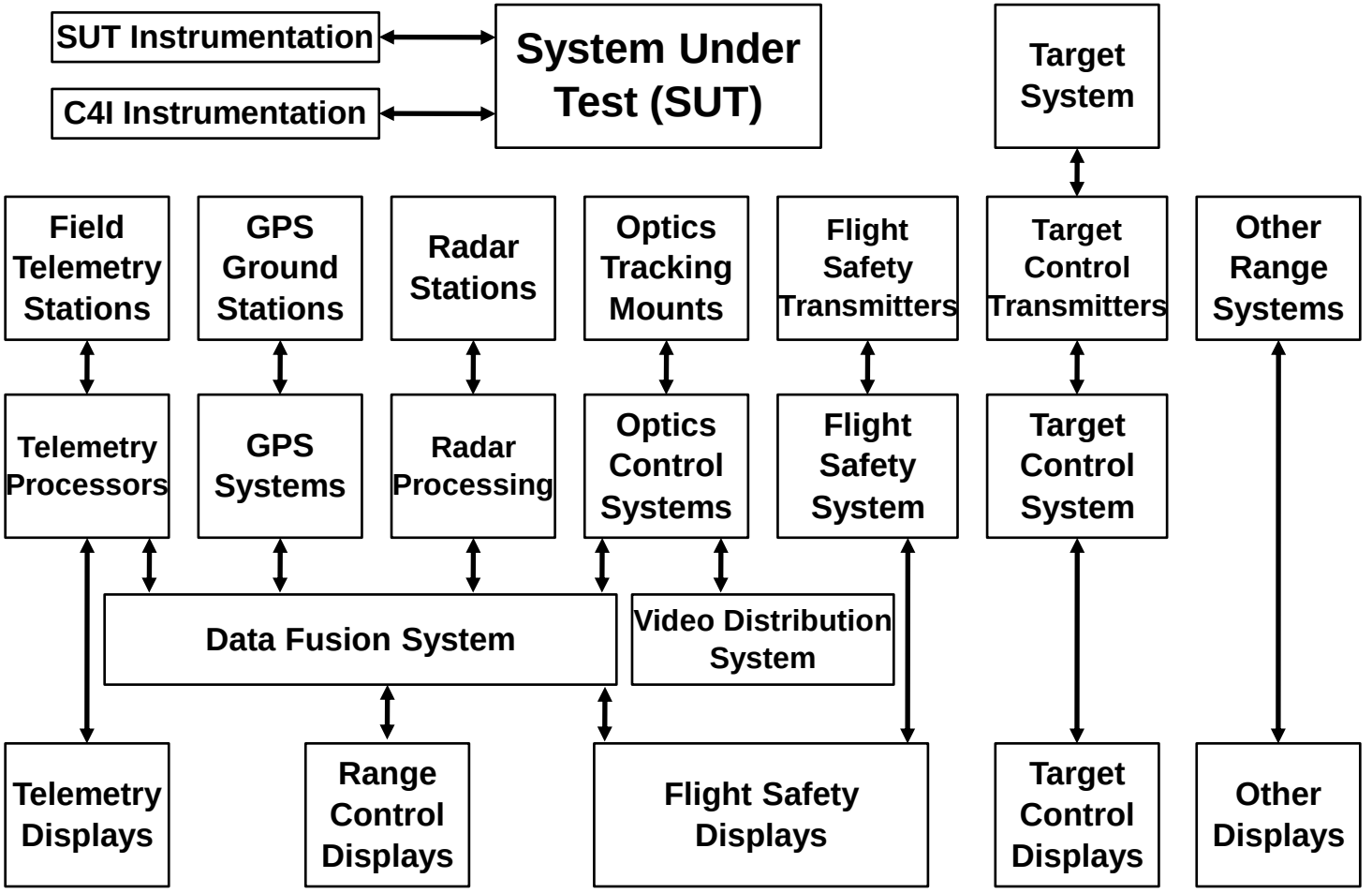
- Historically, range systems tend to be developed in isolation, focused on narrow requirements, and constrained by aging techniques/technologies
- Range infrastructures have grown organically with minimal coordination or sharing, resulting in duplicated effort and many "stove-pipe" systems

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

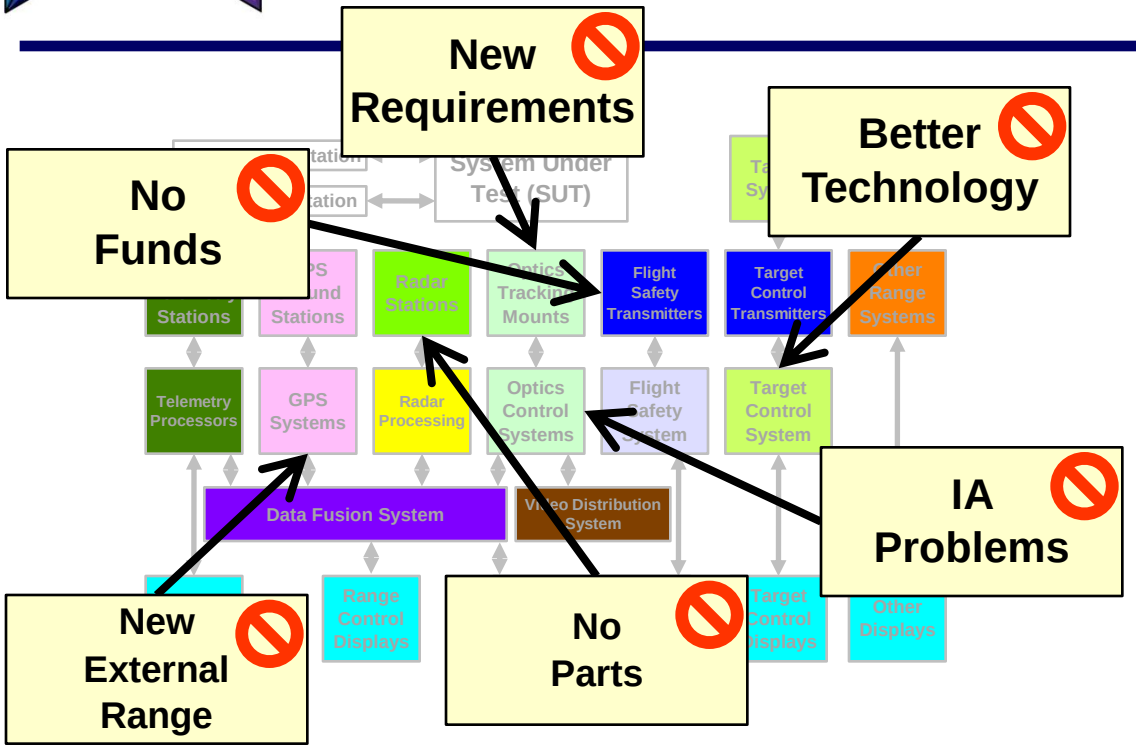
Working with the Range Community to Build the Foundation for Future Test and Training Range Infrastructure

A Notional Test Range



TENA is designed (and has experience) as the common communication infrastructure for these range systems

Range System and Infrastructure Development Challenges



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

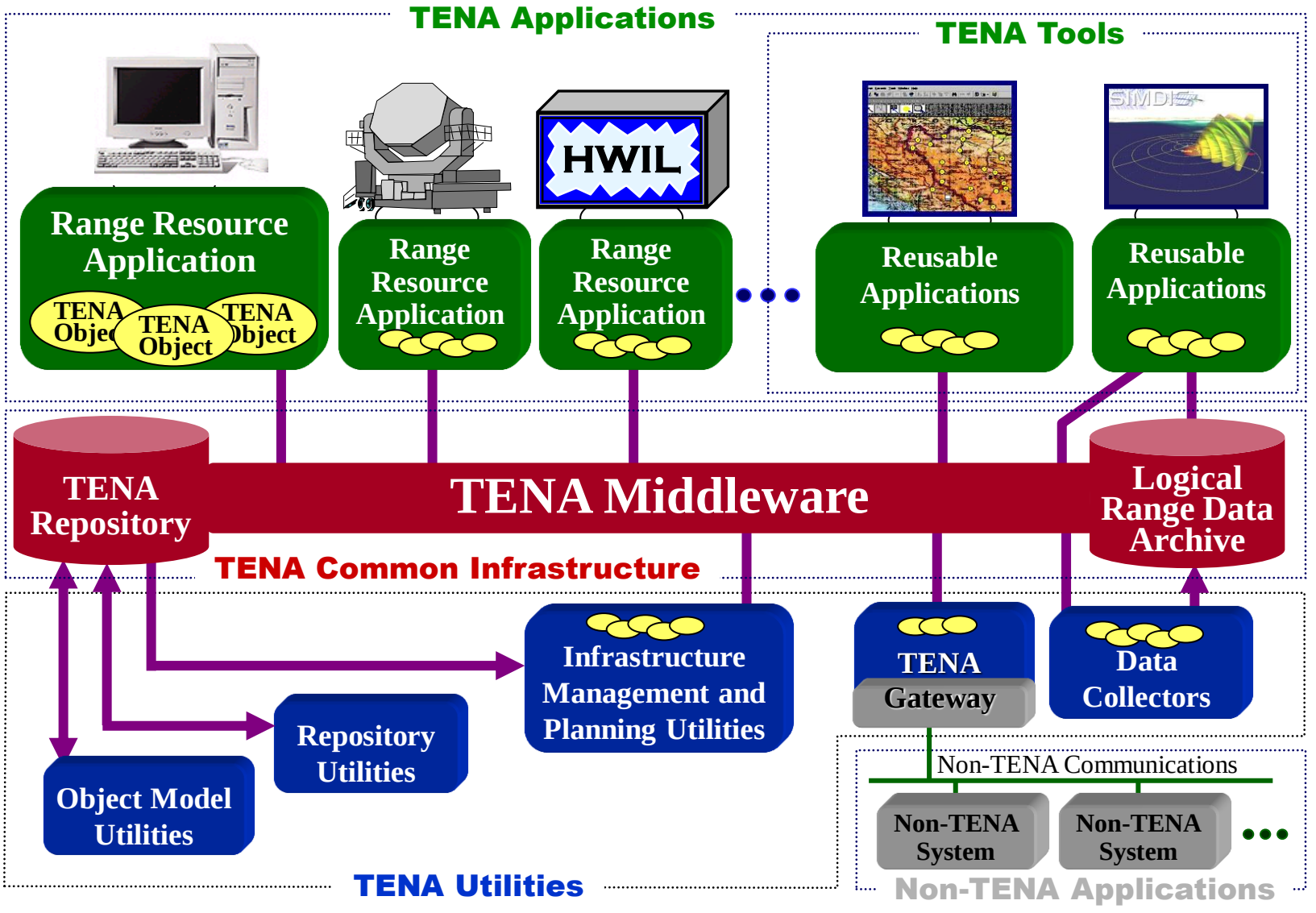
- **Range Specific Development Challenges**
  - Multiple Sponsors and Funding Sources
  - Evolving Test and Training Requirements
  - Expansion of Inter-Range Connectivity
  - Information Assurance Policies and Procedures
  - Range Modernization Must Be Gradual

Past Range Infrastructure Standardization Approaches

- **Standardize on computer/networking hardware**
  - Many ranges have been locked into particular computer vendors (e.g., SGI, Sun) or network technology (e.g., ATM, 2400 baud modem) that have constrained their ability to modernize systems efficiently
- **Standardize on programming language**
  - Many ranges have encountered problems with being able to maintain code developed with older programming languages and compilers
- **Standardize on the network protocol**
  - Many range protocols only support UDP broadcast or multicast, which can cause problems when connecting with external networks
- **Standardize on the message format**
  - Many message protocols emphasize the specific bit layout of message formats which prevents evolution for newer technology and requirements

Everything gets designed around the most difficult elements to upgrade

TENA Architecture Overview



Core Architectural Tenets of TENA

- **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

How do we use TENA for a particular system?

1. **Determine the "ins and outs" of the Particular System**
   - Any system that needs to interoperate with other systems needs to define the data and services shared with these other systems—TENA defines these "ins and outs" as formal data contracts that are easily understood by humans and enforced by computers
   - Determine if existing interfaces (called object models) already exist—TENA Repository has over 1,200 object models that have already been defined by the user community
2. **Auto-Generate Application Source Code**
   - TENA Repository will automatically generate source code for a tested and working example application based on the user's particular object models—developers just need to replace the "dummy" behavior for setting/getting attribute values and implementing methods
3. **Integrate Generated Code into Existing System**
   - Working example code simplifies ability to insert the TENA specific code into an existing system, or the example code can be used as the basis for developing a new system
4. **Connect System to Network to begin Collaborating with Others Systems**
   - Publish-Subscribe paradigm makes it easy (no event specific configuration) for multiple participants to share data and services, as well as providing support for redundancy and evolution to new systems

TENA's auto-code generation capability creates tested and proven user specific example applications in minutes!

How do we integrate TENA into our existing environment?

- **Gradual Deployment**
  - TENA can be introduced into an existing environment in a gradual manner in which certain systems are replicated using TENA functionality
  - These initial systems will typically require temporary gateways to bridge between TENA and the legacy protocol and systems
- **Gateway with Legacy Protocol and Systems**
  - TENA gateway systems are well understood, and a separate project, PRITEC, has even created a Gateway Builder product to facilitate automated gateway creation
  - Migration to TENA can be coordinated with respect to publishing/subscribing characteristics to minimize any performance degradation caused by the gateway
- **Utilize Redundancy during Testing**
  - Access to both the legacy and the upgraded TENA system provides system redundancy during initial testing and operational deployment to minimize risk

TENA can be introduced to a range gradually using a properly designed protocol gateway system

Will TENA meet my performance requirements?

- **Users are encouraged to conduct experiments by customizing the auto-generated example programs to be representative of actual systems**
  - Use actual object models, computers, and networks
- **Primary requirement for TENA is to support high performance, real-time distributed communication**
  - TENA uses compiled code to avoid interpretive marshalling/demarshalling
  - Minimizes data copies, utilize single thread to perform network write, etc.
- **Representative TENA Middleware Performance**
  - RRRP RadarTrack updates (~3 year old laptops running Fedora 12)
    - **Update Throughput: 6,700 updates/second**
    - **Update Latency: 0.50 milliseconds**

There is some overhead associated with TENA, versus a highly customized communication infrastructure, but those "one-off" solutions are expensive to maintain and are, ultimately, very limiting

TENA is an Open Architecture

- **The Software Engineering Institute 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 Middleware is U.S. Government owned (no proprietary software)
  - TENA is freely releasable (Distribution A)
  - We have many non-U.S. users (website visits from over 150 countries)

Architecture Management Team (TENA AMT)

- **AMT Members:**
  - 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 Range Integration Instrumentation Systems (CRIIS)
  - Common Training Instrumentation Architecture (CTIA)
  - 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 National Training Capability (JNTC)
  - Naval Air Warfare Center – Aircraft Division
  - Naval Aviation Training Systems Program Office (PMA-205)
  - NAWC – Weapons Division
  - NAVSEA Warfare Center - Keyport
  - Naval Undersea Warfare Center (NUWC)
  - P5 Combat Training System (P5CTS)
  - Pacific Missile Range Facility (PMRF)
  - Redstone Technical Test Center (RTTC)
  - T&E/S&T Non-Intrusive Instrumentation
  - White Sands Missile Range (WSMR)

Meetings every few months

US Advising Members:
- BMH Associates, Inc.
- Boeing
- Cubic Defense
- DRS
- Embedded Planet
- EMC
- MAK Technologies
- NetAcquire
- SAIC
- Scientific Research Corporation (SRC)
- Scientific Solutions, Inc. (SSI)

International Participation
- Australia
- Denmark
- France
- Singapore
- Sweden
- United Kingdom

- **Design Decisions / Trade-offs / Status / Technical Exchanges of Lessons Learned / Use Cases / Testing / Issues & Concerns Identification, Investigation & Resolution**

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)**
  - Submitted 9/14/2011, will cover middleware, EM, TENA Console and TENA-enabled applications
  - Approved (by IAM) for use on Redstone Test Center network infrastructure pending CoN completion
- **S/DREN (Secret/Defense Research and Engineering Network)**
  - TENA protocol and TENA-based applications approved between DREN and SDREN sites
- **NIPRnet**
  - JTTOCC (which includes TENA Middleware) obtained IATO and pending full approval
- **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

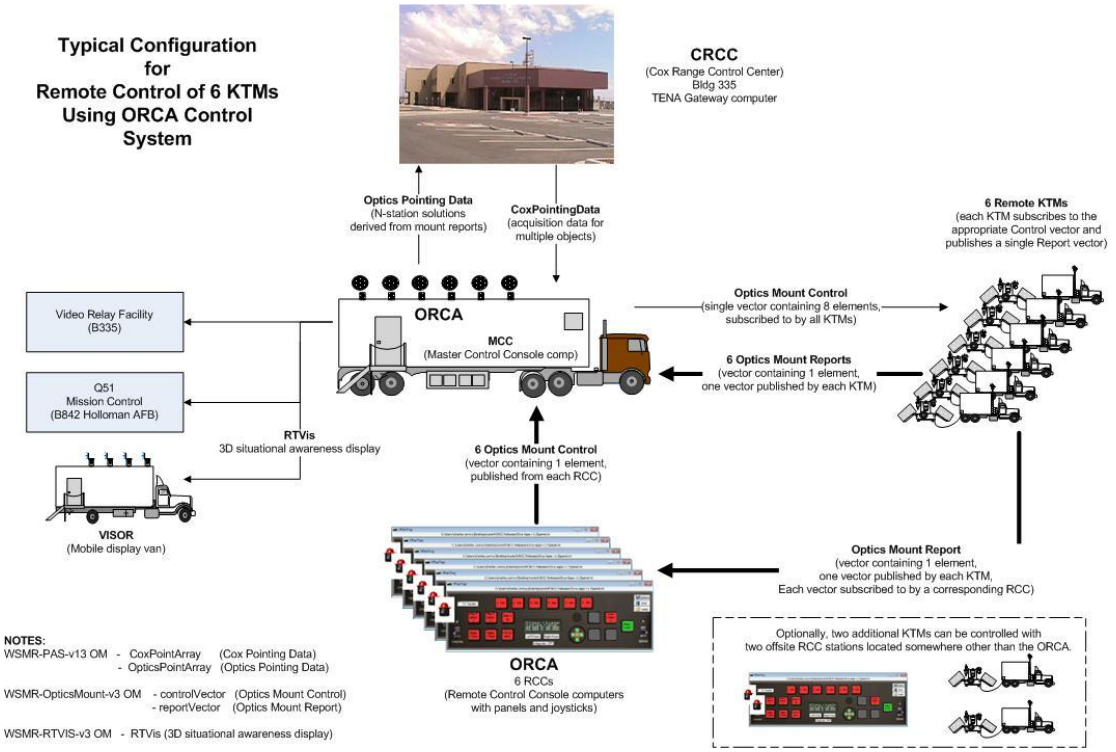
TENA project working with IA organizations to reduce cost and delays with ability to operate TENA applications

Some Examples of TENA Usage

- InterTEC (C4ISR stim/sim/collection)
- JDAS (data archive)
- TVDS (video distribution)
- JMITS (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

TENA at White Sands Missile Range (WSMR)

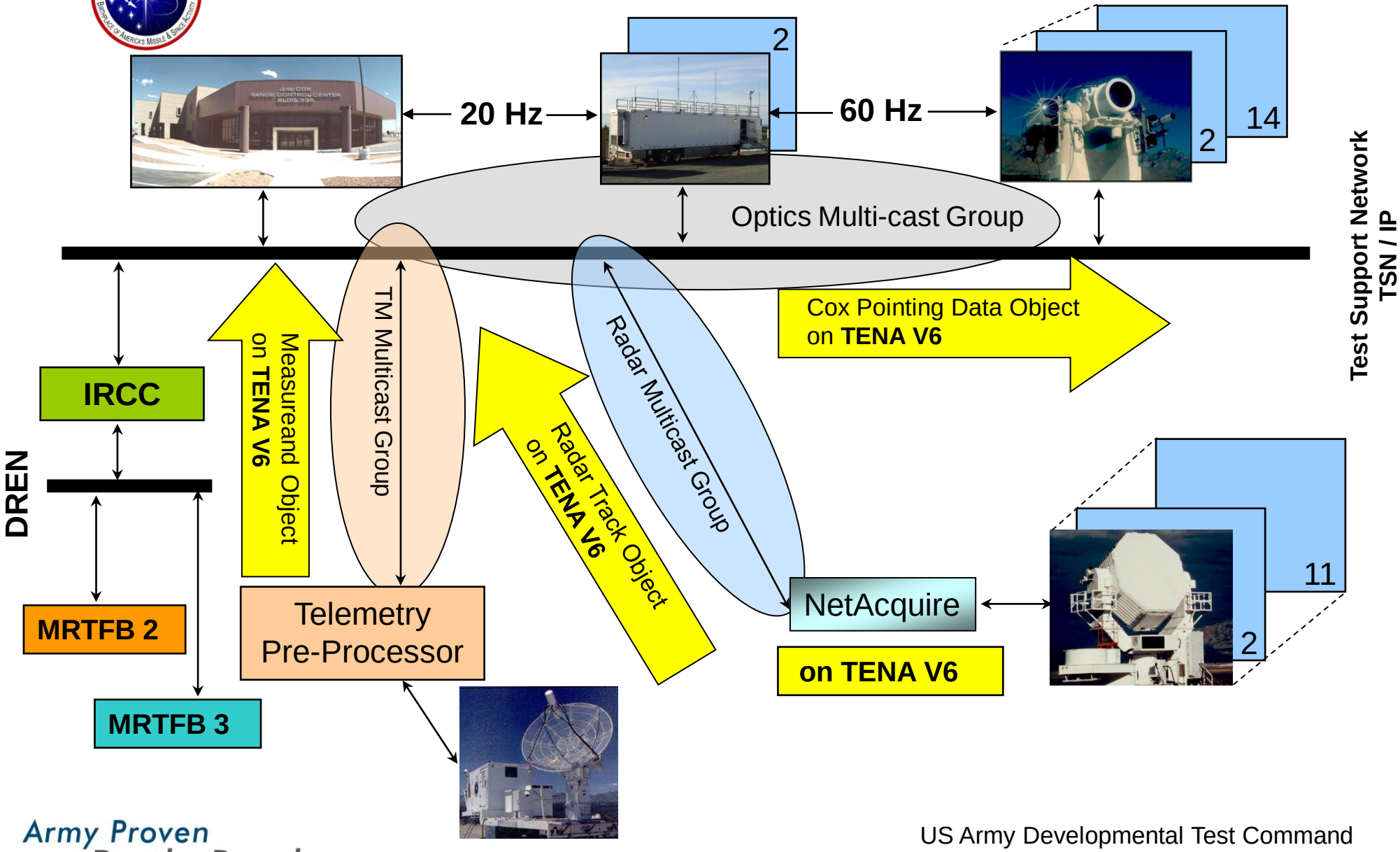
- **TENA has been supporting the real-time distributed operation of the WSMR optics systems for the past 5 years, including data exchange and remote operation**
  - **Based on the success of optics, TENA is being expanded to other range systems**



"TENA has functioned extremely well in our network environment and the rigorous requirement of 60 Hz updates to the instrumentation."

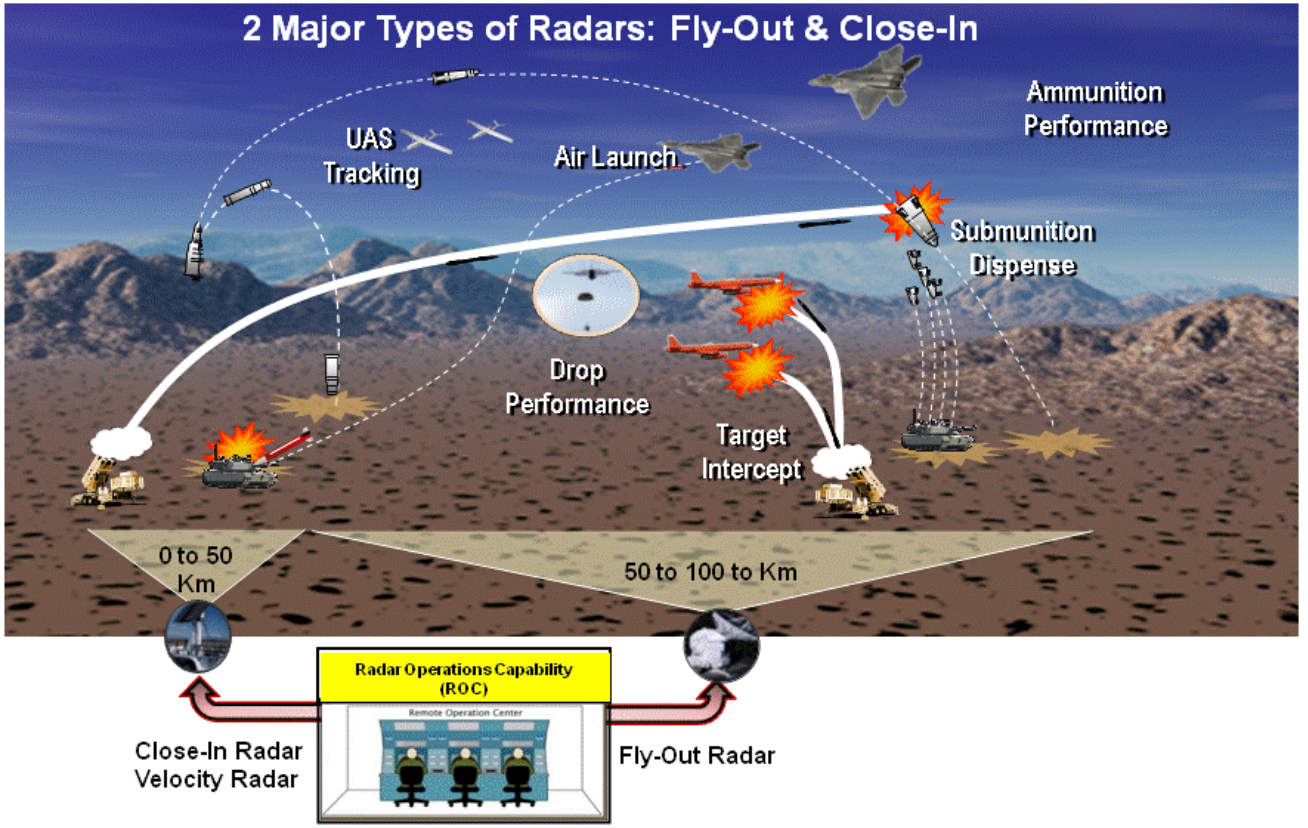
Charlie Conroy
WSMR Optics Development Engineering Lead

A Compelling, Comprehensive Range Instrumentation Use Case at White Sands



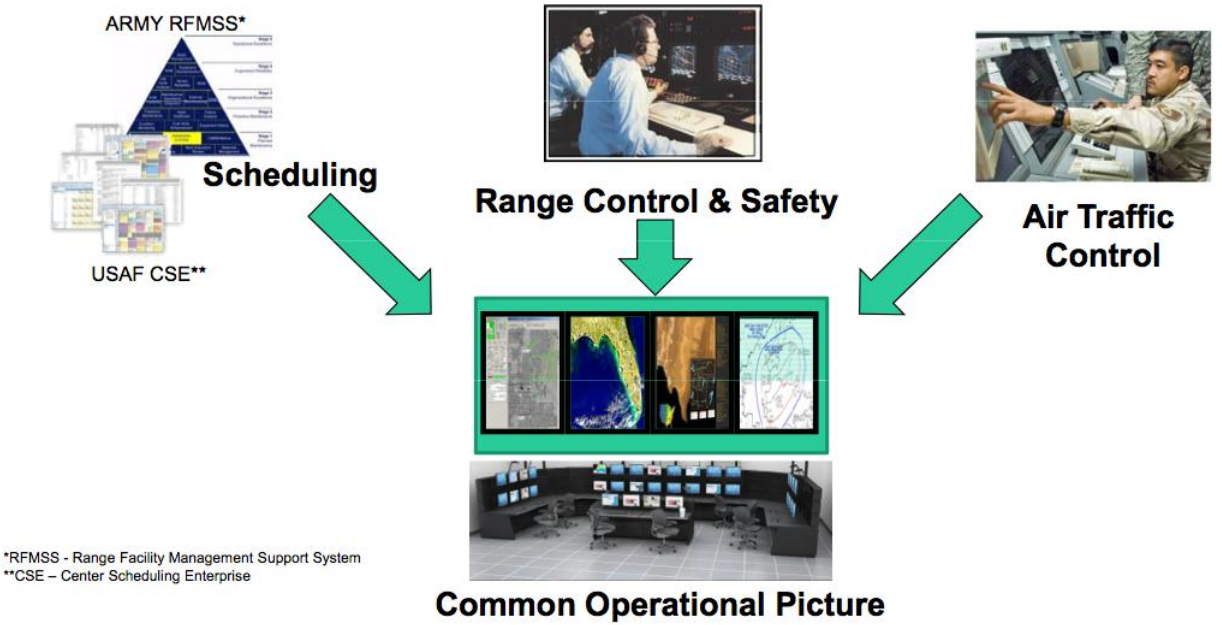
Range Radar Replacement Program (RRRP)

- **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



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**

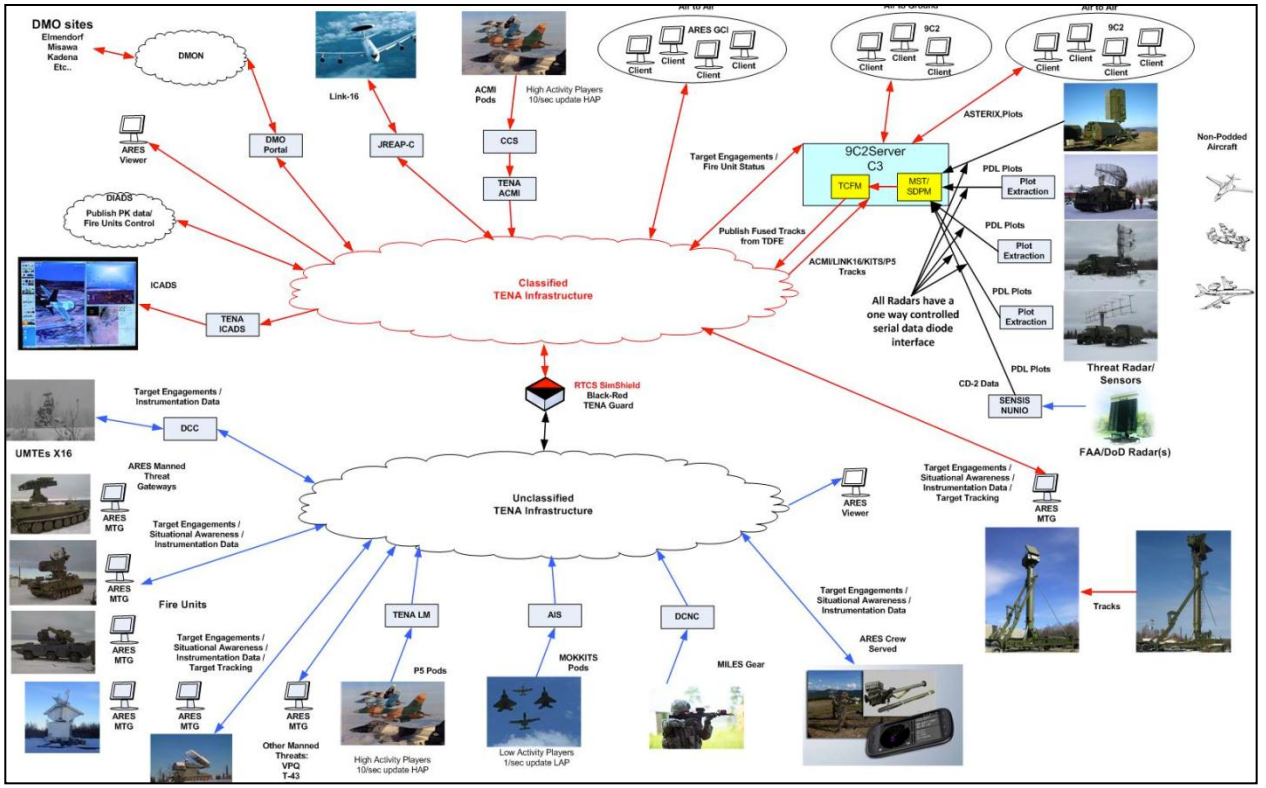


"TENA gave us a common environment that greatly simplified the efforts of our two non-co-located software development contractors. It also significantly aided in our ability to meet information assurance criteria, allowing us to move from requirements to fielding on the NIPRNet in under 18 months. "

Chris Short
JTTOCC Lead Systems Integration Engineer

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**



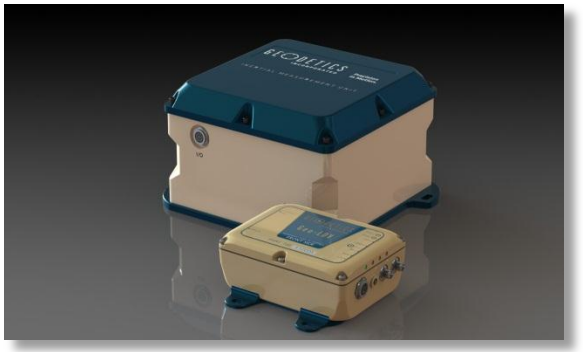
"TENA is the greatest thing that ever happened to us. We couldn't be doing today with all these systems–and we couldn't have all the participants that we do–if it weren't for TENA"

Billy D. Smith
Chief of electronic combat training requirements for Red Flag at JPARC

Geodetics Inc.

- Geodetics produces a range of TENA Enabled high-accuracy real-time TSPI solutions for tracking dismounted soldiers and low to high-dynamic platforms

PDSU TSPI for Dismounted Soldiers



Geo-LDV TSPI for Manned and Unmanned Vehicles

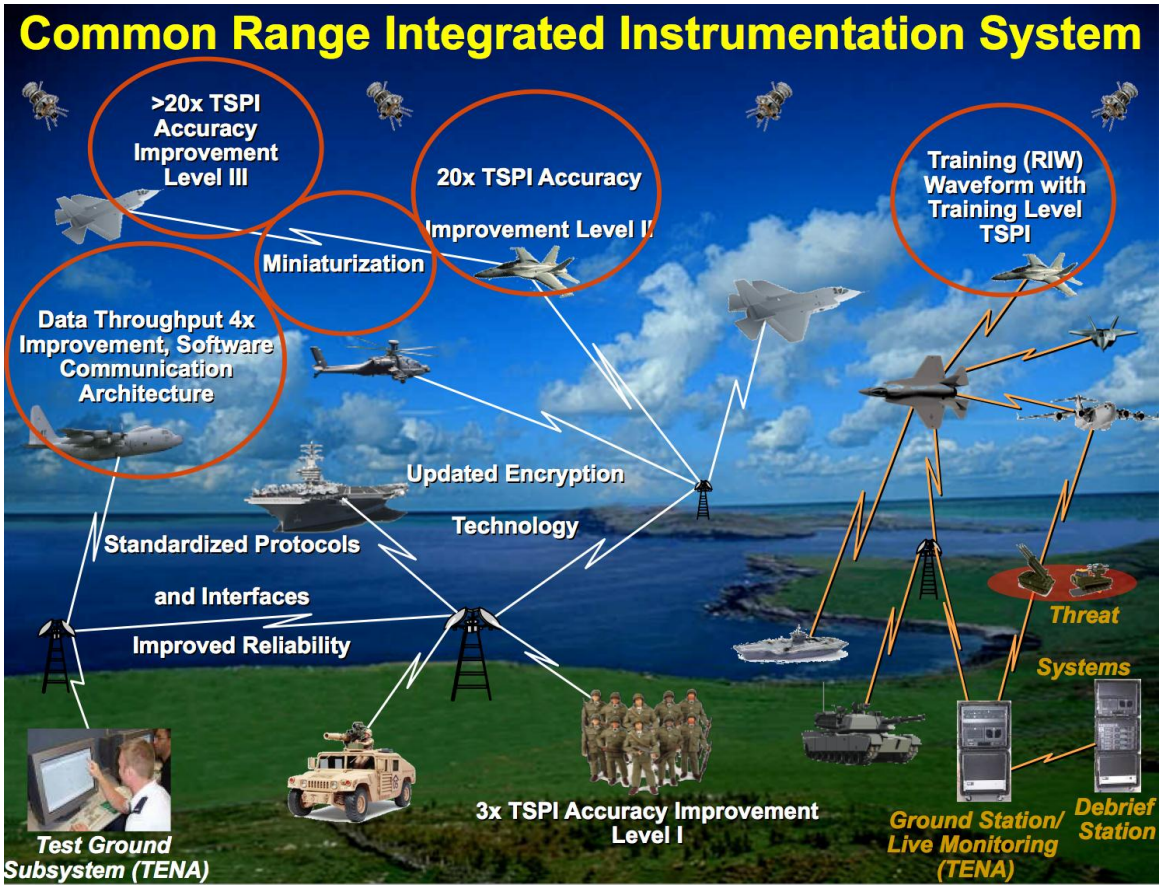
Geo-TRX

"Integration with TENA took only 3 weeks and enhanced our products with distributed test and training capabilities as well seamless integration with a wide range of standard tools widely used by the T&E and Training communities"

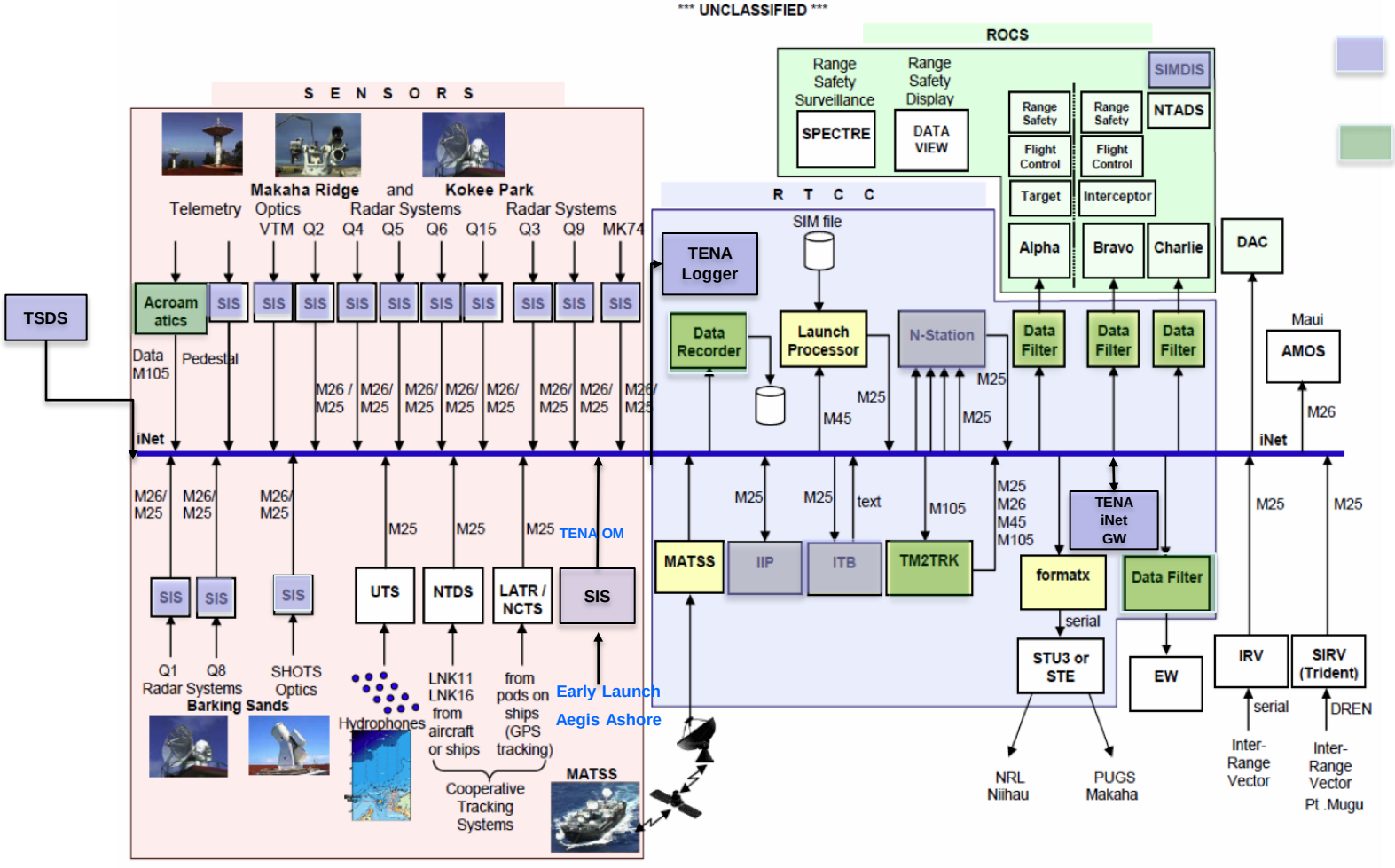
Dr. Jeffrey Fayman
Vice President Business and Product Development

Common Range Integrated Instrumentation System (CRIIS)

- **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



PMRF Migration to TENA Architecture



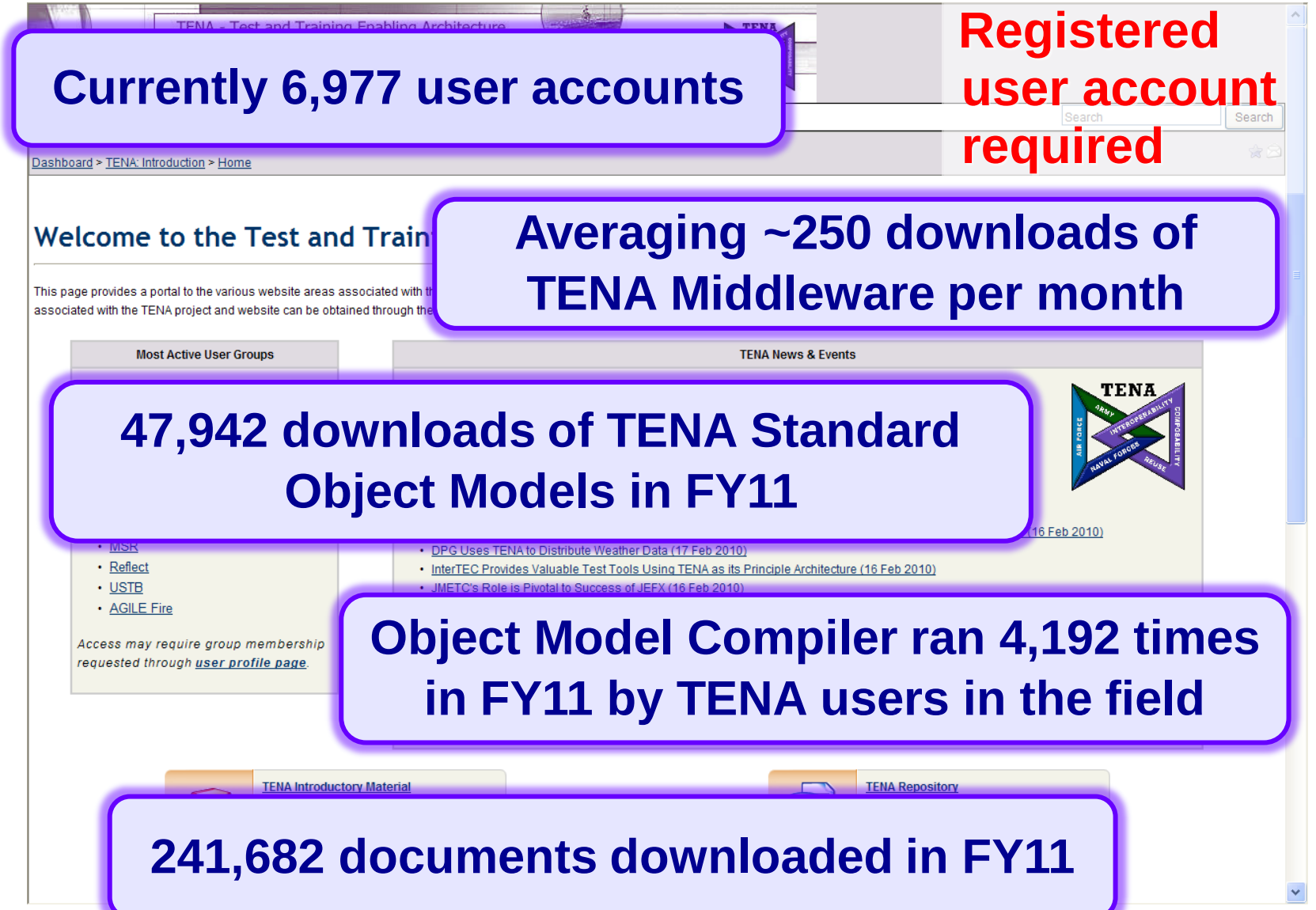
New TENA Capability

Supports Legacy iNet

But Not Required For TENA

"PMRF's high-level direction for future information technology is to move to the TENA Object Model standard for information exchange between PMRF systems and between PMRF and other ranges" PMRF Tech Director

TENA Web Portal
http://www.tena-sda.org/



Currently 6,977 user accounts

Registered user account required

Averaging ~250 downloads of TENA Middleware per month

47,942 downloads of TENA Standard Object Models in FY11

Object Model Compiler ran 4,192 times in FY11 by TENA users in the field

241,682 documents downloaded in FY11

TENA Standard Object Models

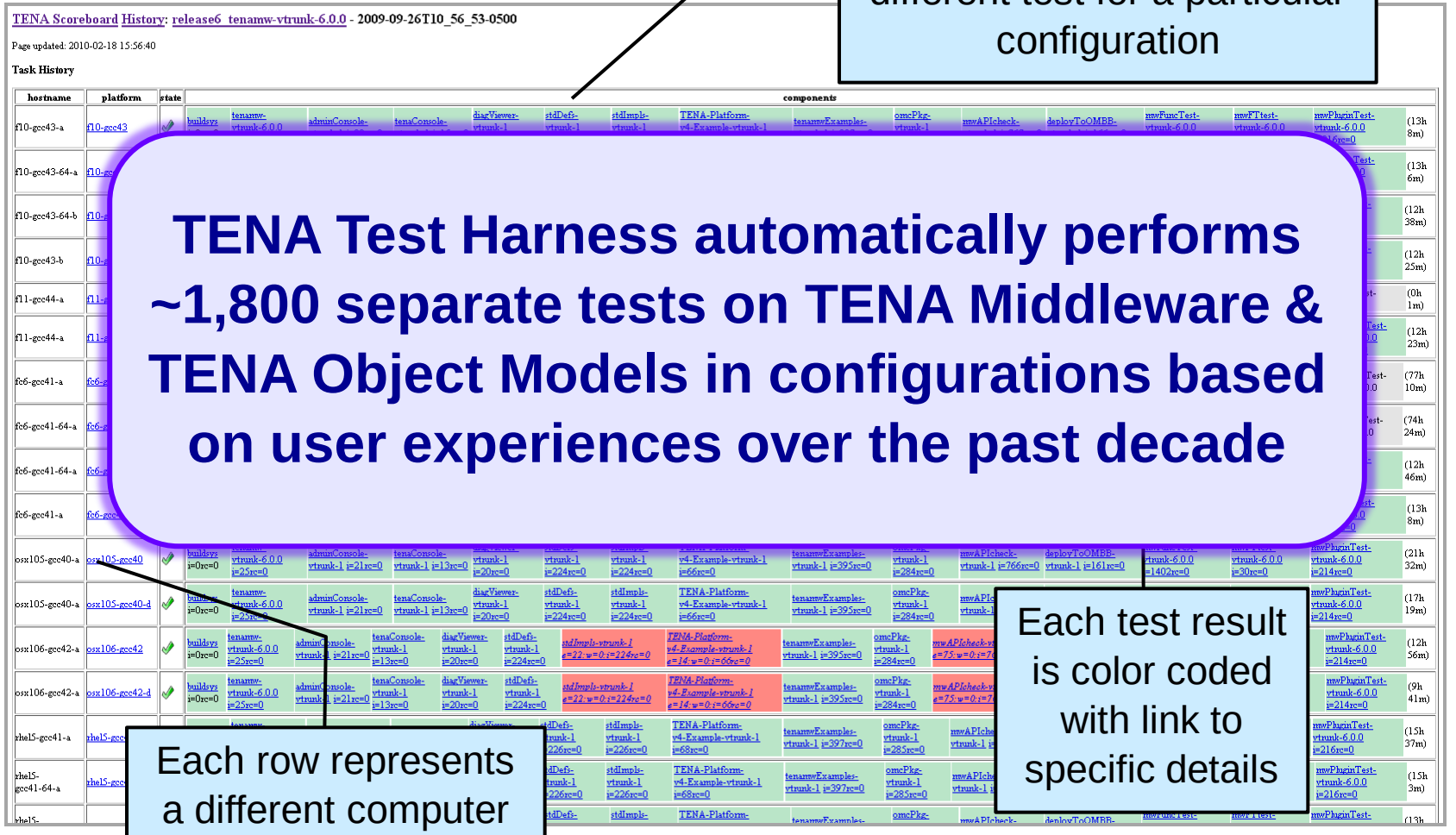
- **Platform Related**
  - TENA-Platform-v4
  - TENA-PlatformDetails-v4
  - TENA-PlatformType-v2
  - TENA-Embedded-v3
  - TENA-Munition-v3
  - TENA-SyncController-v1
  - TENA-UniqueID-v3

- **JNTC OMs (for Training)**
  - JNTC-AirRange-v2
  - JNTC-CounterMeasure-v2
  - JNTC-IndirectFire-v2
  - JNTC-Instrumentation-v2
  - JNTC-NBC-v2
  - JNTC-ObstacleMinefield-v2
  - JNTC-Threat-v2

- **Time-Space Position Information (TSPI) Related**
  - TENA-TSPI-v5
  - TENA-Time-v2
  - TENA-SRFserver-v2
- **Others**
  - TENA-AMO-v2
  - TENA-Engagement-v4
  - TENA-Exercise-v1
  - TENA-GPS-v3
  - TENA-Radar-v3
- **In Progress**
  - TENA-TelemetryMeasurand-v1
  - TENA-Weather-v1
  - Additional JNTC OMs for training

TENA Automated Test Harness

Each column represents a different test for a particular configuration



TENA Test Harness automatically performs ~1,800 separate tests on TENA Middleware & TENA Object Models in configurations based on user experiences over the past decade

Each test result is color coded with link to specific details

Each row represents a different computer platform

TENA On-Line Documentation

TENA - Test and Training Enabling Architecture

Home [Documentation] Downloads View Edit Search

Dashboard > TENA: Middleware > Release Documentation > Middleware -v6 > Middleware -v6 User Guide > Middleware Services -v6 > Advanced Filtering -v6

Advanced Filtering

Nominally, the publish-subscribe behavior of the middleware operates on matching the object model type being published with the type of interest for the subscriber. Advanced filtering extends this type-based filtering to allow publishers and subscribers to provide additional criteria to provide finer control of subscription interests to minimize the amount of unwanted information that would occur with a pure type-based filtering system.

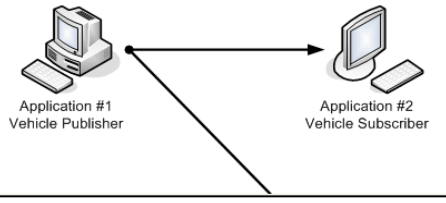
Description

The TENA Middleware provides a peer-to-peer publish and subscribe capability in which the underlying software connects publishers with interested subscribers. Once connected, a publisher will attempt to provide the data of interest to the subscriber. The TENA Metamodel supports Stateful Distributed Objects (SDOs) and Messages that can be exchanged between publishers and subscribers. A key objective in many distributed publisher-subscriber systems is to minimize the unwanted data that is sent to the subscribers, for the purpose of improving network utilization and minimizing unnecessary computer processing. If the subscribing application has to perform "receive-side" filtering to throw away a large percentage of received network messages, there is wasted computer resources in sending and processing the unwanted network messages.

Note that the term "object" will be used in the following discussion to represent either an SDO Servant or an SDO Proxy, depending on whether the object exists in the publishing or subscribing application, respectively.

A primary technique that is used to support publisher-subscriber filtering is based on the particular data types defined in the object model. Type-based filtering ensures that a subscriber will only receive data associated with either an SDO or Message type that matches a subscription request made by the subscribing application. For example, if an object model includes an SDO type named `Vehicle`, and if a subscribing application only subscribes to the `Vehicle` SDO type, then any other data that is published in the execution will not be delivered to the subscribing application.

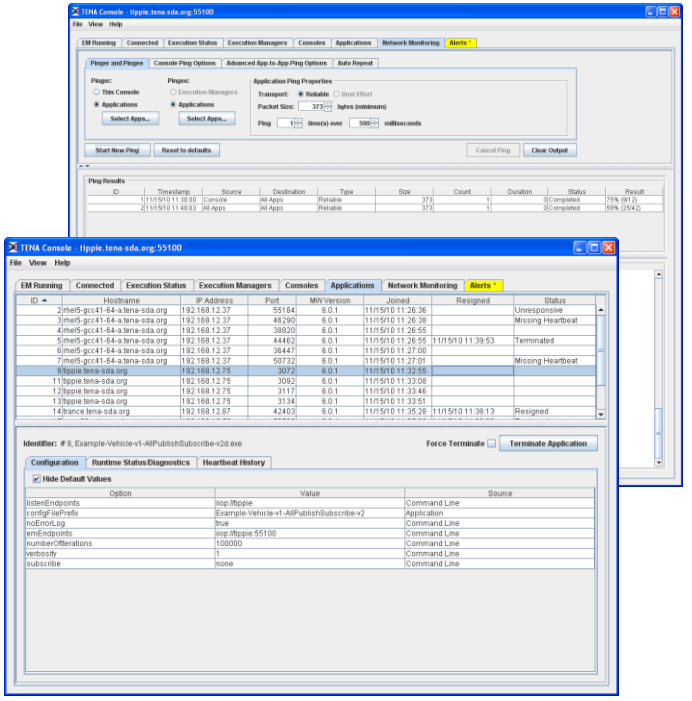
A simple illustration of type-based filtering is shown in the figure below. In this hypothetical scenario, Application #2 only subscribes to type `Vehicle` and will not receive any of the `Person` data published by Application #3. Application #4 subscribes to both type `Vehicle` and type `Person`, so it will receive data from both Application #1 and Application #3.



- **Installation Guide and Release Notes**
- **Middleware Guide arranged in individual topic pages**
  - Simplifies user navigation

TENA Console

- **TENA Console is a GUI-based event management tool used to evaluate and monitor applications and network**
  - Utilizes capabilities automatically built into the middleware
  - Multiple TENA Consoles can be run anywhere on the network



- **Application Diagnostics**
  - Evaluate middleware and application configuration
  - parameters to detect incorrect settings
  - Obtain runtime diagnostic values related to the state and
  - performance of the application
- **Network Monitoring**
  - Perform TCP and (unobtrusive) UDP Multicast “ping” operations between applications to test communication
  - Establish continuous ping operations to notify operators of transient network problems
- **Application Alerts**
  - Notify operators of application warnings that require investigation

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
  - Hands-on training classes on using “TIDE” (a TENA Development Tool)

Opportunity to Get Assistance in Using TENA

e-mail request to: feedback@tena-sda.org

TENA in a Resource Constrained Environment (TRCE) S&T Background

- **Low Data Rate Networks**
  - TENA must be able to establish and maintain data connections on low data rate networks
  - Need to optimize use of low data rate networks to support relevant operational scenarios
- **Wireless Networks**
  - Current range environments use wireless links extensively for various systems under test
- **Variable Quality Networks**
  - T&E systems poorly tolerate high loss, link failure, or heterogeneous links
  - Need to provide data continuity for degraded or heterogeneous networks
- **Specification of Interests**
  - Subscribers must be able to specify data "interests" to more efficiently use available & limited network resources

TRCE Phase 1 will:

•Developed Use Cases and Requirements

•Developed Proof-of-Concept Applications to Investigate Candidate Technologies

•Quantified Benefits of Candidate Technologies

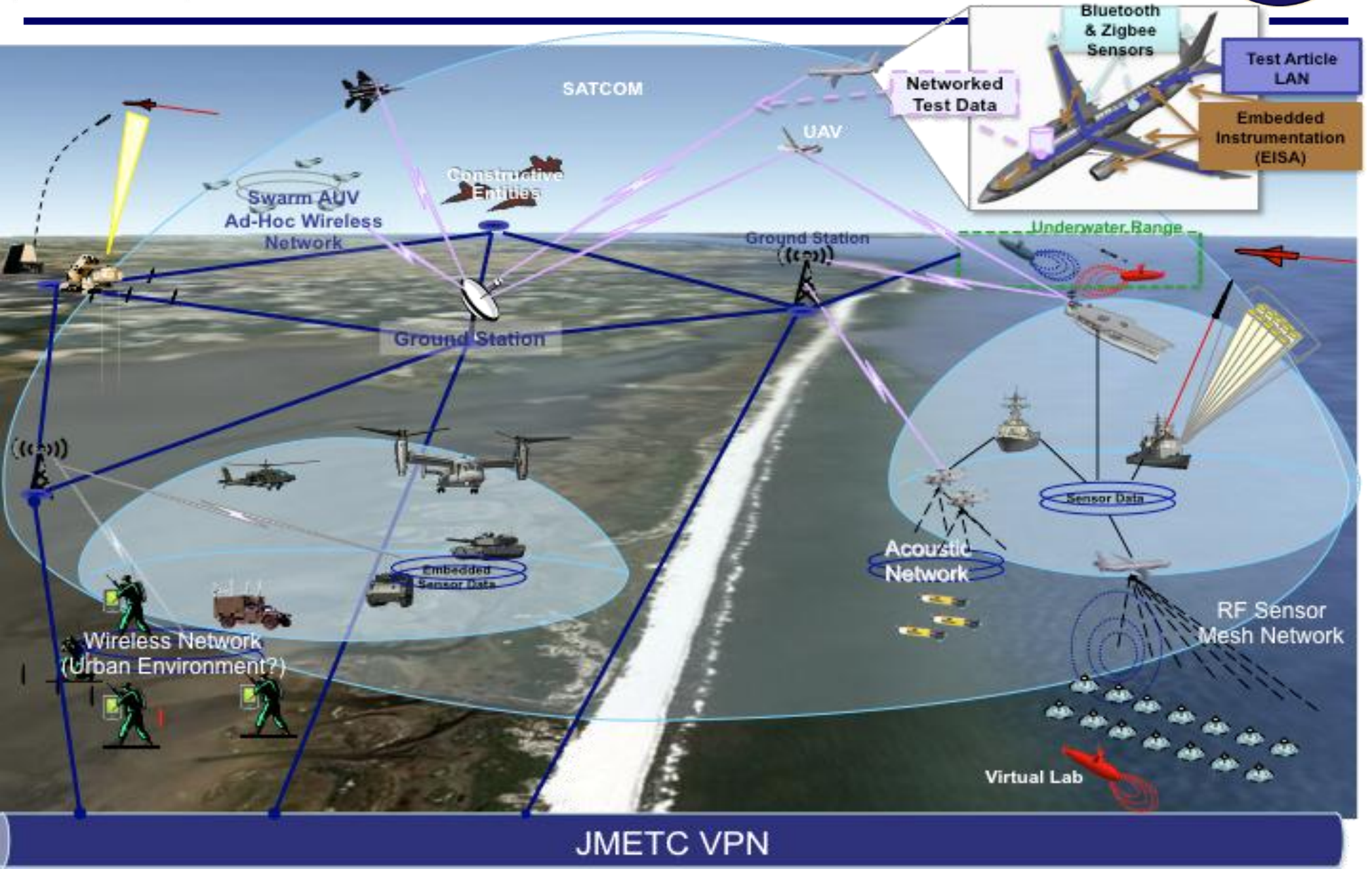
•Representative Laboratory Environment

•Successful Phase 1 Technology Demonstration

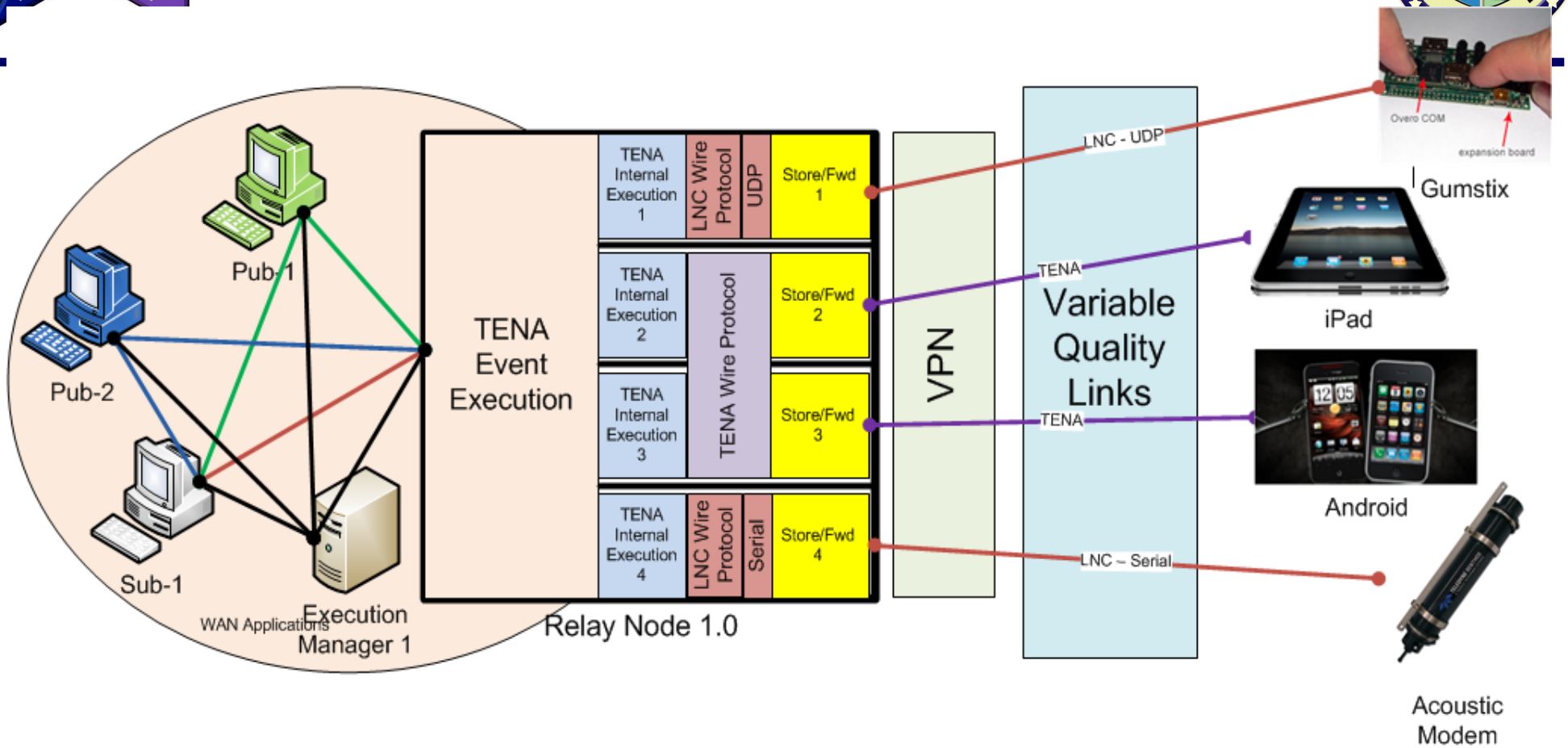
•Recommended Technologies for Further Development and Inclusion in the TENA Middleware

TRCE is providing TENA for variable quality and low data rate network links including wireless networks

TRCE Use Case OV-1



RelayNode 1.0



- Auto-generated application that will support a wide range of object models
- Can be deployed at strategic points geographically on the LAN/WAN
- Supports each device connection in separate thread
- Will eventually support Bluetooth and Zigbee devices

Summary: Benefits of TENA

- **TENA represents an enormous amount of practical experience focused on addressing common range infrastructure requirements**
  - More than 7,000 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 1,200 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!**

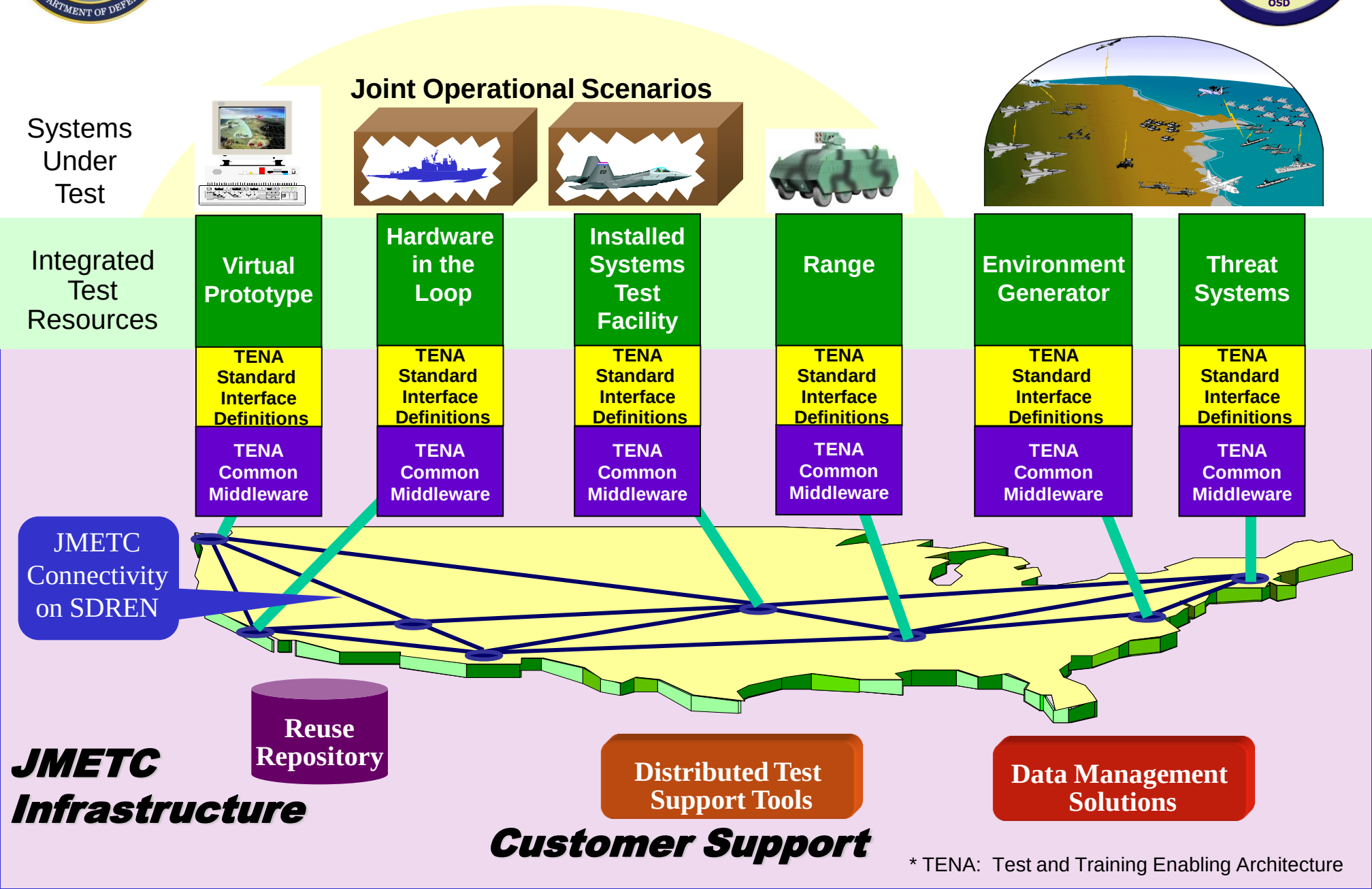
What is JMETC?

- 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 Virtual Private Network using SDREN

TENA Software, Object Models, Tools, Repository

JMETC Enables Distributed Testing



* TENA: Test and Training Enabling Architecture

JMETC Benefits

- **Provides Department-wide capability for:**
  - Evaluation of a weapon system in a joint context
  - DT, OT, Interoperability Certification, Net-Ready KPP compliance testing, Joint Mission Capability Portfolio testing, etc.
- **Provides test capability aligned with JNTC**
  - Both use TENA architecture
  - Both use Network Aggregator
- **Reduces time and cost by providing**
  - Readily available, persistent connectivity with standing network security agreements
  - Common integration software for linking sites
  - Distributed test planning support tools
- **Provides distributed test expertise**

The corporate solution to distributed LVC Testing

JMETC Connectivity

- Functional Sites: 67
- New Sites Planned: 12
- Connection Points to Other Networks: 7

- Dedicated, trusted connectivity on SDREN (part of the GIG)
- Encrypted for Secret – System High
- DISA-registered IP address space
- Active monitoring of network performance
- Capable of supporting multiple simultaneous test events

Boeing LabNet: Tukwila
Keyport: NUWC
Ft Lewis: EPG

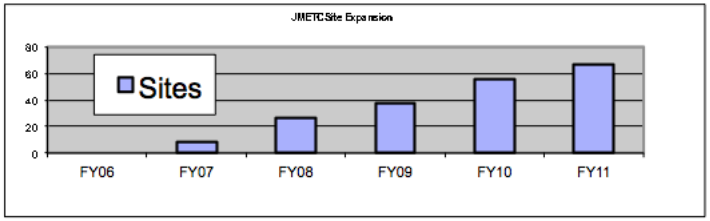
Site in Alaska
Ft. Greely: CRTC

Edwards (2): Ridley, 412th EWG IFAST
China Lake (2): F/A-18, IBAR
TSPIL
Point Mugu (2): ITEC, EA-6B
El Segundo: NGC B-2
Camp Pendleton: MCTSSA
Corona: NSWC
Palmdale, NGC BAMS
Point Loma :
SSC-PAC 59140
SSC-PAC HAIPE
West Agg Rtr.
Rancho Bernardo, NGC BAMS

Sites in Hawaii
PMRF: Bldg 105
MHPCC

Dugway Proving Ground
Schriever AFB: JEWL
Nellis AFB: CAOC-N
Yuma PG
Ft Huachuca: (4) JITC, JTDL, CMIS, JTRS
WSMR: IRCC
Tinker AFB: AWACS
Ft. Sill: FSED
Greenville: Rivet Joint
Ft Hood (2): CTSF, TTEC
Boeing LabNet: Berkeley
WPAFB: SIMAF
Crane: NWSC RDT&E
Redstone (10): SMDC
RTC: DTCC, GMAN
SED: Patriot, THAAD, FAAD, GSIL, JLENS, MUSE, SIV
(2) SED-PSEM, AMRDEC
GTRI
Charleston (2): IPC, MEF-MEU
Hurlburt Field: C2DAC
Eglin AFB (5): AOC, DTF, GWEF, KHILS, JDAT
Melbourne: NGC JSTARS
Hanscom AFB: CEIF
Bethpage: NGC BAMS
Bethpage: NGC BCN
Moorestown: CSEDS

Aberdeen: ACCN
Pax River:
(8)ESTEL E2C/D, MCL, ACETEF, SAIL, ATR, E-2C SIL, UASIL, MFS
JMETC SYSCON
East Agg Rtr.
Dahlgren (2): CEDL,IWSL
JS J8 DDC4: C4AD
Langley (2): C-GIIF, TDLITC
Norfolk: COMOPTEVFOR
Dam Neck: CDSA
Wallops Island: (2) SCSC, SSDS
Newport News: NGC VASCIC
McLean: MITRE NCEL
LMCO Global Vision Network, Arlington, VA

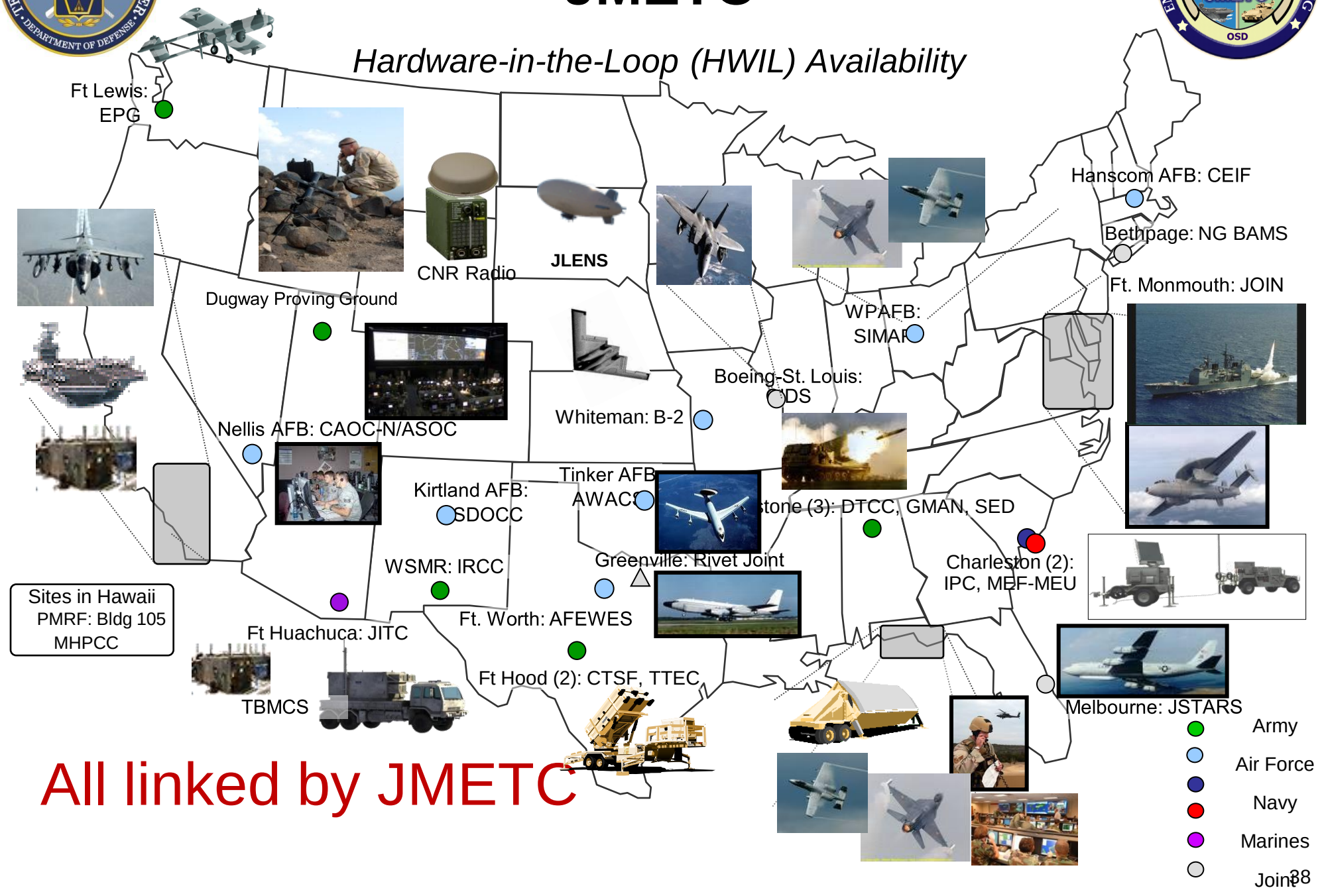


As of 27 Feb 2012

Army
Air Force
Navy
Marines
Joint
Industry
Academia

How a Test Planner Should View JMETC

Hardware-in-the-Loop (HWIL) Availability



All linked by JMETC

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 11- Ongoing
  - 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
  - JITC 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

JMETC Users Group Meetings

- **Identify core infrastructure requirements and use cases**
- **Identify, investigate, & resolve issues**
- **Identify opportunities to collaborate**
- **Discuss available solutions, tools, and techniques**
- **Share lessons learned**

Next JMETC Users Group Meeting:

May 8-9, 2012

Location: Phoenix, AZ

Tracks:

- User Requirements
- Networking
- Data Management
- Threat Systems (FOUO)
- Cyberspace T&E (FOUO)

Users Group #06

Users Group #07

Users Group #08

Users Group #09

Users Group #10

Users Group #11

Users Group #12

Users Group #13

- 22-23 March 2011
  - Norfolk, VA
  - ~200 participants
  - Plenary session:
  - JFCOM Senior Leaders
  - Tracks:
  - User Requirements
  - IA / Security
  - Networking
  - Data Management
  - InterTEC Tools

Summary

- **TENA offers significant benefits to the range community**
  - Common data standards, interfaces, communication software, and tools to improve interoperability, reuse, and long-term sustainability of range assets for reduced O&M
- **TENA is the CTEIP architecture for future instrumentation, the JNTC architecture for Live integration, and an enabling technology for JMETC**
- **JMETC provides inter-range connectivity and supports the full spectrum of Joint testing, supporting many customers in many different Joint mission threads**
- **TENA and JMETC are:**
  - Being built and evolved based on customer requirements
  - Partnering with Service activities and leveraging existing capabilities
  - Coordinating with JNTC to bridge test and training capabilities
  - Provide a forum for users to develop and expand the architecture
    - TENA AMT and JMETC User Group Meetings
    - Next Meeting is week of May 7-10 in Phoenix, AZ

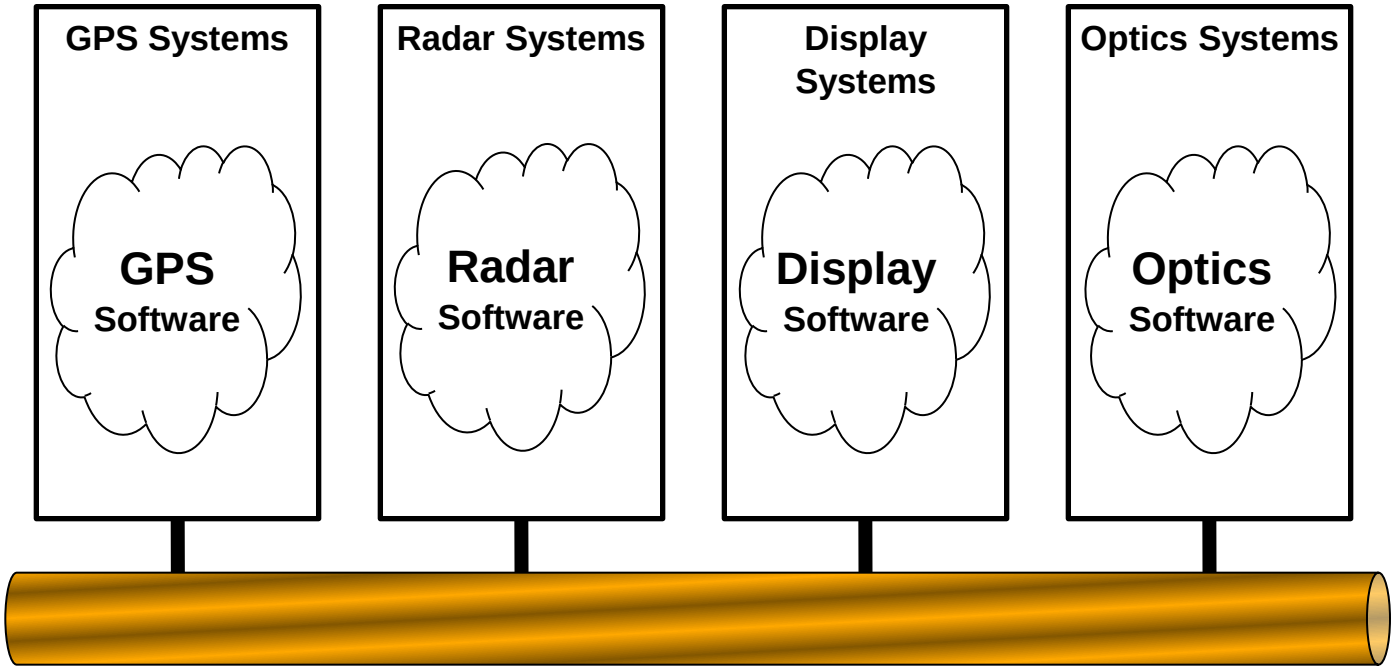
Important Contact Information

- **TENA Website: www.tena-sda.org**
- **TENA Feedback: feedback@tena-sda.org**
- **JMETC Website: www.jmetc.org**
- **JMETC Feedback: jmetc-feedback@jmetc.org**

TENA and JMETC Enabling Interoperability Among Ranges, Hardware Facilities, and Laboratories

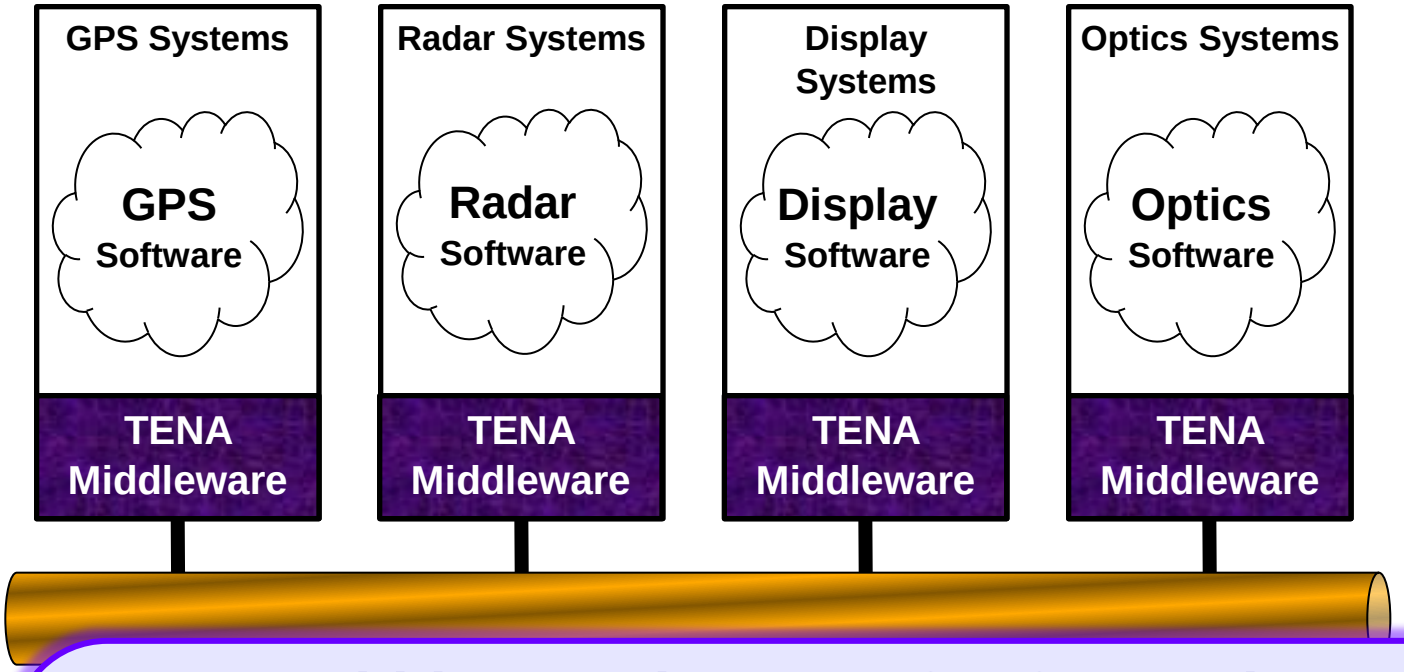
Back-up Slides

Anatomy of Range Systems



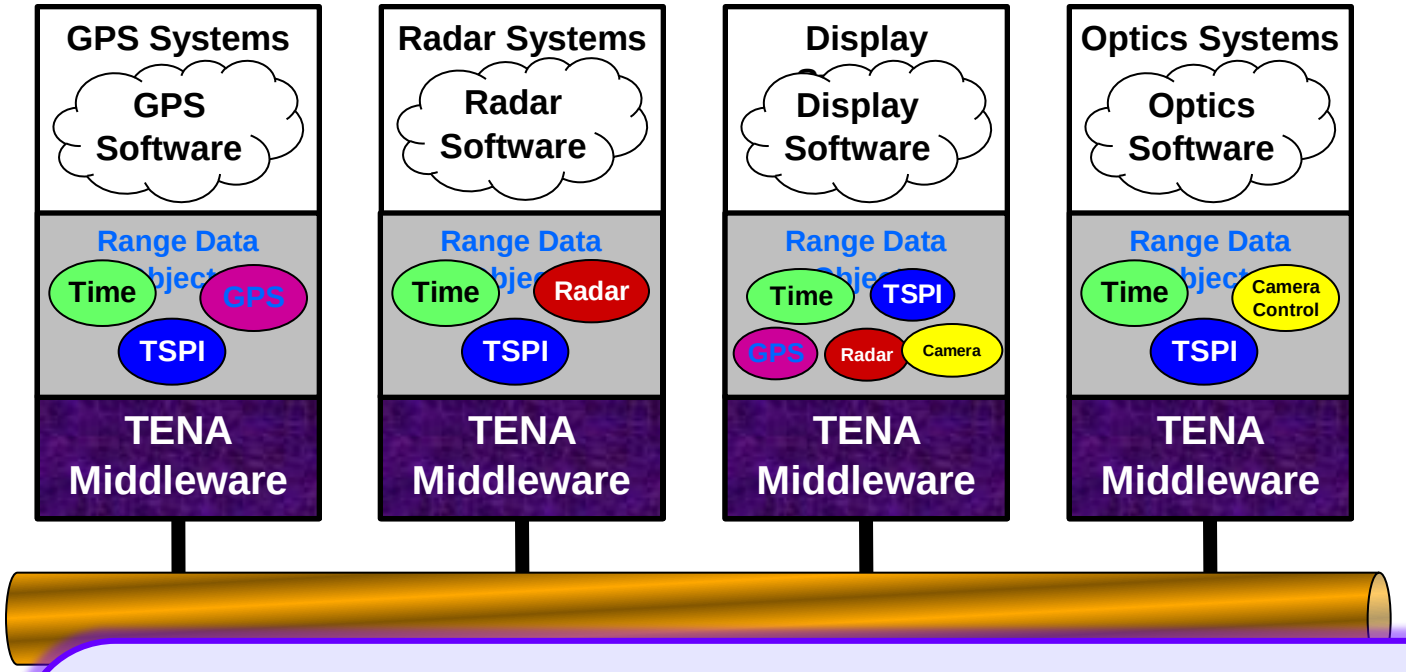
- **Traditionally, all developers must develop (often independently) code that performs the function of data exchange between systems**
  - **Data preparation, packet marshalling/demarshalling, network communication, error handling, etc.**

TENA Middleware
(Software Library of Data Exchange Functions)



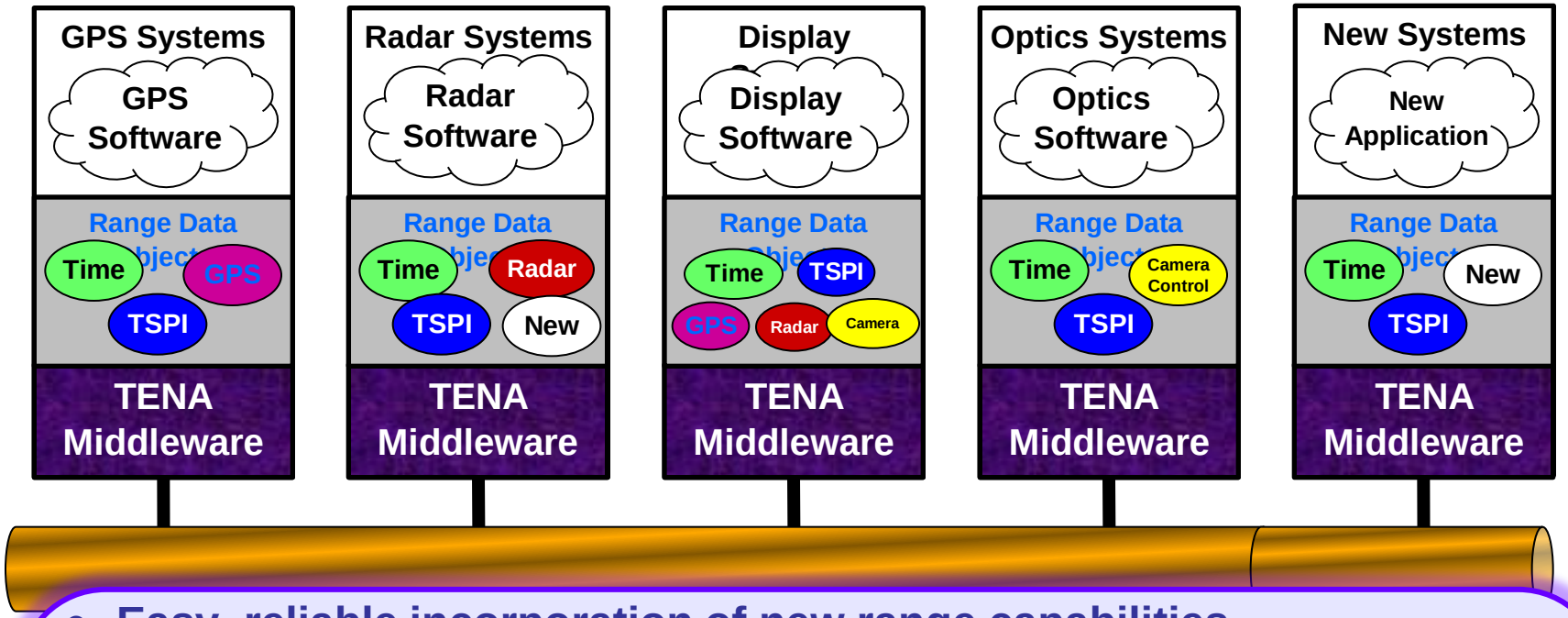
- **TENA Middleware is a set of software that performs real-time data exchange between systems**
- **TENA Middleware available for ~40 platforms, including:**
  - Windows 7, Server 2008, Vista, XP, (32- and 64-bit)
  - Linux: Fedora 12/14/16, Red Hat 4/5/6, Mac OS X, SUSE (32- and 64-bit)
  - Embedded Devices: Overo (working Green Hills real-time port)
  - Mobile OSes: iOS, Android (beta releases)
  - Solaris 10 (deprecated)

TENA Object Models
(Range Data Formats & Algorithms)



- TENA Object Models are auto-code generated software interfaces that include data formats, data definitions, and common algorithms
- Auto-coded interface software can be standard TENA Object Models that the community has designed and agreed upon, or they can be designed for unique user requirements
- Standard TENA Object Models already developed include:
  - Time, TSPI, Coordinate Systems (including conversions), GPS, Radar, Telemetry, SUT Description, Event Control, Video Distribution, Weather

Adding New Range Capabilities



- Easy, reliable incorporation of new range capabilities
  - Known data exchange software (TENA Middleware)
  - Reuse standard range objects (Standard TENA Object Models)
    - Auto-code generate any new object models
  - Range interface on new application verified while application is developed (verification performed during software compile)
  - TENA Middleware verifies new application is using the same formats & algorithms when the application is started

TENA Utilities and Tools (Partial List)

- **TENA Utilities—Making TENA easier to use**
  - MagicDraw UML-to-TDL Plugin
  - TENA Integrated Development Environment
  - TENA Wiki (Confluence)
  - TENA Issue Tracking System (Jira)
  - TENA Installer
- **TENA Tools—Helping you manage your event**
  - TENA Console
  - Gateway Builder
  - Interface Verification Tool
  - SIMDIS
  - TENA Video Distribution System
  - Network Analysis Tools
  - Network Communication Tools (chat, file transfer, etc.)
  - Reflect Data Collection System
  - TENA AMO Monitor
  - SimShield Trusted Guard
  - Joint Interoperability Modular Evaluation System (JIMES)
  - Starship

April 2012

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
	AMIIP MST1.5 (J Santos/M Stamm)					
	JIT 12-03 Systems Integration/Dry Run (S VanWinkle/ J Jay)					
	B-1B FIDL Interoperability Test (C Juszak / J Bailey)					
8	9	10	11	12	13	14
	JIT 12-03 RFR (S VanWinkle / J Jay)					
15	16	17	18	19	20	21
22	23	24	25	26	27	28
	MSTCT (J Santos / M Stamm) Hours: 1300–2400 ET					
		Pelorus Dry Run for JIT 12-04 (S VanWinkle / J Jay)				
	DCGS-A Testing (E Elmore / J Bailey)					
29	30					
	AFSIT 12-04 (J Rutledge / M Stamm)					
	AMIIP MST2 (J Santos / M Stamm)					

Why do some find TENA to be intimidating at first?

- **TENA has a lot to offer**
  - Requirement studies for a common T&E range infrastructure began in the mid-1990's, with the first middleware release in Oct. 2001
  - All of the TENA features and improvements are a direct result of the practical experience of our users who have made more than 10,000 separate middleware downloads since 2005
- **TENA uses framework software patterns and strong type safety to improve the quality of all user applications**
  - These software techniques enforce certain constraints that may initially seem foreign to some developers, but they enable our community to determine most effective ways to provide common infrastructure solutions

Developing and maintaining range systems is a challenging endeavor, but there is an enormous (and growing) amount of practical range experience embodied in TENA