

Testing and Assessment in a Joint Distributed Environment

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This article presents an overview of the process adopted by the United States Joint Forces Command (USJFCOM) and its partners to meet requirements to conduct testing and assessments in a joint mission environment. The process is based on a distributed joint systems integration/interoperability laboratory concept. The methodology describes the terms of the governance to ensure joint testing and assessments meet the requirements of the warfighter. The process is defined in terms of joint mission threads (JMTs), associated metrics, and the selection and prioritization of JMTs. This is followed by a mapping of JMTs into available exercises with their embedded systems and a risk mitigation analysis to ensure feasibility. Examples of this process are discussed in terms of exercise data collected during USJFCOM-supported exercises.

Key words: Assessments; command and control; integrated architectures, reusability; joint capability development; joint distributed testing; joint mission environment; joint mission threads.

Today, Joint operational systems are allowed to “grow” in an environment composed of agency and Service development and testing activities. It should come as no surprise that many of these efforts result in a perfectly adequate Service system that does not perform well in a Joint environment where integration and interoperability between Services, agencies, and coalition forces are important. To address this shortfall, for command and control systems, the United States Joint Forces Command (USJFCOM) is developing a joint systems integration and interoperability laboratory (JSIIL) concept. The laboratory is “virtual” and composed of joint, Service, and agency partners and their accompanying facilities and capabilities. It will use existing venues, networks, and ranges to perform joint command and control (C2) program support. The title of the laboratory was chosen to reflect the goal of changing the way C2 information technology-intensive systems are developed and fielded and to make the whole process more agile and rapid.

The idea (or ideal) of testing joint programs in a joint operational environment is not new. In fact it was influential in the creation of the Test and Resource Management Center in 2003 and the Testing in a Joint Environment Roadmap¹ in 2004. The Director, Operational Test and Evaluation (DOT&E), devel-

oped the Testing in a Joint Environment Roadmap, which led to the creation of the Joint Mission Environment Test Capability (JMETC) and the Joint Test and Evaluation Methodology (JTEM), a joint test and evaluation (T&E) project. JMETC provides the infrastructure for joint testing, and JTEM provided an initial methodology for conducting the joint tests. Both of these are critical parts of the capability to conduct joint tests, but there remained at least one missing piece: the joint requirements along with the joint mission threads (JMTs) to provide the operational context and the criteria used to measure effective performance.

Background

USJFCOM began evaluation of testing in a joint environment process with the advent of responsibility for joint battle management for C2 followed by joint capability development for C2. A major factor in expanding this evaluation was the coincidence of USJFCOM joint capability development (USJFCOM J8) providing command oversight of the Coalition Warrior Interoperability Demonstration (CWID) program and the evolution of test threads into the Empire Challenge (EC) and Bold Quest events. These field demonstrations and assessments have been annual events, and they rely on support from a number of activities including USJFCOM organizations, specifi-

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cally the Joint Systems Integration Center (JSIC) in Suffolk, Virginia, and the Joint Fires Integration and Interoperability Team (JFIIT) at Eglin Air Force Base, Florida. Annually these organizations identify promising technologies that are intended to address current operational concerns in the command and control and intelligence processing, interpretation, and dissemination areas. However, once these technologies are identified, the long process leading to operational fielding only begins. The hypothesis behind the JSIIL is that it is possible to accelerate this fielding process by making more effective use of existing venues that support not only demonstration and assessment but also development testing, operational testing, joint interoperability testing and certification, and information assurance certification and accreditation.

The leadership of USJFCOM J8 investigated requirements for testing and assessments in a joint environment and determined that they actively participate in programs to be tested and assessed, potential venues (e.g., CWID and EC), “testing and assessment” activities through JFIIT and JSIC, and the evolution of test threads into the development of JMTs (scenarios) in support of command and control requirements. What was still needed was a further definition of the criteria for meeting the C2 requirements. In February 2009 the JSIIL idea was proposed to the Joint Staff J6, the Joint Interoperability Test Command (JITC), and the Defense Information Systems Agency (DISA) at a session to determine how JITC and USJFCOM could further enhance their cooperative efforts. It was unanimously endorsed, and USJFCOM set out to refine and develop the concept. Eventually the effort resulted in a Joint C2 Network Partnership (JC2NP) Steering Group.

As criteria were developed (initially called net-enabled Universal Joint Task List criteria for establishing better key performance parameters for measuring and testing C2) it became evident that this approach would need to engage other partners to include the joint testing and the DOT&E and Service operational test communities. So the dialogue with the DOT&E and Service test activities was initiated. Again there was widespread, albeit qualified, acceptance of the concept provided it did not increase cost and resulted in more rapid fielding. The focus was on the development of a Strategic National (SN) Universal Joint Task (UJT) for interoperability called SN 7.8 UJT.

In March 2009, USJFCOM began the development of the JSIIL concept with parallel actions to:

- develop an agreed upon set of JMTs that would provide operational context for measuring im-

provements for C2 capabilities in a full range of Joint operational requirements;

- create a set of SN 7.8 UJT-based criteria that would provide a means of measuring the attainment of the mission thread capabilities;
- begin the process of matching C2 programs (both legacy and new) to a mission thread and a set of SN 7.8 UJT criteria;
- align the evaluation of programs, by mission thread and SN 7.8 UJT, to an existing venue, e.g., CWID and EC, to begin investigating the concept; and
- define, coordinate, and establish a governance forum for the testing and certification process to provide support and oversight of the effort.

Since March 2009, USJFCOM has concentrated on the development of JMTs and an SN 7.8 UJT. In a novel approach the team built and applied the SN 7.8 UJT in an existing venue, the Joint Expeditionary Force Experiment. This first addition of a Service assessment venue, in this case Air Force, helped define other venues that would be needed to make the process persistent throughout the year rather than just episodic. Two lessons were learned in this first effort: additional definition of the SN 7.8 UJTs was needed, and data to support a rigorous objective measurement process were not routinely captured in the demonstration and assessment events. Both of these areas are being further developed in preparation for future events.

Process

USJFCOM, in cooperation with DISA/JITC, the joint staff, the DOT&E community, and the Service operational test agencies (OTAs), has just started on a journey to significantly enable the joint testing and assessment process. There has been widespread endorsement of the need for improvement and the deliberate approach that is being followed by USJFCOM. The goal is to provide an environment that will support joint testing, assessments, and certification through a “one team, one time, one set of conditions” approach. A lot of hard and tedious work lies ahead, but with continued focus on the goal to rapidly field needed operational capability, the effort will succeed. The joint testing/assessment process up to the development of JMTs is summarized in *Figure 1*.

From a USJFCOM perspective, the governance for joint testing comes from USJFCOM’s Unified Command Plan,² which includes the following:

- a. Providing recommendations to ensure integration of Service, defense agency, interagency, and multinational capabilities development;

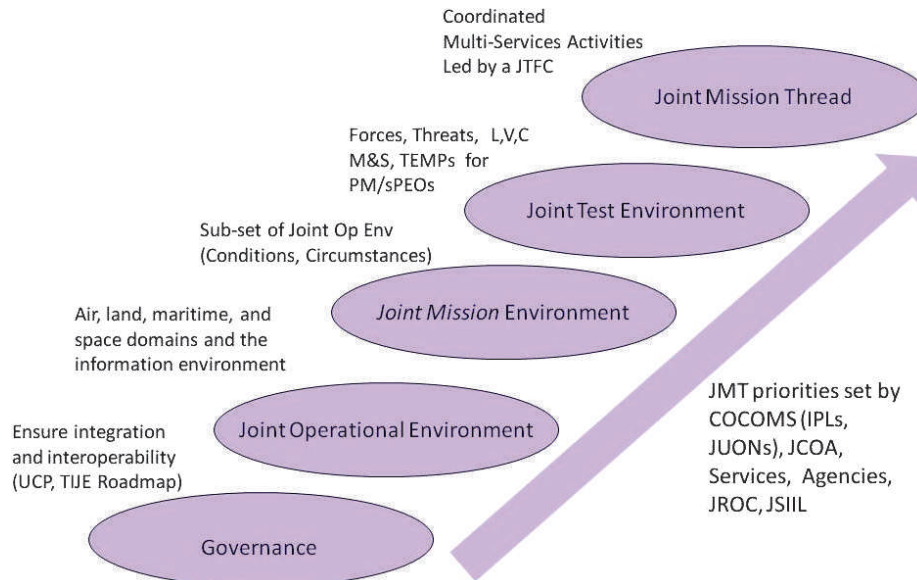


Figure 1. Joint testing/assessment process.

- b. in coordination with the chairman, leading the development of joint concepts, requirements, and integrated architectures for joint C2 to ensure integration and interoperability from the tactical level through the interface with the global level;
- c. in coordination with the chairman, supporting the development of fully interoperable joint warfighting capabilities and concepts.

In addition USJFCOM is a full partner with DOT&E, which leads the development and execution of the Testing in a Joint Environment Roadmap. The Roadmap establishes the policy that developing and fielding joint force capabilities require adequate, realistic T&E in a joint operational context.

DOT&E also leads the Testing in a Joint Environment Roadmap Senior Steering Group (TSSG)³ and has chartered a TSSG Advisory Group (TSSG-AG) to investigate the ramifications of the Roadmap. USJFCOM is a member of each group. The TSSG-AG uses the following working definitions for the elements shown in *Figure 1*:

- joint operational environment: The environment of land, sea, and/or airspace within which a joint force commander employs capabilities to execute assigned missions;
- Joint Publication (JP) 1-02: ⁴ A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander;
- JP 3-0⁵ expands on the JP 1-02 definition: it encompasses physical areas and factors (of the air, land, maritime, and space domains) and

the information environment, which include the adversary, friendly, and neutral systems that are relevant to a specific joint operation;

- joint mission environment: “A subset of the joint operational environment composed of force and non-force entities; conditions, circumstances and influences within which forces employ capabilities to execute joint tasks to meet a specific mission objective”;
- joint test environment (TSSG-endorsed definition): The appropriate combination of representative systems, forces, threats, and environmental conditions assembled for test in a joint mission environment to support evaluations. These representations can be live, virtual, and constructive, or distributed combinations thereof. The joint test environment should also include certified models and simulations, test and evaluation master plans from the program managers and Program Executive Offices;
- joint mission thread: An operational and technical description of the end-to-end set of activities and systems that accomplish the execution of a joint mission (Ref. Chairman Joint Chiefs of Staff Instruction [CJCSI 6212.01E, Dec 08]). This definition is currently being revised by the joint staff.

For the past few years USJFCOM has been using an expanded view of the joint mission environment as a multiservice operation described in the context of a joint integrated architecture. Also under consideration is including the role of a joint task force commander and coalition forces in the definition.

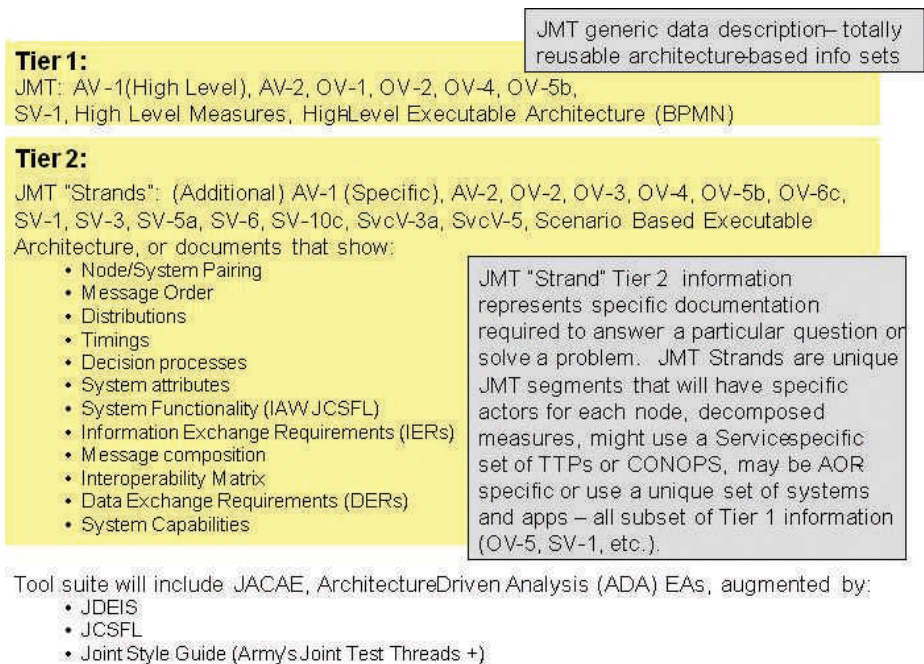


Figure 2. JMT development products.

Over the past several years there has been considerable interest in understanding and executing joint military operations. One approach to this understanding has been the development and use of Department of Defense (DoD) Architecture Framework⁶ products. Combatant commands (COCOMs), Services, and agencies have spent considerable time and energy developing these products to understand and manage the complexity associated with military operations. USJFCOM in particular has worked closely with the services and agencies to develop architecture templates describing major combat operations, homeland security, and disaster relief, among other areas. These products have been used to support joint task force (JTF) organizational planning for the COCOMs, demonstrations, exercises, and test planning. They have also been coordinated with the Master Training Guide for the training of JTFs.

One of the major mission areas of USJFCOM as assigned through the under secretary of Defense is as co-lead of the Command and Control Capability Portfolio manager, whose task is to identify opportunities to improve joint interoperability, eliminate redundancies, identify gaps, and streamline the acquisition and budget processes to support the C2 needs of the Joint force commander. Explicit to this responsibility is the mandate to support integrated architectures for the portfolio.

During this time frame there has also developed a need to provide a joint environment to support testing

and assessment of the increasing numbers of joint systems being introduced into the acquisition process. DOT&E has recognized this requirement and has published the DOT&E Roadmap, established JTEM, and created JMETC, which focuses on the required persistent infrastructure to conduct joint tests. The joint mission environment, however, remains to be defined from the operational perspective for a Joint program manager who has to test systems or systems of systems in the joint mission environment.

Architectures and joint mission threads

The architectural efforts at USJFCOM, coordinated with the services, extend from the operational JTF headquarters to the force component commanders down to the tactical level and at least one level up to the strategic level. It includes everything from mapping of joint capability areas to Universal Joint Task Lists to organizational activities to Joint Common System Function Lists to systems. It is within this architectural context that the joint mission thread can be developed with associated metrics and measures that support testing and training, which can be used to identify gaps, redundancies, and potential solutions.

The approach currently used at USJFCOM is similar to the approach used in the earlier joint battle management for C2 effort at USJFCOM, where a JMT, e.g., Joint Close Air Support, was assessed analytically and assessed/tested in the context of a joint integrated architecture. That approach can be de-

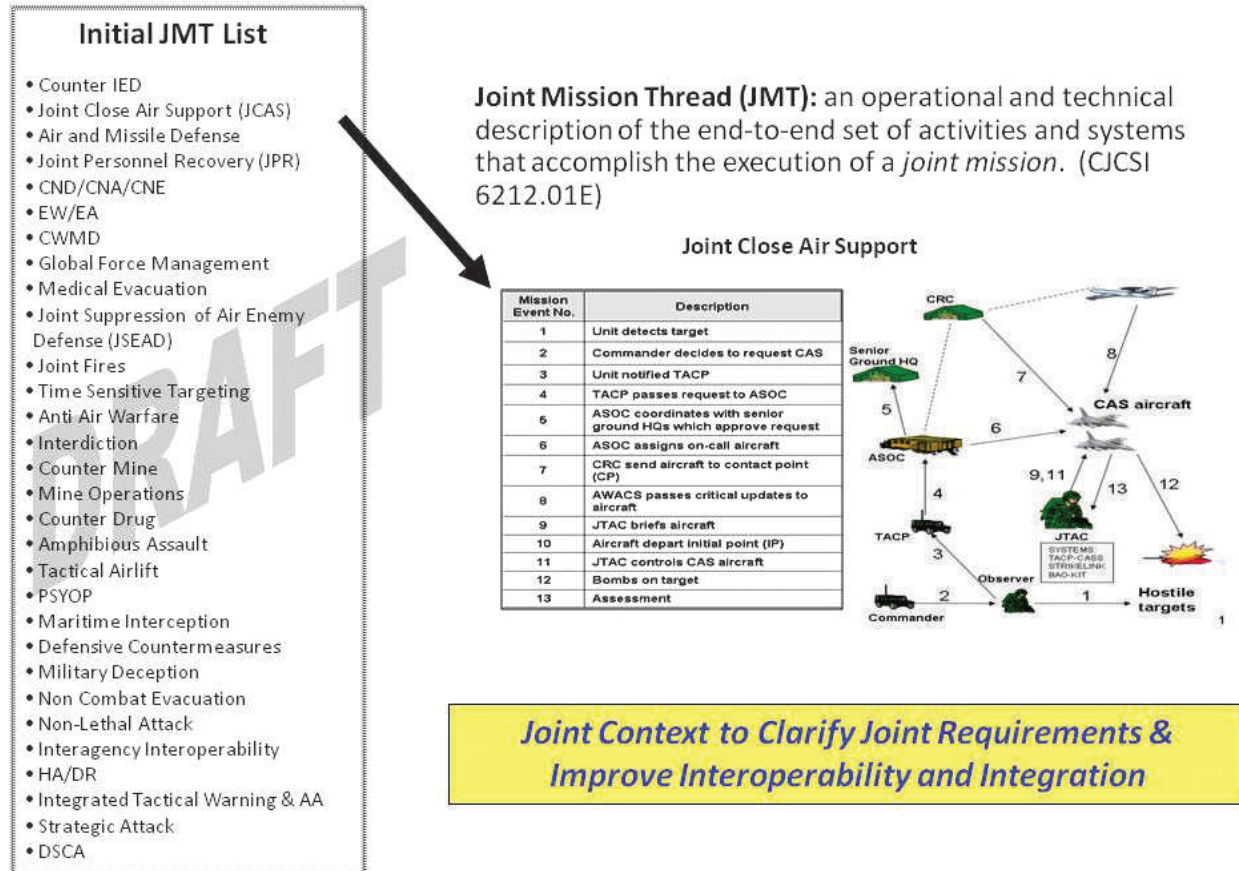


Figure 3. Proposed JMT initial list.

scribed as architecture-driven analysis; the approach recommended here for the T&E community is architecture-driven testing and assessment. The common theme of an integrated architecture provides continuity and unity of effort across the DoD. Some may prefer to call this a JMT approach to testing and assessment vice an architecture approach. That is acceptable because JMTs are to a large part made up of architectural products. This is a natural evolution of the communities of interest to understand and deal with the complexity of testing and assessing joint C2 capabilities. Figure 2 illustrates the JMT development products.

As can be seen in Figure 2, many of the JMT products are DoD Architecture Framework products composed of operational views, system views, and all views and may include tactics, techniques, and procedures for particular JMTs. Tool suites can also be included, e.g., Joint C2 Architecture and Capability Assessment Enterprise, a USJFCOM architecture development and data base tool augmented by the Joint Doctrine Education and Training Information System and the Joint Common System Function List (JCSFL). The JMTs are broken down into higher

resolution levels called tier levels. Through efforts of the Joint Mission Thread Architecture for Testing Working Group (JMTAT WG),⁷ composed of several hundred participants from COCOM, Services, and agencies, this community of interest is converging on a workable (if not yet common) definition of a JMT. From the acquisition and tester perspectives, JMTs can provide the common solution to the needs of both communities and are being widely recognized as such.

The proposed JMT initial list under consideration for investigation by USJFCOM in the future is shown in Figure 3. Also depicted is a high-level nodal diagram for a Joint Close Air Support mission. If USJFCOM and the testing community are to speed up the delivery of capability to the warfighter, there needs to be multiple partnerships in a parallel development and assessment of these JMTs. Currently a JMT Concept of Operations document is in the Joint Staff Action Processing review external to USJFCOM.

Up to this point the process has been one of analysis, sometime referred to as a desktop analysis phase, requiring constructing JMTs at different levels of fidelity, developing the associated metrics, developing executable architecture, and running appropriate mod-

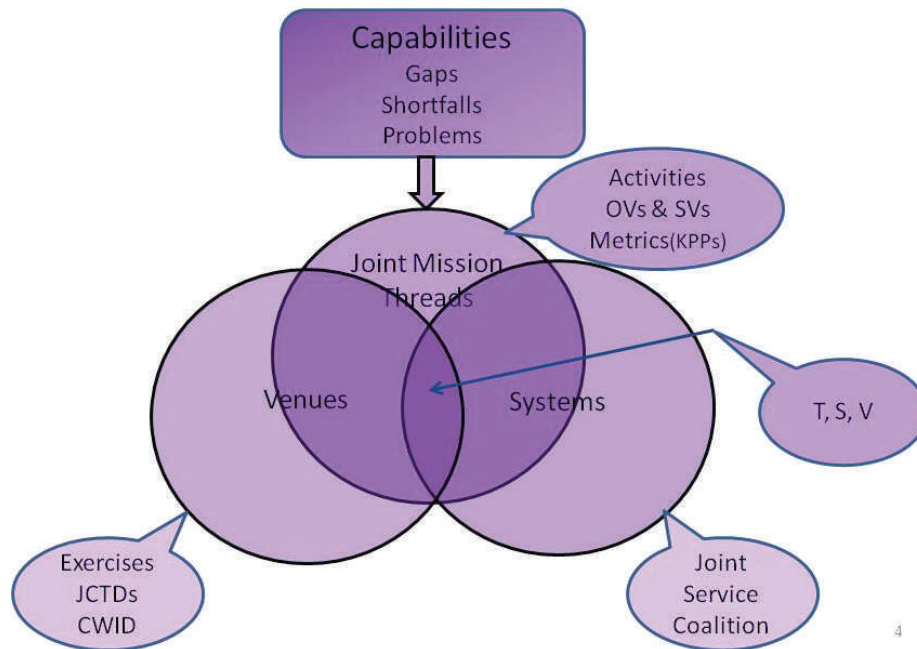


Figure 4. Selective process.

els and simulations to provide guidance on the possible way ahead to a more formal testing and assessment process.

The selection process to move toward a testing and assessment approach of C2 capabilities through JMTs is shown in *Figure 4*, where, along with the JMT of interest, suitable venues and necessary systems that are available need to be considered. Venues can include training exercises, CWID, joint capability technology demonstrations (JCTDs), multiservice events, etc. Systems can include Service, joint, and coalition systems in various stages of development from concept to development to programs of record to postdeployment. The intersection of the three Venn diagrams in *Figure 4* represents a synchronized compilation of threads, systems, and venues to be tested/assessed. Once developed and tested, these JMTs are reusable and provide an efficiency in follow-on tests that may need pieces of these JMTs to investigate and test related JMTs.

There is still a requirement for a set of selection criteria in choosing an appropriate subset of threads, systems, and venues.

USJFCOM has partnered with DOT&E to participate in its Interoperability and Information Assurance program. Under a congressional mandate administered by DOT&E, an Interoperability and Information Assurance assessment must be conducted in at least one COCOM exercise per year *per* COCOM. USJFCOM has been working with DOT&E in developing JMTs to support several COCOM exer-

cises. DOT&E provides data collectors primarily through the OTAs for these exercises. Because of mutual support, these exercises are of high interest to USJFCOM as likely venues to pursue.

The Training Directorate of USJFCOM, J7, conducts several major training exercises per year including mission rehearsal exercises. While training exercise objectives are of primary concern, there is a formal mechanism for introducing technology elements, including operational test events, into a training exercise without compromising the training objectives. The mechanism is a slightly outdated acronym, JETA, standing for Joint Experimentation, Joint Test & Evaluations, and Advanced Concept & Technology Demonstrations. It is considered slightly outdated because Advanced Concept & Technology Demonstrations have been replaced with JCTDs. With the shortage of troops available for many venues, it is a matter of necessity and efficiency that the common goals of the testing and training communities be aligned wherever possible. Within USJFCOM and with DOT&E there is an extensive effort to take advantage of the widely perceived efficiencies to be gained by both the testing and training communities through closer cooperation. A simple example is the certification by the training community of a particular tool used to collect data during a test. Following certification by the training community, there was no problem using that tool to collect valuable test data in a training exercise. Examples like this are important so that extensive test tools being developed by InterTEC⁸

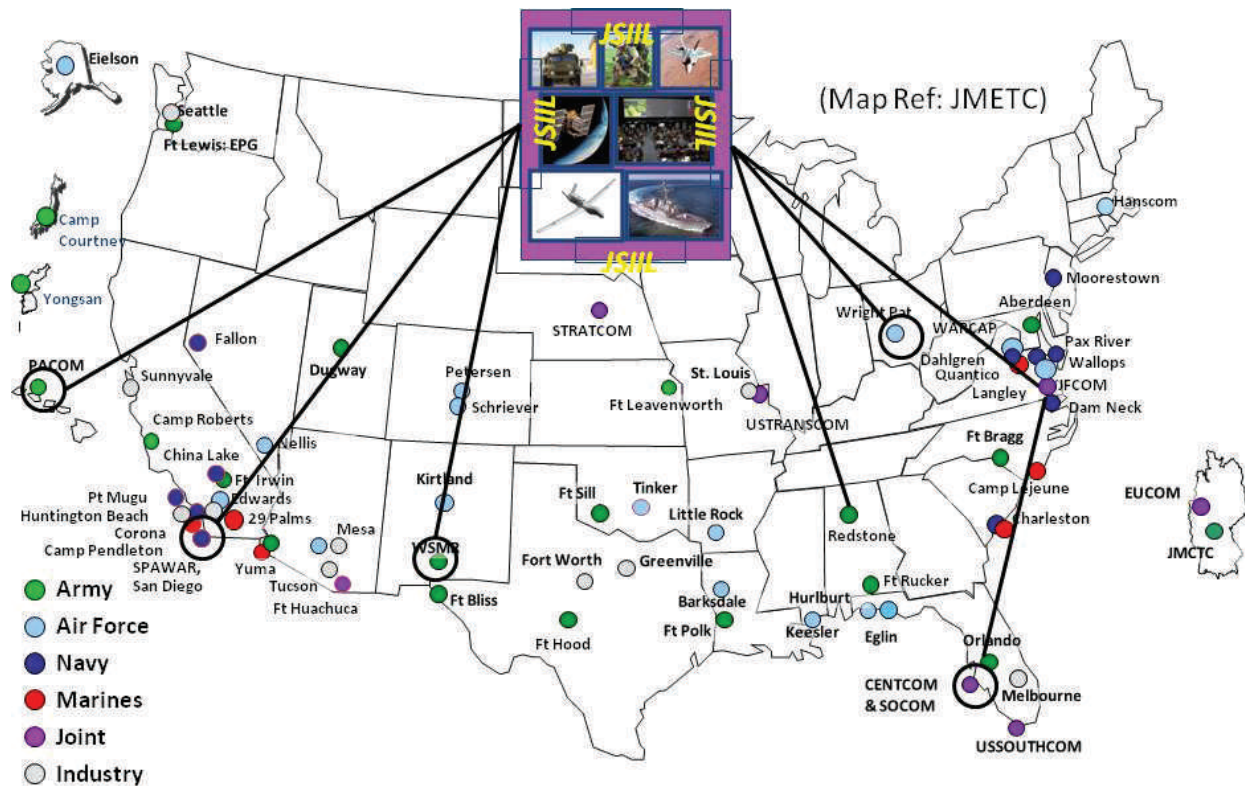


Figure 5. Integration of test and training networks.

can be used in training exercises without fear of jeopardizing training objectives. A more complicated example relates to the gains to be had when taking simultaneous advantage of test and training ranges, another area of interest to both USJFCOM and DOT&E.

USJFCOM is also responsible for conducting the CWID program, which provides numerous opportunities for the United States to investigate, assess, and test new technologies with coalition partners. USJFCOM is also a major participant in the JCTD program, which is another opportunity to provide demonstrated, operationally assessed, and tested technologies for meeting warfighter requirements. There are also numerous multiservice events that provide additional opportunities for testing and assessment.

In selecting from various events, a simple risk mitigation approach is used that considers time, funding, program synchronization, measurable metrics, certified tools, verified models and simulations, and suitable facilities. At this point a recommendation of where and how to conduct the test/assessment is made.

Distributed testing/assessment

Figure 5, compiled by the JMETC office, shows integration of test and training networks/sites that could be used to conduct a specific test/assessment.

Approximately 40 of these sites are linked together via the efforts of JMETC with several more sites to be added over time, providing a sustainable base infrastructure to support testing/assessment and training. Based on the analysis to identify an appropriate set of threads, systems, and venues under the JSIIL concept, a suitable set of facilities can be selected for the test/assessment process. The Joint Systems Integration Center and the JFIIT are part of the USJFCOM J8 Directorate and would be considered like any other organization as a possible candidate to participate in the test/assessment process. Neither JSIC nor JFIIT is a formal test agency, although both have worked with the OTAs and JITC by providing supporting assessments. The ultimate selection is a consensus provided by the JC2NP Steering Group. An early example of this selection approach for a distributed event was evaluated with the Simulation and Analysis Facility (Menke and March 2009) at Wright-Patterson Air Force Base, Ohio, in support of the Air Ground Integrated Layer Exploration project, which provided valuable lessons learned. As additional sites are needed they become part of the configuration.

A draft JSIIL organization chart is shown in Figure 6. JSIIL would serve as a focal point for joint integration/interoperability assessments. It would provide a coordinating and facilitation service; harness the

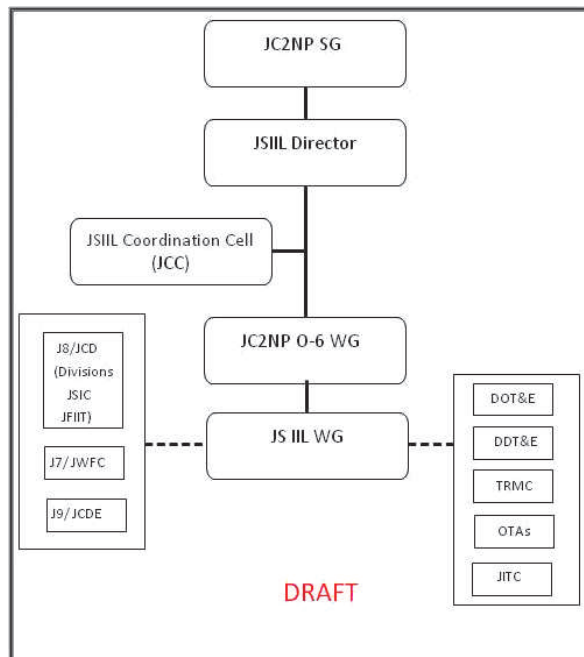


Figure 6. JSIIL organization.

conditions present in operationally realistic joint, coalition, and combined arms environments; provide alignment of JMT development and supporting systems engineering efforts; and provide objective feedback and recommendations to the Under Secretary of Defense for Acquisition, Technology, and Logistics; DOT&E; Services; and the TSSG for determining annual priorities and establishing a longer term plan of action and milestones for JSIIL.

The JSIIL director is provided by USJFCOM J8 and coordinates findings of the 0-6 Working Group. The director briefs those findings to the JC2NP Steering Group. The JC2NP Steering Group is the senior governance body with a tri-chair under consideration that approves a JSIIL priority list and the JSIIL annual project plan. The JSIIL Coordination Cell is chaired by USJFCOM's Joint Capability T&E division head. JSIC and JFIIT from USJFCOM J8, the USJFCOM J7 Joint Training/Joint Warfighting Center Directorate, and the J9 Joint Concept Development and Experimentation Directorate support the JSIIL Working Group.

In summary, the JSIIL joint assessment process is shown in Figure 7. It is a virtual concept of a consortium/partnership of organizations brought together to satisfy the requirement to assess/test in a joint environment. It is made up of a variety of organizations, e.g., DDR&E; DOT&E; the Under Secretary of Defense for Acquisition, Technology, and Logistics; the chairman; the Joint Chiefs of Staff; the Under

Secretary of Defense for Personnel and Readiness; the Assistant Secretary of Defense for Networks and Information Integration/Department of Defense chief information officer; the Under Secretary for Intelligence; OTAs; Test and Resource Management Center ranges; JMETC; training ranges; DISA; JITC; Service Warfare Centers; academia; industry; agencies; and COCOMs. It is in effect an effort to marshal this nation's technological expertise to speed capabilities into the hands of the warfighter through more efficient testing in the joint environment. This is not a task that can be done by any one organization.

In 2007, an article appeared in *ITEA Journal* entitled "Born-Joint"—Is the T&E Community Ready?" (Hutchison 2007). The answer then was no, not without additional efforts in the areas of policy, funding for JMETC, completion of JTEM, and creation of joint environments for training and T&E and leadership. With advances in all these areas and the subsequent development of more refined joint architectures and JMTs, creation of a JC2NP, support of a JSIIL concept, and a more open dialogue among the communities of interest, considerable progress has been made. A JSIIL endorsement letter by flag officers, general officers, and Senior Executive Service members from the testing community; acquisition community joint staff; and USJFCOM has recently been signed. This endorsement, coupled with an expansion of the existing partnerships, strengthens the foundation for continued progress in joint distributed testing and assessment. □

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DR. THOMAS M. FITZGERALD received his doctor of philosophy degree in physics from Brown University. He has been a research scientist for NASA; RAND Corporation, in Santa Monica, California; and Navy R&D laboratories including the Naval Underwater Systems Center, Newport, Rhode Island, and the Space and Naval

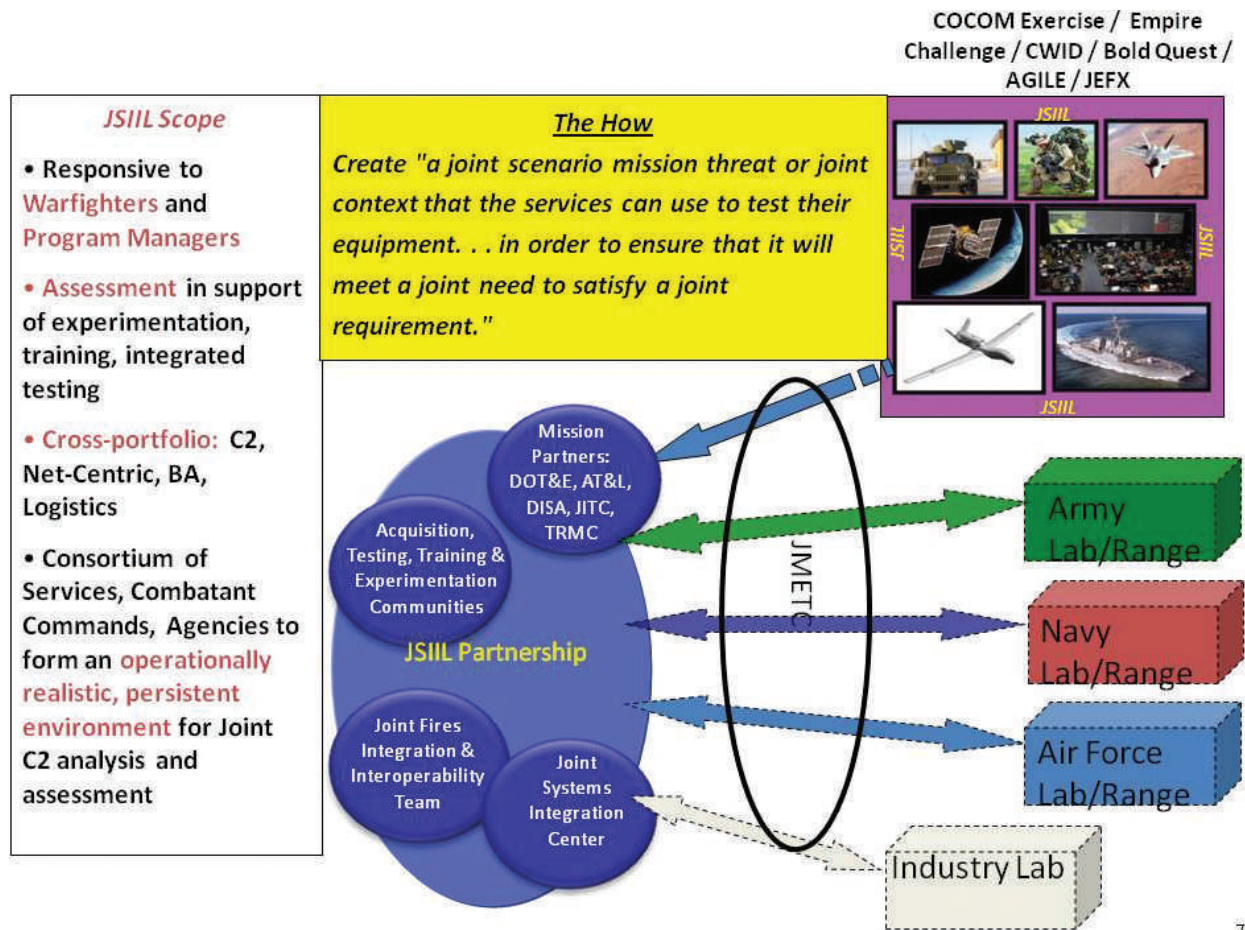


Figure 7. Joint assessment.

Warfare Center, San Diego, California. Specialties include microwave and undersea acoustics, modeling and simulation, wargaming, test and evaluation, and command and control. He was the first science advisor to Joint Forces Command (JFCOM) and has continued to support JFCOM and the joint community in government and contractor positions. He is a government member of ITEA and the JFCOM staff.

Endnotes

¹DoD Testing in a Joint Environment Roadmap signed by the Deputy Secretary of Defense, November 12, 2004.

²Unified Command Plan, Secretary of Defense, October 3, 2008.

³TSSG. A senior DOT&E advisory group of flag officers, general officers, and Senior Executive Service members.

⁴DoD Dictionary of Military and Associated Terms, Joint Publication 1-02, April 12, 2001.

⁵Doctrine for Joint Operations, Joint Publication 3-0, September 10, 2001.

⁶DoD Architecture Framework version 2.0, May 28, 2009.

⁷The JMTAT WG was formed as a sub-working group to the JSIIL concept. The JMTAT WG represents a convergence of internal USJFCOM JMT groups with stakeholders from other communities across DoD including testing and architecture.

⁸InterTEC. An Office of the Secretary of Defense-sponsored program under the Central T&E Investment Program to develop and field a distributed test capability to conduct end-to-end joint mission interoperability and net ready testing in coordination with JMETC.

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