# Distributed Testing

## A Significant Tool in the Program Manager's Arsenal

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Despite our successes over the last decade in fielding dramatic increases in joint intelligence, surveillance, and reconnaissance capabilities and compressing the find-fix-target-engage-assess timeline, we continue to have many challenges in the joint interoperability regime. That was the reason the 2004 Testing in a Joint Environment Roadmap recommended establishing a DoD-wide distributed test infrastructure. That recommendation led to the establishment and subsequent rapid growth of the Joint Mission Environment Test Capability (JMETC), a distributed test program launched in fiscal year 2007 that is designed and funded to support Department of Defense programs. However, many program managers and sys-

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tems engineers in the DoD acquisition community may be unaware of JMETC, and that lack of awareness results in a lost opportunity because well-planned and well-executed distributed testing can significantly reduce program risk and increase operational effectiveness. This article will provide program managers and systems engineers with an introduction to the advantages of distributed test and the benefits JMETC can provide to their program.

## Why Distributed Test?

Program managers should consider conducting a distributed test based on three principal advantages:

- The ability to reduce overall programmatic interoperability risk.

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- The ability to identify deficiencies early on, and finding and fixing problems early in the program life cycle will have much less impact on cost and schedule than deficiencies identified in initial operational test and evaluation (IOT&E).
- The ability to efficiently assess and test the system in its joint context early on, with the potential for early assessment from operational testers.

Testing is an expensive endeavor; and testing in a systems-of-systems environment is inherently more expensive because of the requirement to bring multiple systems together to verify data link interoperability and create a realistic environment that provides friendly command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems as well as threat capabilities. Many of our major weapons systems and systems in development have high-fidelity hardware-in-the-loop systems that use actual integrated hardware and software in a lab environment and accurately replicate weapons system performance, simulating a weapons system into behaving as though it is receiving real-world inputs and outputs. Integration of hardware-in-the-loop systems throughout the continental United States and overseas across a wide area network in realistic mission environments offsets the significant cost and coordination burden associated with bringing the systems together physically.

When conducting interoperability testing, an unmanned aerial system may need to work with Marine and Army tactical units on the ground as well as other airborne systems such as the Air Force's Airborne Warning and Control Systems, the Navy's E-2 Hawkeye, and the Joint Surveillance and Targeting System. They may also need to be tested with other weapons systems with which they will interact, such as the Marine's F-18, the Air Force's F-16, or the Army's Advanced Field Artillery Tactical Data System Joint Fires system. All of those C4ISR and weapons systems have test-quality hardware-in-the-loop simulators with current software available for testing through distributed means.

Not only is it smart to assess interoperability early in the developmental cycle to reduce program risk, it is also required by DoD Instruction 5000.02, which states, "During DT&E [*developmental test and evaluation*], the materiel developer shall assess technical progress and maturity against critical technical parameters, to include interoperability, documented in the TEMP [*test and evaluation master plan*]." Additionally, DoD Instruction 5000.02 states, "All DoD Major Defense Acquisition programs, programs on the OSD T&E Oversight list, post-acquisition (legacy) systems, and all programs and systems that must interoperate are subject to interoperability evaluations throughout their life cycles to validate their ability to support mission accomplishment." That policy indicates DoD senior leadership is serious about joint interoperability.

Looking beyond basic interoperability, once a system's hardware-in-the-loop capabilities are integrated for distributed test, those same systems can be linked together to address specific mission threads, such as intelligence, surveillance, and reconnaissance support to troops in contact in an urban setting, time-sensitive targeting using simulated weapons, or ground convoy overhead escort. Again, DoD Instruction 5000.02 provides common sense guidance: "Systems that provide capabilities for joint missions shall be tested in the expected joint operational environment." Distributed testing can allow operational testers to execute early assessments of those mission threads during the developmental test phase, providing feedback to the program for suggested changes that may be implemented prior to IOT&E. Alternatively, where systems are performing well early on, the operational test community, armed with previous early exposure, enters IOT&E with a higher level of confidence in the program's capabilities and limitations and can tailor IOT&E appropriately, in some cases potentially saving program dollars.

As programs transition to IOT&E, the focus should shift to live operations; and distributed testing's role at this point may shift to augmentation, which can help overcome impediments during live operations. For example, in testing future unmanned aircraft systems, many will have a requirement to integrate with JSTARS, which tracks surface targets over a wide area and can provide the unmanned aircraft systems operator with increased situational awareness. JSTARS deployment, however, is costly in terms of identifying unmanned aircraft systems test sites, and limited state-side availability will preclude live JSTARS test support in many cases. Alternatively, the JSTARS high-fidelity hardware-in-the-loop capability is persistently on the JMETC network, providing higher availability and much lower cost than live JSTARS in support of joint and unmanned aircraft system testing. There are several impediments to meeting the DoD Instruction 5000.02 mandate that systems be tested in their expected joint operational environment. The first is that many systems operating in such an environment are low-density/high-demand assets that may not be available at all or for the required amount of time for realistic testing. The second issue is that even if all assets are available, the cost associated with deploying multiple assets, maintenance support, and spares can be significant. Therefore, augmenting the system under test with high-fidelity virtual and constructive systems can enable one to create the realistic joint environment needed to properly test the system. Moreover, prior to live testing, virtual and constructive systems can be used to rehearse and refine the live test plan.

## Improving Test Infrastructure

JMETC is the DoD corporate program that provides the necessary test infrastructure to conduct joint distributed events by cost-effectively integrating live, virtual, and constructive test resources to support a program's needs for assessments and tests. JMETC consists of a core reconfigurable infrastructure with associated products and customer support that enables the rapid integration of live, virtual, and constructive resources to link systems and facilities needed for a joint testing environment. JMETC is currently integrated with 40 test and hardware-in-the-loop sites, with planned expansion to approximately 60 sites over the 2010-11 timeframe. The network is optimized for test with very high throughput, low latency, and negligible data loss. The network has a common networking protocol and middleware optimized for test that is compatible through gateways with legacy simulations and facilities. It also has an associated collection of high-performance, primarily government off-the-shelf software applications—known as JMETC Tools—that help JMETC improve test planning, management, and analysis capabilities while ensuring required network performance is maintained. JMETC Tools also include the command, control, and communications assessment tools that aid in assessing interoperability—the same tools used by the joint community to assess interoperability for certification. The JMETC Web portal provides information on distributed test procedures, upcoming test events, tool and software access, site status, lessons learned, and help desk contacts. Finally, JMETC provides an expert team that will assist in planning and supporting distributed test events. That expert team brings procedures, methodologies, and solutions that have already been tested, proven, and put into practice.

The principal mechanism for direction of the JMETC program is the quarterly JMETC users group meetings. The JMETC program relies heavily on the collaboration of the Services, U.S. Joint Forces Command, and other test and evaluation agencies to build an infrastructure relevant to current and future requirements. In order to facilitate and formalize this exchange process, the JMETC Program Office instituted the JMETC users group. The group is composed of representatives from acquisition program offices, technical experts, labs, test facilities, and ranges that use or will potentially use JMETC infrastructure and products. Its focus is on technical requirements and solutions. The users group makes recommendations to resolve JMETC technical issues and improve integration capabilities, to include connectivity and modernization issues, middleware and object model requirements, and change coordination. The users group meetings are scheduled quarterly and dates are posted on the JMETC Web portal at <https://www.jmetc.org>. First-time users will have to register on the portal, with approval normally taking several hours at most. Program managers should have appropriate representatives begin attending JMETC users group meetings as soon as they see the potential need to conduct distributed test and evaluation as part of their programs.

## Distributed Test Examples

There are several programs and test and technology initiatives that have leveraged distributed testing and the JMETC program. One of the best examples is the Joint Surface Warfare Joint Capability Technology Demonstration. JSuW focuses on leveraging traditional intelligence, surveillance, and reconnaissance assets to provide long-range guidance to net-enabled weapons in high-threat littoral environments, posing new challenges and requirements for data-link functionality and concepts of operations. During JSuW's February 2009 SIMEX [*simulation exercise*] event, JMETC partnered with the Defense Information Systems Agency to connect three separate sites for one week of focused events to simulate the littoral warfighting environment, with virtual F-18s in the Boeing Center for Integrated Defense Simulation in St. Louis, Mo., constructive P-3s in the MITRE Naval C4ISR Experimentation Laboratory in McLean, Va., and the Virtual JSTARS at Northrop Grumman in Melbourne, Fla. The exercise, which included hundreds of tactical engagements, enabled the JSuW team to validate their more mature data link message sets associated with net-enabled weapons and evolve their concept of operations.

According to Bobby Cornelius, the U.S. Navy lead and JSuW JCTD program manager, "Because of the dedication and expertise of the JMETC team, the simulated exercise stayed up and was stable all week, allowing us to execute all desired scenarios." The JSuW team will continue to use distributed testing to assess the full suite of net-enabled weapons-related data-link messages that provide control and guidance commands until the JSuW effort transitions to live-fly in this fiscal year.

Another example is the U.S. Air Force Global Cyberspace Integration Center, which conducts Joint Expeditionary Force Experiments (JEFXs) for concept development, advanced technology initiatives, and early acquisition testing of net-centric capabilities. JEFX initiatives include net-enabled weapons and network interoperability focusing on airborne networking integration. The experimentation program enables early informal operational assessments by the test agencies that will use the same processes, procedures, and tools used in JEFX later in program of record formal testing. JEFX has a 10-year history of aggressively using distributed live, virtual, and constructive operations and, in fiscal year 2009, determined that JMETC was the optimal path to provide the required tools, connectivity, and on-demand network infrastructure for JEFX's continuous experimentation requirements. By leveraging JMETC, the Global Cyberspace Integration Center has saved an estimated $4 million in fiscal year 2009. The savings were predominantly manpower related, achieved by outsourcing expanding connectivity requirements to JMETC and by transitioning from the extensive coordination (and manpower) involved with temporary networks to the streamlined coordination associated with a persistent network.

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The Army has also done extensive distributed infrastructure testing using JMETC to prepare for Future Combat Systems testing and the follow-on Brigade Combat Team modernization. For example, the Army's 2008 Joint Battlespace Dynamic Deconfliction Event was designed to investigate and verify test methodologies to asses near-real-time joint airspace command and control processes during Joint Close Air Support and Joint Fires operations, including assessment of airspace deconfliction. Eighteen separate sites were integrated for the event. Joint Battlespace Dynamic Deconfliction was supported by several partner Service and joint initiatives from the U.S. Army, U.S. Air Force, U.S. Navy, U.S. Joint Forces Command, and the Office of Secretary of Defense; and it will provide a framework for future Army and joint modernization testing.

Use of JMETC is steadily growing. JEFX initiatives in 2010 will include B-2 Bomber link-16 integration testing and assessment of new close air support capabilities. Other fiscal year 2010 testing includes the Navy's Broad Area Maritime Surveillance unmanned aerial vehicle and the Air Force's Battlefield Airborne Communications Network, a U.S. Central Command joint urgent operational need program.

## Is Distributed Test on Your Horizon?

If you are considering distributed testing, or are already committed to distributed testing but want to explore options with JMETC, contact the JMETC Program Management Office. Any inquiries can be made by sending an e-mail to JMETC-feedback@jmetc.org, and you will receive a response within two business days. Other points of contact are available from the JMETC Web portal under the "Questions, Comments, and Suggestions" section.

JMETC team members will work with your program office and integrated test team to determine options, requirements, and resources needed to execute optimal distributed testing. For more significant efforts, JMETC members are well-positioned to become one of your program's teammates, participating in test working groups and assisting in writing the test and evaluation strategy and test and evaluation master plan. The costs to use JMETC will vary. For small test events, there may be no cost. Please note that JMETC institutional funding, combined with the ability to leverage existing infrastructure and software tools, makes the cost of teaming with JMETC significantly less than establishing a program-specific network. Finally, JMETC team members encourage potential customers to attend the JMETC users group to share requirements and collaborate with other distributed test users.

For more information on JMETC, please go to the JMETC Web portal at <https://www.jmetc.org>. The portal will provide specific dates on the June/July 2010 JMETC users group meeting.

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