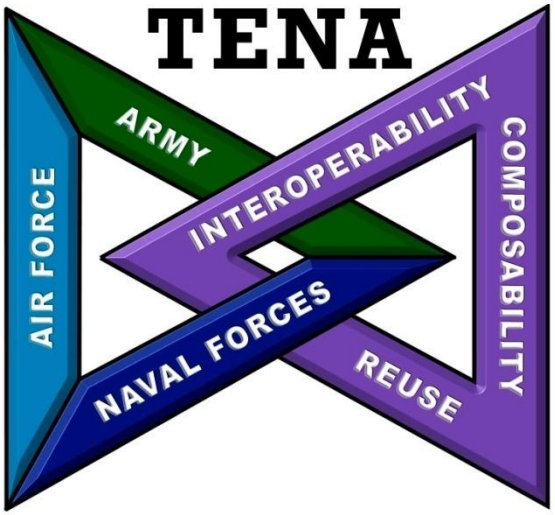
TENA and JMETC Enabling Interoperability Among Ranges, Facilities, and Simulations



Briefing for:
NDIA 27th Annual National T&E Conference

March 16, 2011

Gene Hudgins, TENA SDA User Support Lead

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**

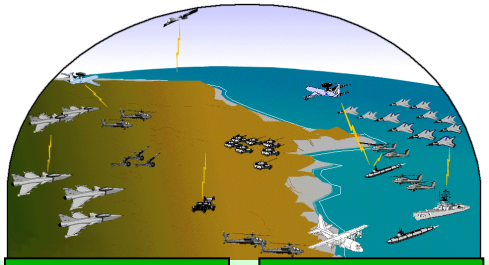
JMETC Enables Distributed Testing

Joint Operational Scenarios

Systems Under Test



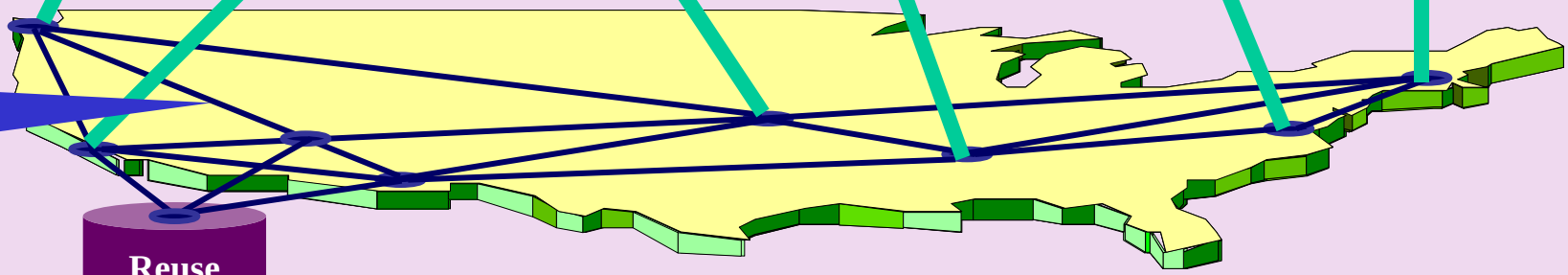




Integrated Test Resources

Virtual Prototype	Hardware in the Loop Lab	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 VPN on SDREN



Reuse Repository

JMETC Infrastructure

Distributed Test Support Tools

Data Management Solutions

Customer Support

JMETC: Here and Now

- **Uses the Secure Defense Research & Engineering Network (SDREN) for connectivity**
  - 61 sites currently on-line
- **Uses Test & Training Enabling Architecture (TENA)**
  - Gateways to link to existing DIS and HLA simulations
- **Incorporates InterTEC test tools**
- **Uses the JNTC-sponsored Network Aggregator to link together other networks**
- **Being expanded based on customer requirements**
- **Holding JMETC Users Group meetings to discuss emerging requirements and technical solutions**
  - Seeking the “best of breed” solutions across the community

JMETC Connectivity

- Functional Sites: 61
- New Sites Planned: 6
- Connection Points to Other Networks: 4

- 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: Tukwila
Keyport: NUWC
Ft Lewis: EPG
Dugway Proving Ground
Schriever AFB: JEWL
Nellis AFB: CAOC-N
Whiteman: B-2
Boeing: Berkeley
WPAFB: SIMAF
Hanscom AFB: CEIF
Bethpage: NGC BAMS
Ft. Monmouth: JOIN
Tinker AFB: AWACS
Ft. Sill: FSED
WSMR: IRCC
Greenville: Rivet Joint
Ft Huachuca: (2) JITC, JTDL
Ft Hood (2): CTSF, TTEC
Redstone (6): RTC: DTCC, GMAN
SED: Patriot, THAAD, FAAD, SIV
Charleston (2):
IPC, MEF-MEU
Melbourne:
NGC JSTARS

Sites in SoCal
- Edwards: Ridley
- China Lake (3): AV-8B, F/A-18, IBAR
- Point Mugu (2): ITEC, AEA
- El Segundo: NGC B-2
- Camp Pendleton: MCTSSA
- Corona: NSWC
- Point Loma (2): RLBTS SSC-PAC
- Rancho Bernardo, NGC BAMS
- West Agg Rtr.

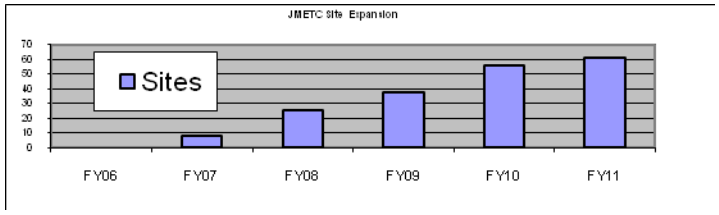
Sites in Hawaii
- PMRF: Bldg 105
- MHPCC

Site in Alaska
- Ft. Greely: CRTC

Sites in Gulf Range
- Hurlburt Field: C2DAC
- Eglin AFB (4): AOC, DTF, GWEF, KHILS

Sites in MD, DC, VA
- Aberdeen: ACCN
- Pax River (5): ESTEL E2C/D, MCL ACETEF, SAIL, ATR JMETC SYSCON East Agg Rtr.
- Pentagon: WARCAP
- DISA: Sky 7
- Dahlgren (2): CEDL,IWSL
- JFCOM: JSIC
- Langley (2): C-GIIF, TDLITC
- Norfolk: COMOPTEVFOR
- Norfolk:C2F Mitscher Ctr
- Dam Neck: CDSA
- Wallops Island: (2) SCSC, SSDS
- Newport News: NGC VASCIC
- McLean: MITRE NCEL

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



As of 09 Dec 2010

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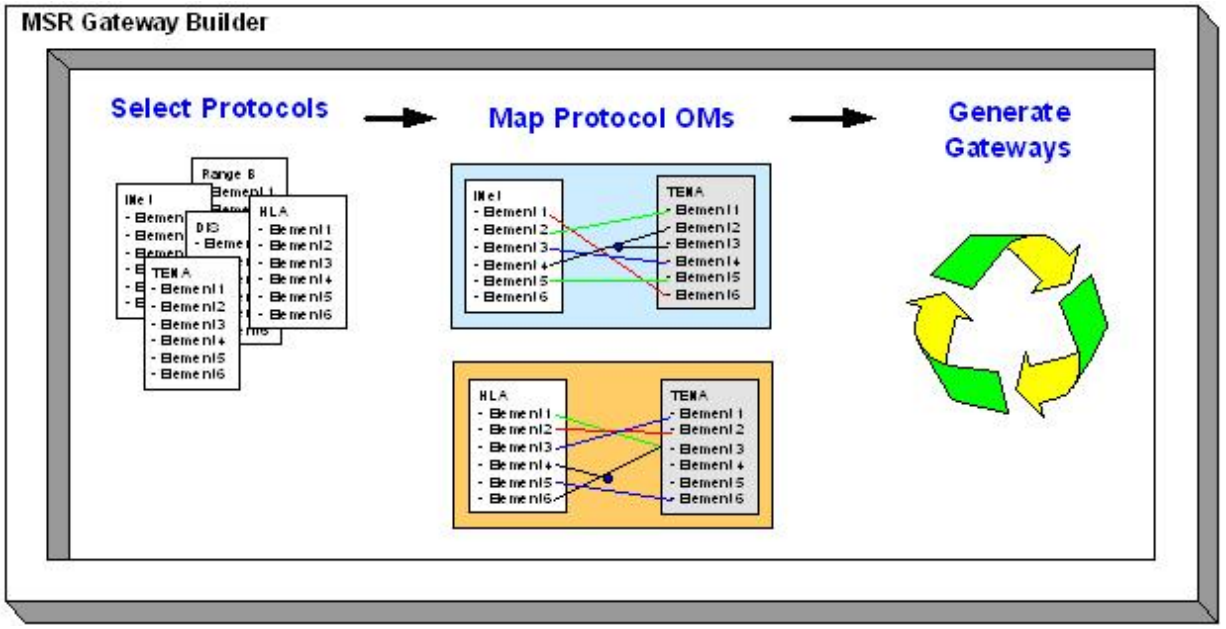
JMETC Uses TENA to Integrate Sites

(Can gateway to existing DIS and HLA simulations)

- TENA is:
  - Developed, upgraded, and sustained by CTEIP and JNTC
  - Middleware that provides a single, universal data exchange solution
  - Common for test and for training (core standard in JMETC and JNTC)
  - Available for download at www.tena-sda.org for free
- TENA provides:
  - Interoperability among range systems, hardware-in-the-loop laboratories, and simulations in a quick, cost-efficient manner
  - A capability to rapidly and reliably develop LVC integrations
  - A set of community-agreed object models that define the data elements used in LVC integrations – maximizes reuse from event to event
  - An auto-code generator to drastically reduce TENA incorporation time
- Newest version of TENA (version 6.0) provides:
  - Advanced data filtering (only data of interest sent over the wire)
  - Improved fault tolerance and embedded diagnostics
  - Downloadable on the TENA Website

Gateway Builder

- GWB is focused on integration of distributed live, virtual, and constructive (LVC) systems into a common synthetic battle space that comprises various simulation protocols, training ranges, live systems and platforms
- Gateway Builder streamlines integration process and reduces time and effort of creating gateways
- Gateway Builder is a flexible, extensible, graphically driven tool that automatically generates gateways to bridge simulation and live protocols
- Gateway Builder supports mappings between TENA, DIS, and HLA and message-based protocols using any object model



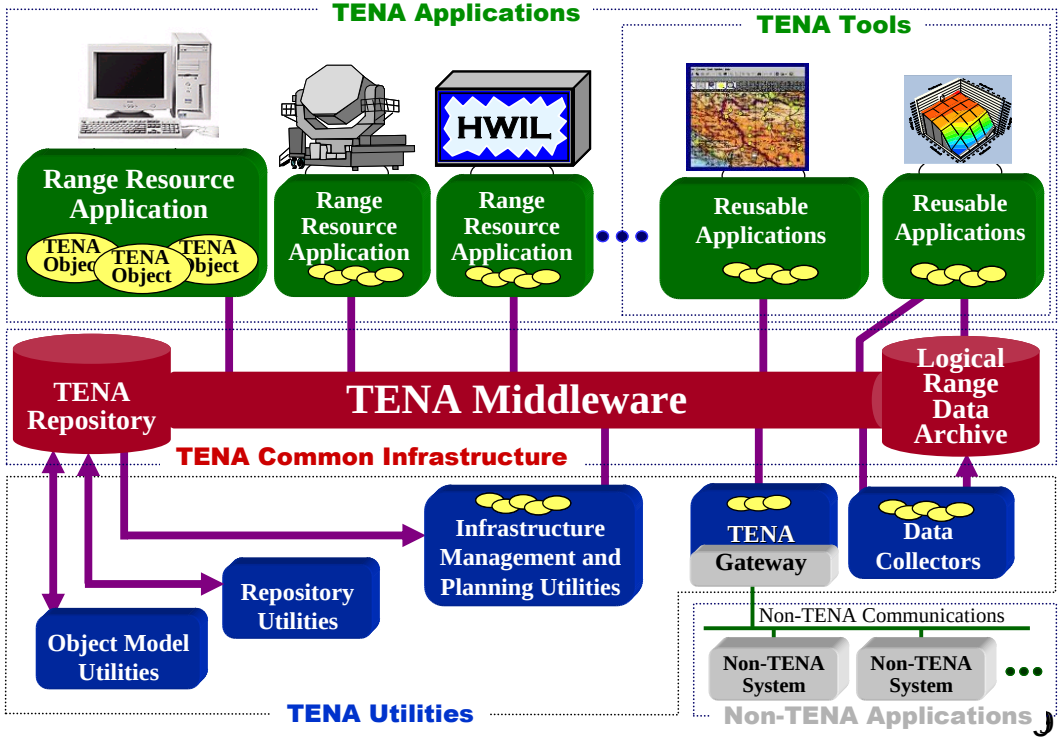
Gateway Builder Simplified Block Diagram

TENA Overview

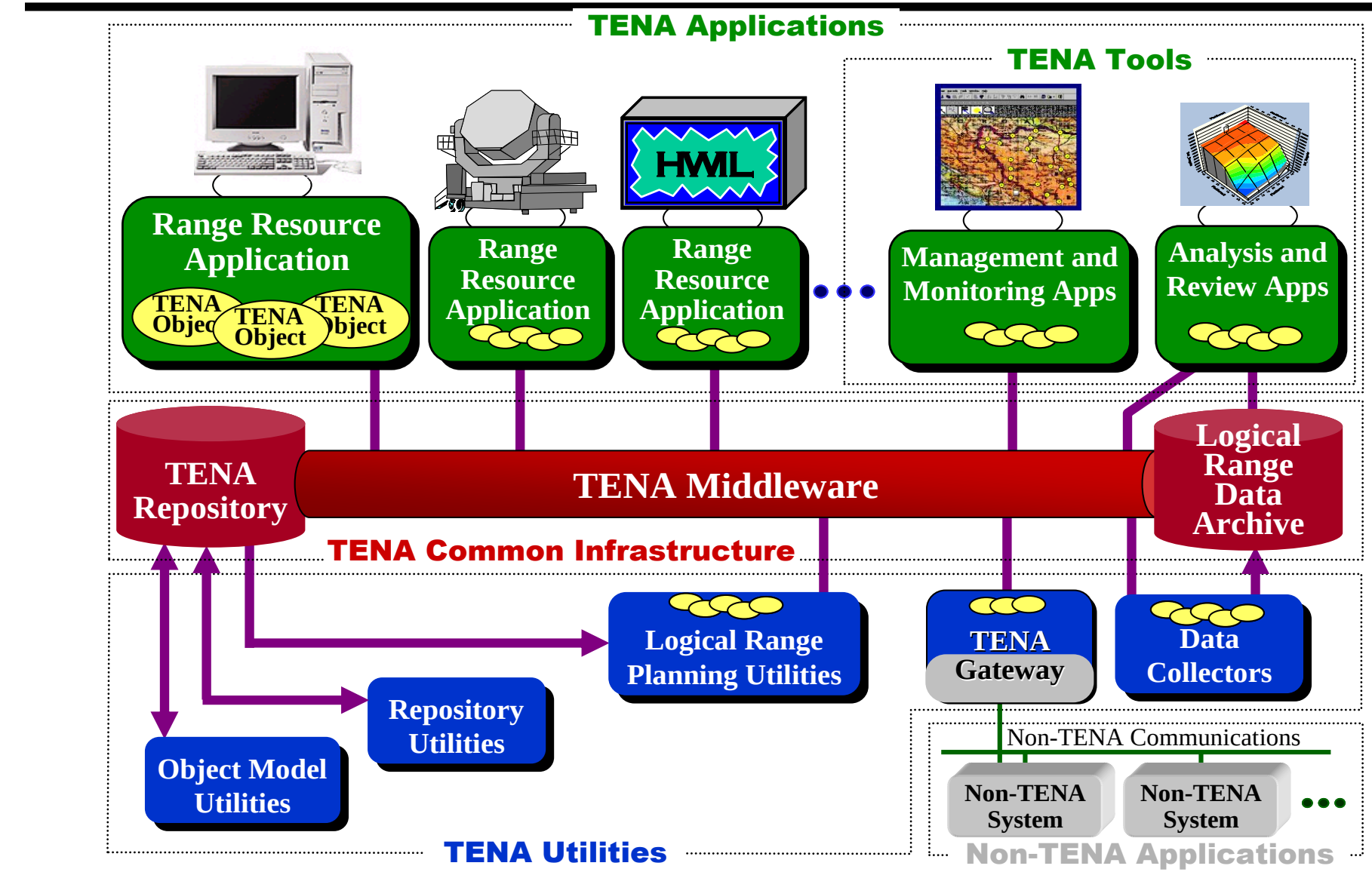
- **Requirements**
  - Interoperability
  - Reuse
  - Composability
  - **Support Rapid Integration**
  - **Gradual Deployment**

- **Supports**
  - **Testers & Trainers**
  - **Joint, Army, Navy, Air Force, Agencies**
  - **Live, Virtual, Constructive**
  - **Range, Laboratories, Simulations**
  - **Real-Time & Non-Real-Time**

- Guiding Principles
  - Provide middleware
  - Use real software objects
  - Maximize code generation
  - Management by users (AMT)
  - No license fee (GOTS)



TENA Architecture Overview



Key Release 6 Improvements and New Capabilities

New Middleware Capabilities

- Advanced Filtering
- OM Subsetting Support
- SDO State Processing Support
- Self-Reflection Option
- Object Reactivation
- Separate Inbound/Outbound ORBs

Metamodel and Model Improvements

- Fundamental Sized Type Aliases
- Const Qualifier
- Optional Attributes
- SDO Initializers
- Middleware Metadata
- Middleware IDs

New Event Management Capabilities

- Object Model Consistency Checking
- Remote Object Termination
- Execution Manager Fault Tolerance
- Embedded Diagnostics
- TENA Console

Usability Improvements

- Observer Pattern (with Callback Aggregation)
- Local Methods Factory Registration
- Code Installation Layout

Key Release 6 Improvements and New Capabilities

New Middleware Capabilities

- Advanced Filteri
- OM Sub
- S
- port
- ion
- ctivation
- parate Inbound/Outbound ORBs

•Enhanced data distribution
•Optimized network usage

Metamodel and Model Improvements

- Fundamental Si
- Const O
- C
- Metadata
- ddleware IDs

•Better ways to define data
•Remove ambiguity

New Event Management Capabilities

- Object Model C
- Remot
- t Tolerance
- gnostics
- onsole

•Improved reliability
•Enhanced troubleshooting

Usability Improvements

- Observer Patt
(with C
- stallation Layout

•Easy to use
•Harder to use wrong

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

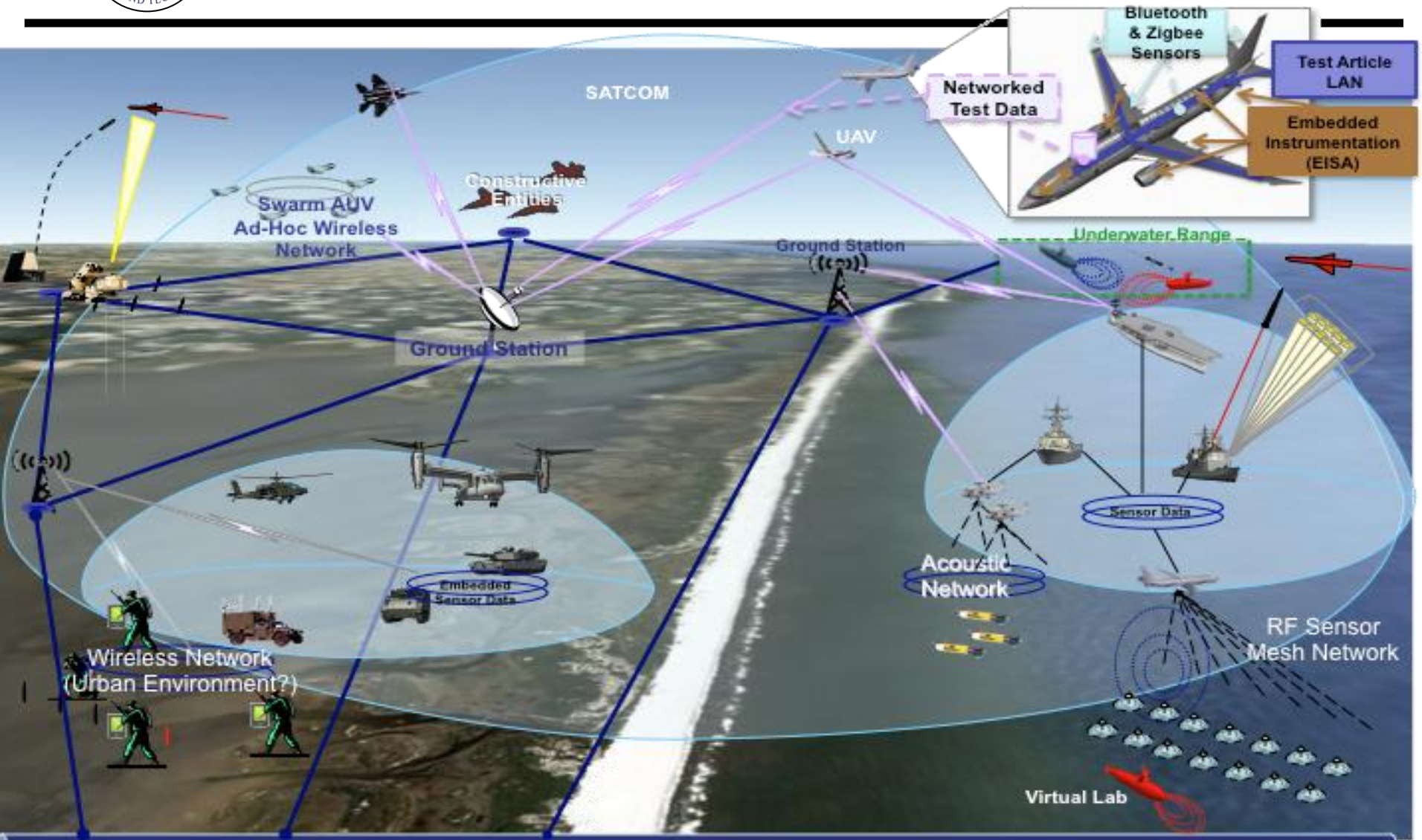
- **Low Data Rate Networks**
  - **TENA must be able to establish and maintain data connections on low data rate networks**
  - **Need to optimize use of low data rate networks to support relevant operational scenarios**
- **Wireless Networks**
  - **Current range environments use wireless links extensively 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



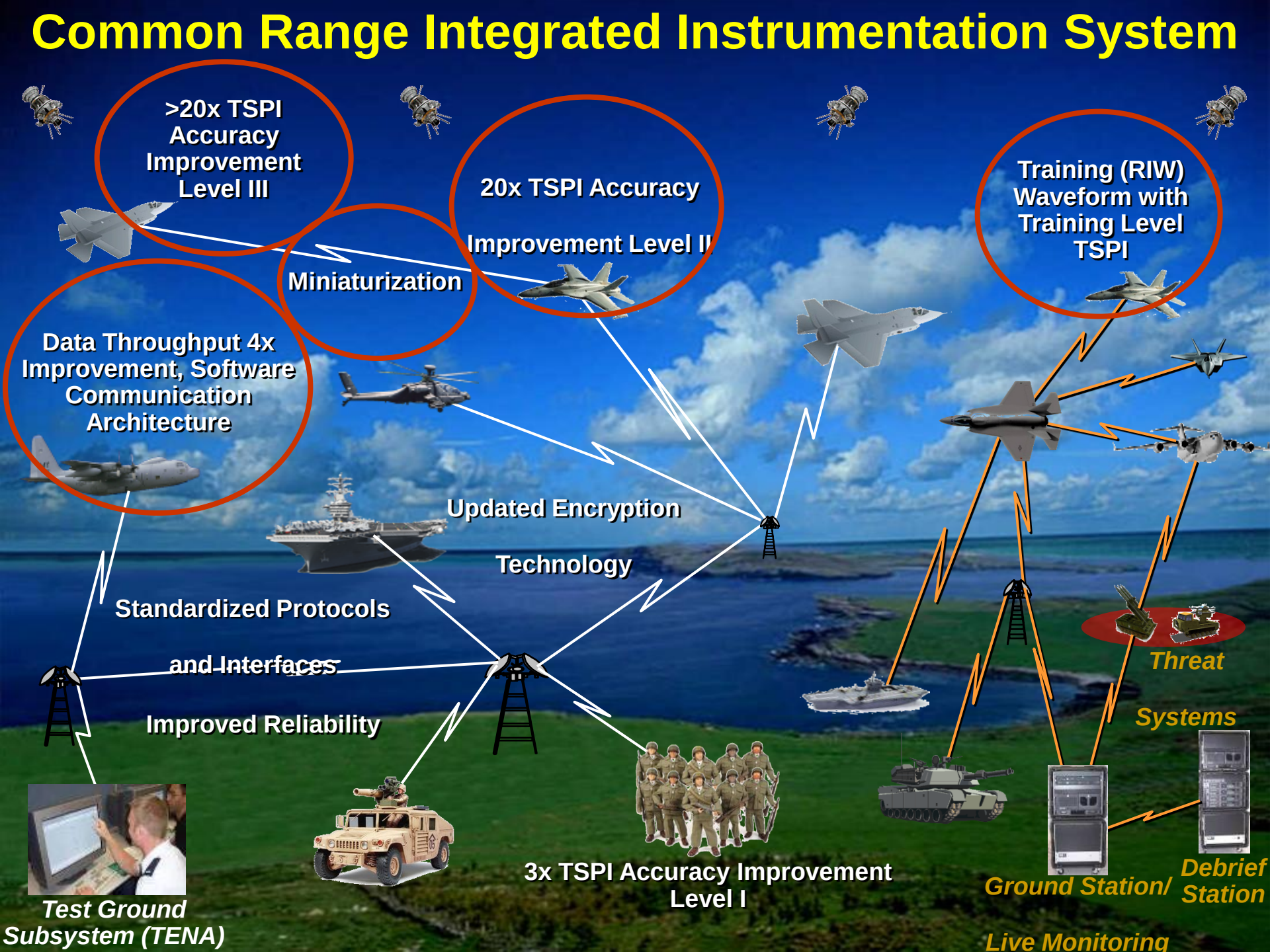
Hands-on TRCE Current "Smartphone" Capabilities at the TENA/JMETC Booth

- Booth Demonstration Capabilities Using TENA RelayNode and TENA Video Distribution System (TVDS) with iPads and iPod Touch Devices
  - Display of Platform positions on static maps stored locally on the handheld devices
  - Selection and real-time viewing of available video streams managed by TVDS on handheld devices (iPhone/iPad/Android)
  - Pan/Tilt control of remote cameras (and firing of Nerf remote "missile launcher") via TENA remote methods
- Highlights the Flexibility of TENA Middleware
  - Remote control of instrumentation via TENA Remote Methods
  - Use of wireless networks including 3G
  - Middleware implementations on small form factor computers such as Smartphones

TENA and RRRP

- Use of TENA will facilitate Remote Operations and Interoperability of the Ranges' Radar Systems
- TENA Instrumentation Radar Object Models will be used for all communications external to the individual Radar Systems
  - Pointing data for optics, telemetry, or other radars
  - Remote Single Integrated Air Picture (SIAP)
- Development of TENA Instrumentation Radar Object Models
  - Developed initial Instrumentation Radar TSPI Object Model
    - Received input from Test Center SMEs
    - For CW Doppler and Pulse radar systems
  - Instrumentation Radar Object Models will be finalized after contract award

Common Range Integrated Instrumentation System

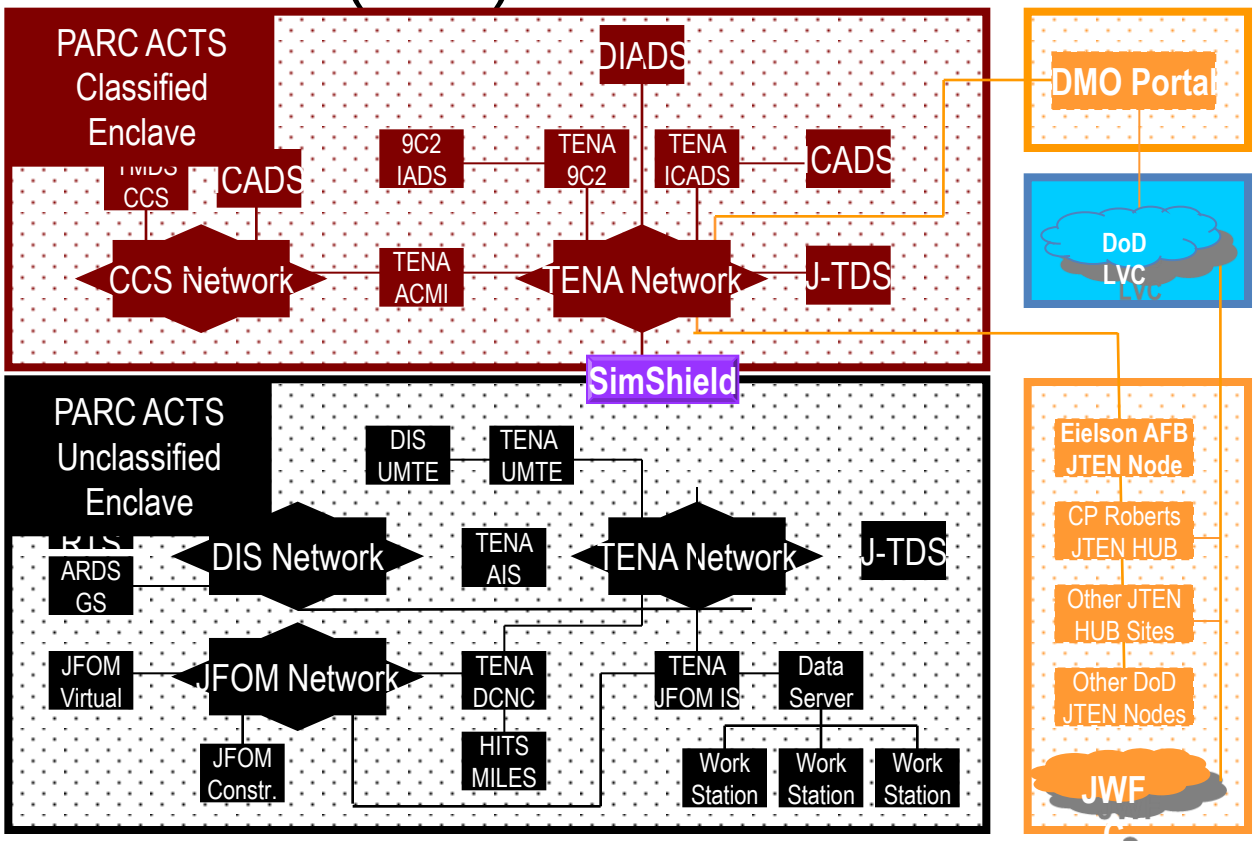


Alaska Training Range Evolution Program (ATREP) use of TENA

ATREP's intent is to enhance the existing Pacific Alaska Range Complex air and ground capabilities by providing a 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.

High Side
- TENA ICADS
- TENA ACMI
- TENA 9C2
- TENA DIADS
- TENA SimShield

Low Side
- TENA MOKKITS
- TENA MILES 2000
- TENA I-HITS
- TENA UMTE



Partial Listing of Recent Testing, Training, and Experiments Using TENA-Compliant Capabilities

- *Test Events*
  - SIAP JDEP Combined Hardware-in-the-Loop Phase 5, Jan-May 09
  - Digital Close Air Support – Integrated Model Test Event, Jan-Mar 09
  - Multi-Service System-of-Systems Test-bed, Jul 09
  - Strategic Integrated M&S Capability, May-Aug 09
  - Joint Electronic Warfare Assessment for Test and Evaluation, Sep 09
  - Tactical End-to-End Closed Loop Sim, Nov 09
  - Joint Distributed IRCM System Test Event, Mar 10
  - Joint Close Air Support Distributed Test, Jun 10
  - Battlefield Airborne Communications Node (BACN) Joint Urgent Operational Need (JUON), Aug 10
  - JIAMDO Air & Missile Defense Correlation / Decorrelation Interoperability Test (CDIT) CONUS, Sept 10
  - Unmanned Aircraft System (UAS) in National Air Space (NAS) Oct 09 and Oct 10
  - JITC Joint Interoperability Test (JIT) Sep-Nov 10
  - JIAMDO CDIT UK, Oct 10
  - Air-to-Ground Integrated Layer Exploration AGILE Fire III, Feb 11
- *Training Exercises*
  - Daily Training, Eielson AFB
  - Daily Training, Fallon AFB
  - Red Flag Alaska (RFA) 09-1, October 08, Pacific Alaska Range (PARC)
  - JDEWR Cope Tiger 09, Mar 09, PARC
  - RFA 09-2, April-May 09, PARC
  - Distant Frontier, May-June 09, PARC
  - Northern Edge 09, June 09, PARC
  - Talisman Sabre 09 - Australian Army and US Army, July 09, Shoalwater Bay, Queensland Australia
  - RFA 09-3, July-Aug 09, PARC
  - JDEWR Talisman Sabre 09, July 09, PARC
  - RFA 10-1, October 09
  - RFA 10-2, April 10
  - Northern Edge, June 10
  - RFA 10-3, Aug 10
- Experiments
  - Joint Surface Warfare JCTD, Feb 09 and 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

Distributed Events operated over the JMETC and JTEN Connectivity

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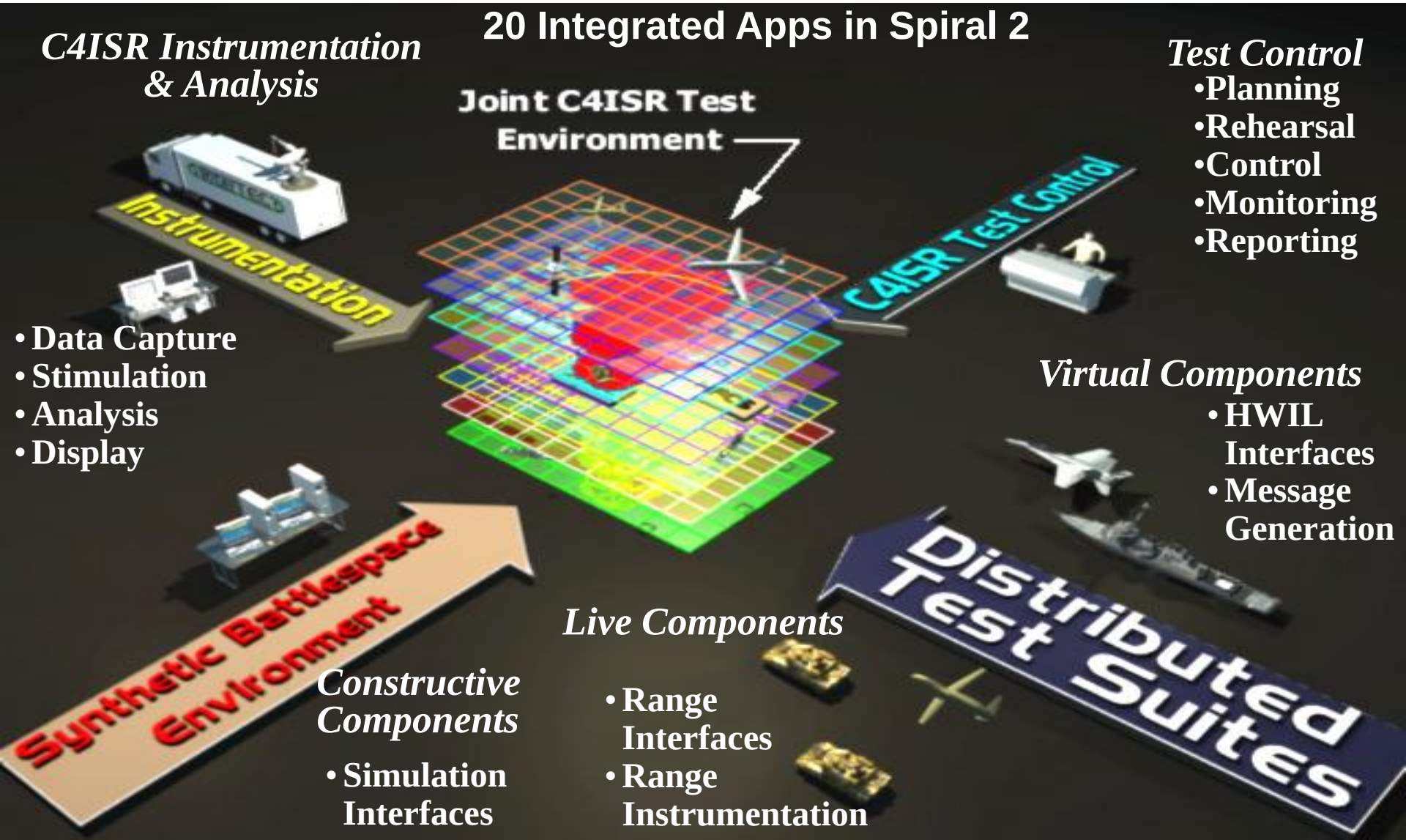
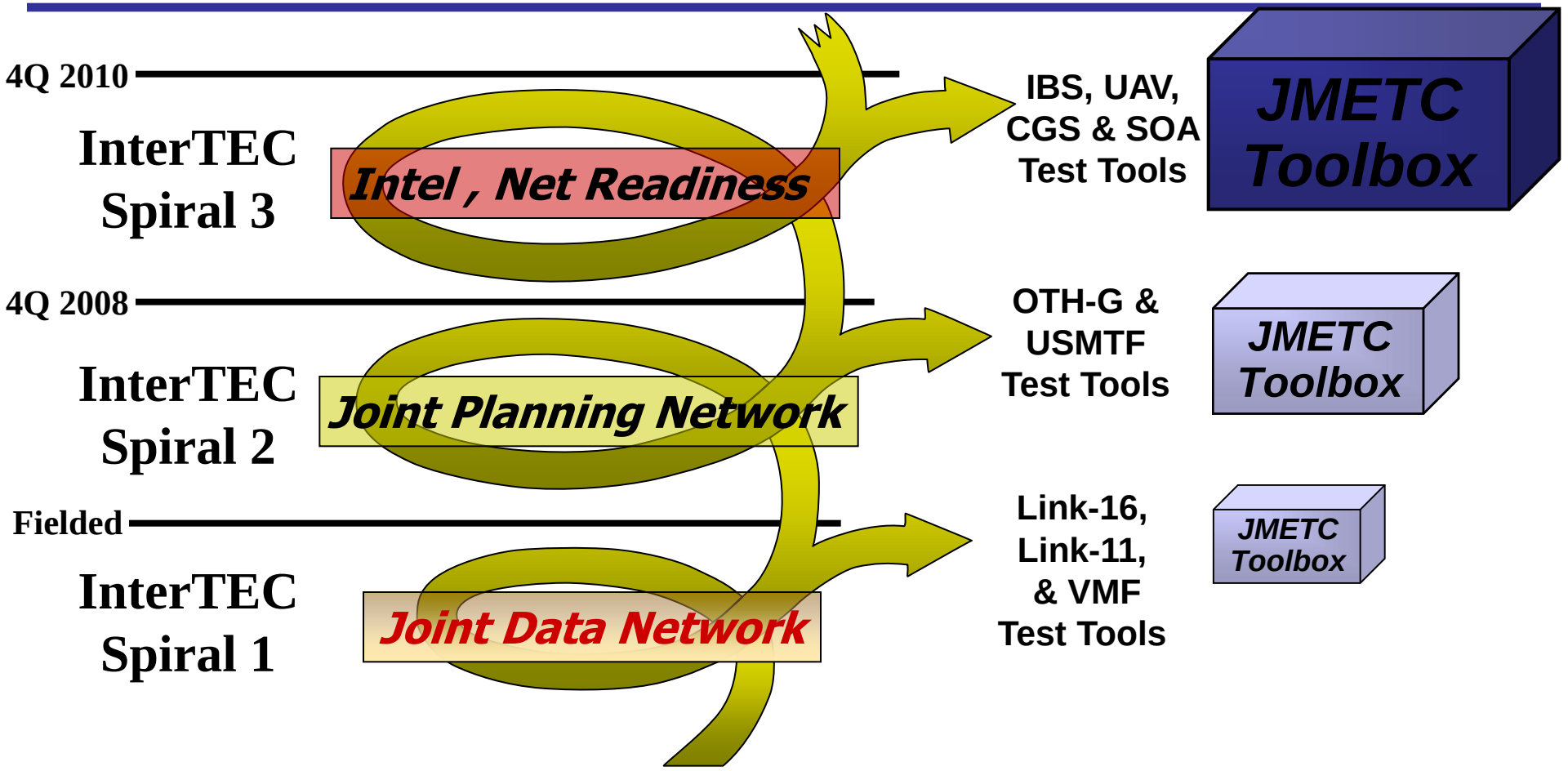
InterTEC Operational View-1

TENA-Based Integrated Test Tool Applications



InterTEC Integration with JMETC Inextricably Intertwined



- JMETC supports InterTEC during their spiral development
- InterTEC expands JMETC toolbox with certified C4ISR Test Tools

TENA Integrated Development Environment (TIDE)

- **TIDE is a tool designed to assist developers in the creation, development, testing and deployment of TENA applications**

- **Initial Capabilities**
  - **Catalog installed object models on a user's machine**
  - **Migrate user applications between object model versions**
  - **Migrate user applications between middleware versions**
  - **Browse and download object models available in the TENA Repository**
  - **Request object model distributions from the TENA Repository**

- **TIDE 2.0 is the current version**
  - **Available at http://www.tena-sda.org/tide web site**

TENA Tools used by JMETC Interface Verification Tool (IVT)

- **Designed to support the integration testing of TENA applications**
  - **TENA Standard OM's**
  - **JNTC and InterTEC LROM's**
- **Provides real-time monitoring, logging and statistics gathering**
- **Operates in three different roles, either stand-alone or in combination:**
  - **Data Subscriber Role**
  - **Data Publisher Role**
  - **DIS to TENA Gateway Role**
- **Available at https://www.tena-sda.org/display/Tools/IVT**

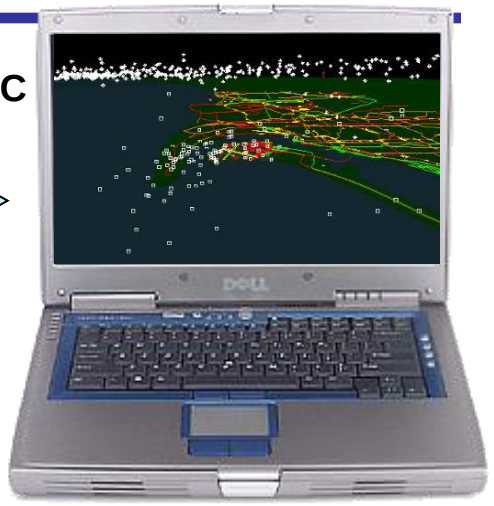
SIMDIS Use of TENA

SCORE TSPI Feed

Southern California

TENA

NRL Washington, DC



- **Duration testing using SCORE TSPI data feed**
  - Four consecutive days
    - Win XP, Red Hat 9, Solaris 5.8
    - Processed 180,000+ entities
  - Two consecutive days
    - Win XP, Red Hat 9
    - Processed 53,000+ entities
- **Results and observations**
  - No issues with discovery latency
  - No issues with update latency
  - No issues with CPU usage
  - No issues with memory usage

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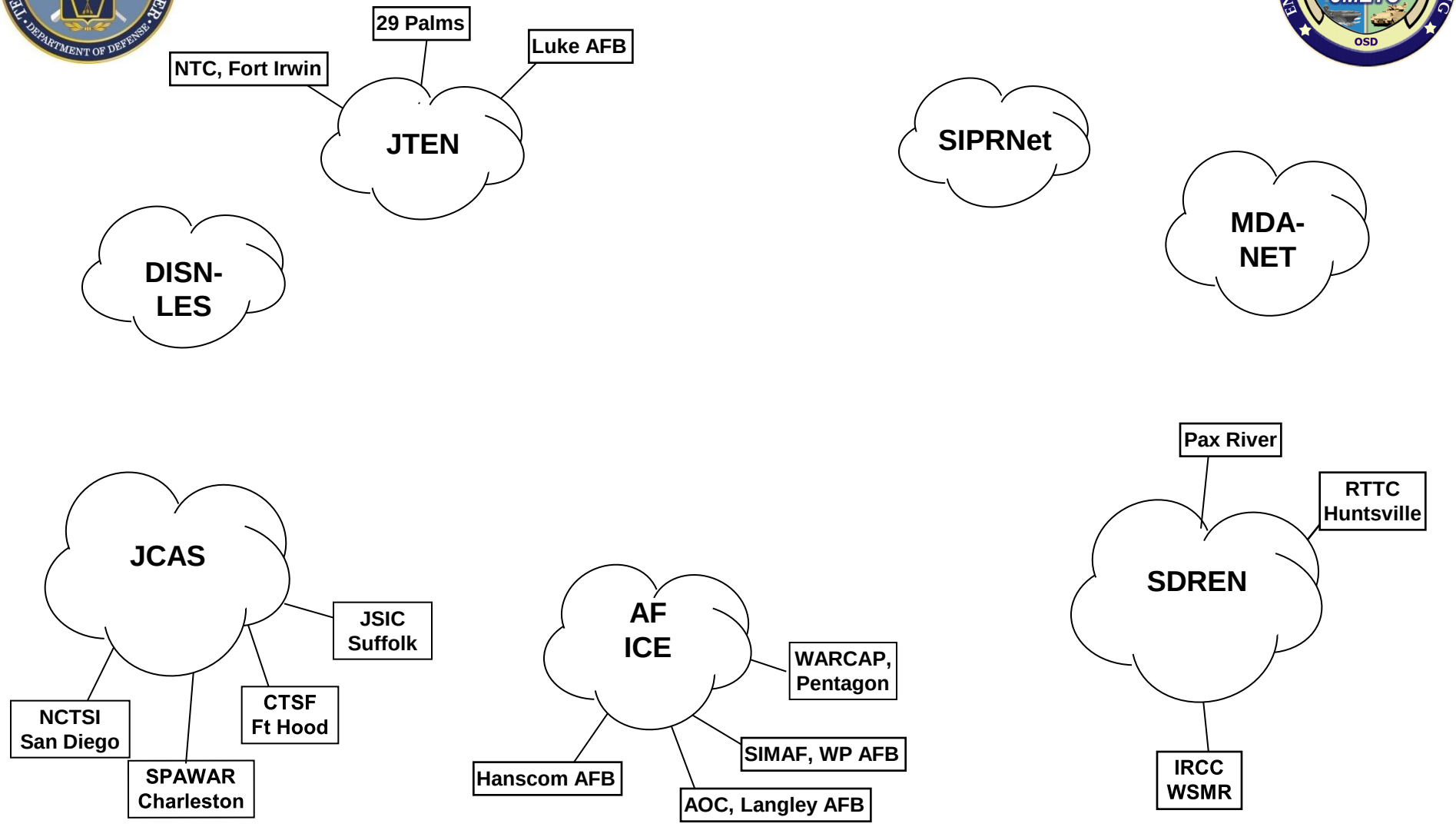
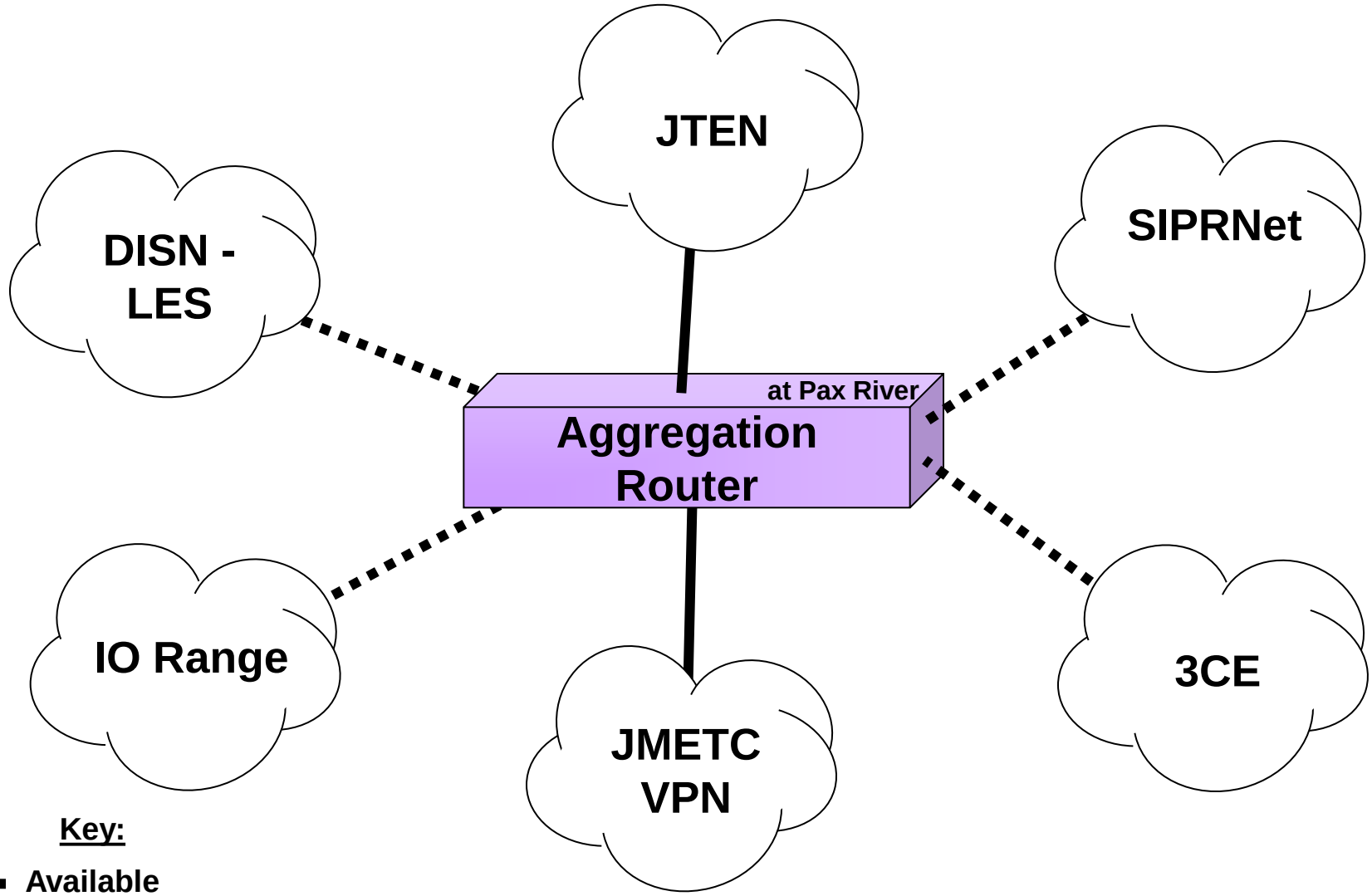
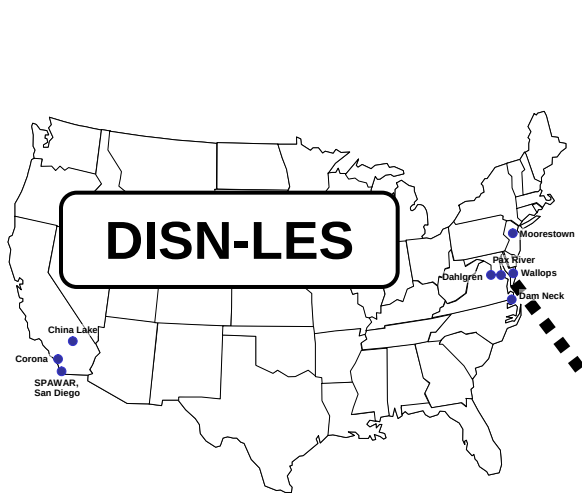
Traditional Network Dilemma

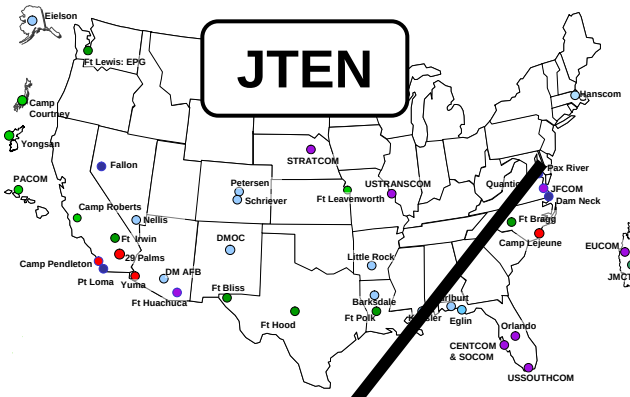


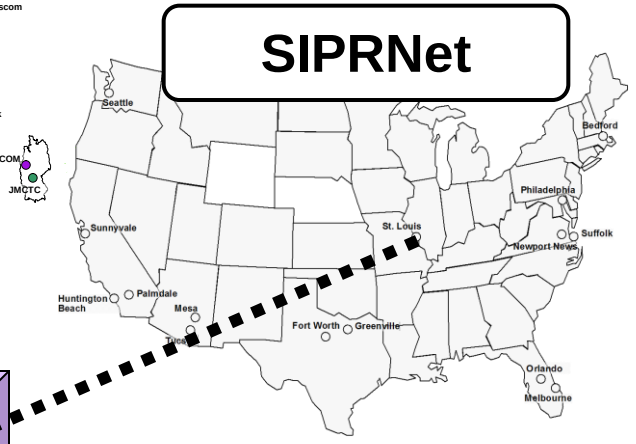
Network Aggregation
Bridging Networks

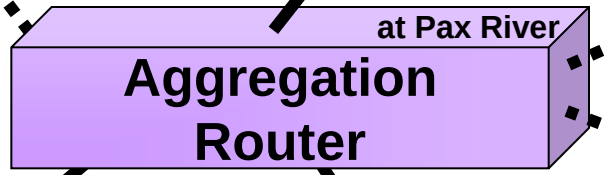


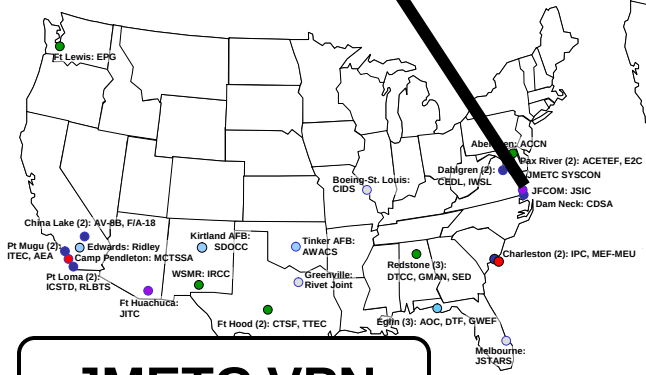
Network Aggregation Bridging Networks

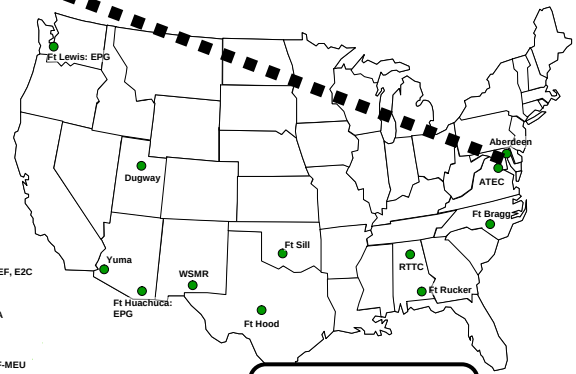






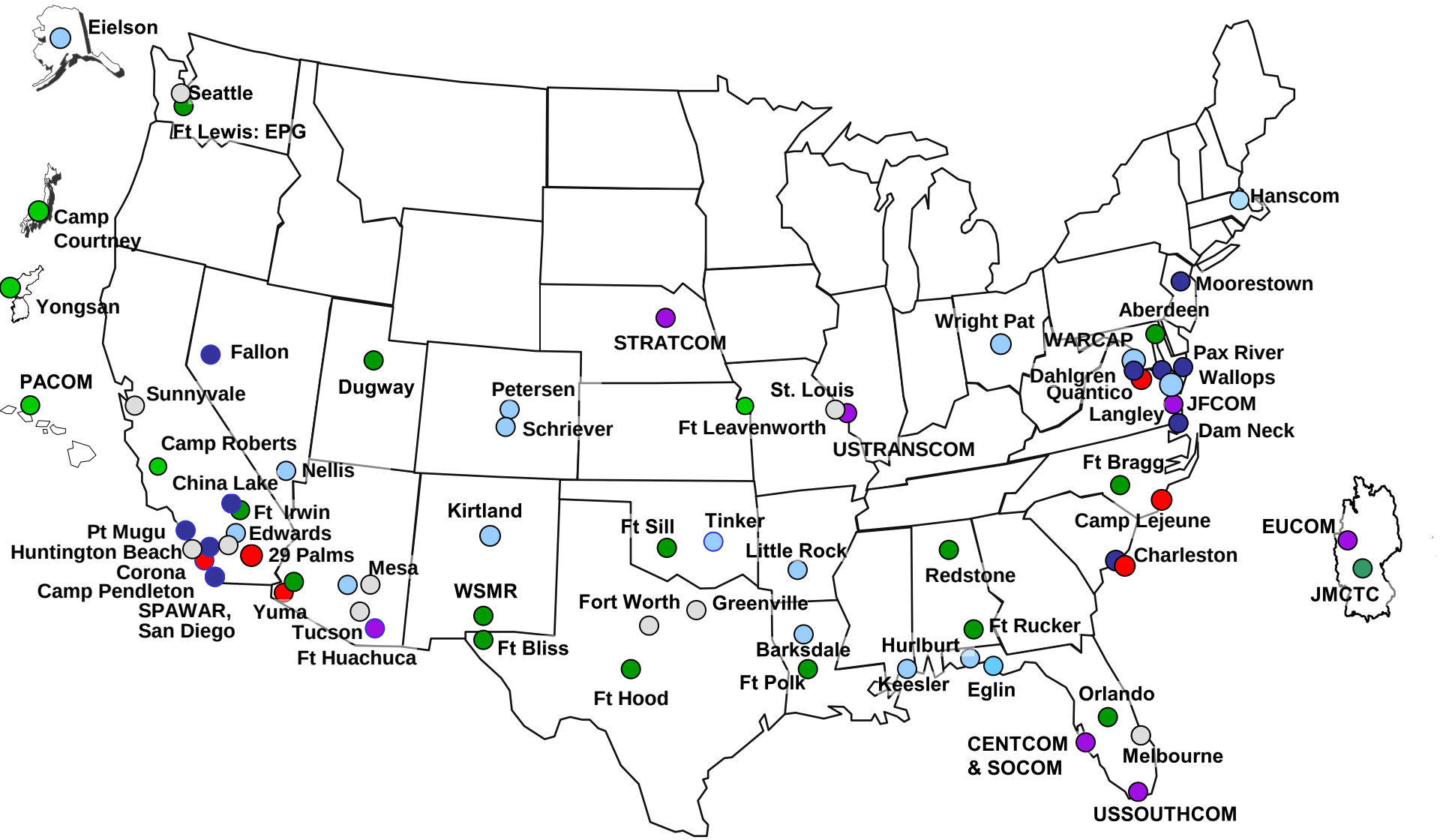






JMETC VPN

Available Sites from Integration of Test and Training Networks



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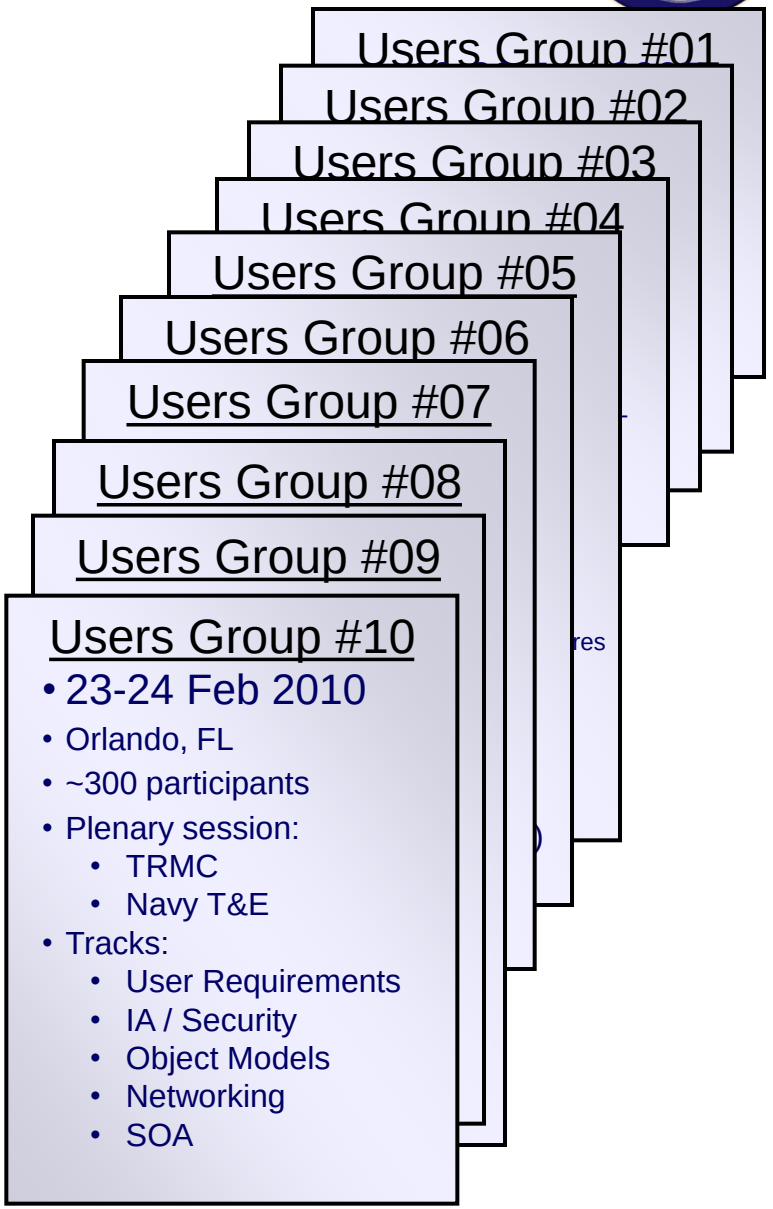
JMETC Users Group Meetings

- 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 #13:

- Scheduled for 22-23 March
- Location: Norfolk, VA
- Potential Tracks:
  - User Requirements
  - Information Assurance / Security
  - Data Management
  - Networking



Architecture Management Team (TENA AMT)

- **AMT Members:**
  - 329 Armament Systems Group (329 ARSG)
  - Aberdeen Test Center (ATC), Aberdeen Proving Ground, MD
  - Air Armament Center (AAC), Eglin AFB, FL
  - Air Force Flight Test Center (AFFTC), Edwards AFB, CA
  - Army Operational Test Command (OTC), Fort Hood, TX
  - 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
  - NAWC – Weapons Division
  - Naval Aviation Training Systems Program Office (PMA-205)
  - Naval Undersea Warfare Center (NUWC)
  - NAVSEA Warfare Center - Keyport
  - P5 Combat Training System (P5CTS)
  - Pacific Missile Range Facility (PMRF)
  - Redstone Technical Test Center (RTTC)
  - T&E/S&T Non-Intrusive Instrumentation
  - White Sands Missile Range (WSMR)

Meetings every 3 months

US Advising Members:
- **BMH Associates, Inc.**
- **Boeing**
- **Cubic Defense**
- **DRS**
- **Embedded Planet**
- **EMC**
- **Kenetics**
- **MAK Technologies**
- **NetAcquire**
- **Science Applications International Corporation (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**

Summary

- JMETC supports the full spectrum of Joint testing, supporting many customers in many different Joint mission threads
  - CVN-21, JSF, MMA, NECC, DD1000, WWF, BAMS, JIAMDO
- TENA is the CTEIP architecture for future instrumentation, the JNTC architecture for Live integration and an enabling technology for JMETC
- TENA and JMETC:
  - Being built based on customer requirements
  - Partnering with Service activities and leveraging existing capabilities
  - Coordinating with JFCOM to bridge test and training capabilities
  - Provide a forum for users to develop and expand the architecture
    - JMETC User Groups, TENA AMT Meetings
    - Next Meeting is week of March 21 in Norfolk, VA

Important Contact Information

- **TENA Website: www.tena-sda.org**
  - Download TENA Middleware
- **JMETC Website: www.jmetc.org**

- **TENA Feedback: feedback@tena-sda.org**
  - Provide technical feedback on TENA Architecture or Middleware
- **JMETC Feedback: jmetc-feedback@jmetc.org**

- **TENA SDA Contact**
  - Telephone: (703) 601-5202
- **JMETC Program Office Contact**
  - Telephone: (703) 601-5280