Paving the Way for Testing in a Joint Environment

The Capability Test Methodology

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As DoD moves away from traditional single-system approaches to new joint capability-based approaches, the department must demonstrate that its future weapons integrate seamlessly into systems of systems and capabilities in complex battlespace environments to produce coordinated and focused effects.

The very nature of modern warfare necessitates major changes to the way the Department of Defense tests and acquires systems and capabilities. Since most systems today are deployed in joint environments, the testing of a system by a single Service may not be adequate to demonstrate that the system meets the warfighter's needs. Future systems, which are expected to operate in a joint environment, should be tested in a realistic joint environment throughout the acquisition life cycle, starting with early experimentation and concept development through the developmental and operational test. The result is an optimally integrated system.

DoD needs to ensure that it is testing systems, systems of systems (SoS), and capabilities consistent with their intended use. In other words, we test, as well as train, like we fight. The warfighter should be confident the systems work as advertised, and the tester must be challenged to deliver the future joint capabilities needed by the warfighter.

A New Roadmap

Changes in testing and acquisition processes are under way to make this happen. DoD instructions acknowledge the need to test joint capabilities in the expected joint operational environment. The Joint Capabilities Integration and Development System (JCIDS) is applying capabilities-based approaches to transform the way the DoD defines requirements for new systems and capabilities by moving materiel developers and testers away from the Service-centric system requirements of the past and toward the necessary joint-centric capability development for future systems. In November 2004, in response to strategic planning guidance direction to provide new testing capabilities and institutionalize the evaluation of joint system effectiveness as part of new capabilities-based processes, then-Deputy Secretary of Defense Paul Wolfowitz approved the Testing in a Joint Environment Roadmap, developed by the DoD director of operational test and evaluation. The roadmap calls for actions that establish a framework for the life cycle evaluation of systems and SoS in a joint

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operational environment beginning with the JCIDS process. Implementation of the roadmap focuses on three elements—policy, infrastructure networks and middleware, and methods and processes—while recognizing the important role of the Services and agencies in the execution. The purpose of the roadmap is to coordinate and synchronize the sometimes disparate Service and agency testing efforts by capitalizing on existing Service test assets, forming an approach to joint testing that will ensure systems and capabilities function as intended when integrated into the joint mission environment.

As individual platforms become part of a complex, networked SoS that must work effectively in a joint battlespace, effective test and evaluation is becoming more difficult. In the future, programs expected to operate in a joint environment should demonstrate their joint capability early and throughout their developmental cycles, regardless of the program's acquisition category. The objective of the roadmap is to address these challenges and define changes that will position test capabilities to fully support adequate test and evaluation of warfighting capabilities developed under DoD's capabilities-based processes in the appropriate joint mission environment.

The joint mission environment provides the operational context in which the capability being developed must perform. Important aspects of this operational context include joint mission, task, threat condition, environmental condition, and system or SoS descriptions of capabilities supporting the joint mission. The joint mission environment is realized when all relevant aspects of the joint operational context are adequately represented in an environment ready for a test that may be live, virtual, and/or constructive and distributed in nature.

The Test Resource Management Center, established as a field activity reporting to the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, is chartered to be the steward of DoD test and evaluation infrastructure. In that capacity TRMC is responsible for the Joint Mission Environment Test Capability Program to help establish a DoD-wide live, virtual, constructive distributed environment (LVC-DE). To date, JMETC has laid the groundwork for an enterprise-level solution to testing infrastructure and has enabled that infrastructure to be assembled more quickly than in the past. Even with an effective infrastructure in place, there is also a need for policy changes and new methods and processes to make valid testing in a joint mission environment a reality.

The Methods and Processes

Traditional methodologies for developing and testing military systems expected to operate in a joint environment—particularly verifying specification compliance for individual systems and testing within a single Service environment—will fail to fully describe real joint capabilities. As DoD moves away from traditional single-system approaches to new joint capability-based approaches, the department must demonstrate that its future weapons integrate seamlessly into SoS and capabilities in complex battlespace environments to produce coordinated and focused effects. In addition, doctrine, organization, training, leadership, personnel, and facility aspects of these new capabilities along with materiel needs must be addressed early in the development process. DoD's long-term strategy calls for evaluations of joint systems effectiveness throughout all phases of a capability's development and deployment. As I mentioned before, we want to be able to test as we fight.

The challenge of testing in a joint mission environment begins early in the system acquisition life cycle; and it is daunting considering the number of systems, network combinations and interactions, environmental conditions, and non-materiel aspects that must be addressed for a realistic test. How much testing and data are sufficient? Must every possible combination of environmental conditions, modes of operation, systems, and entities within the joint mission environment be exercised? Replicating a realistic joint environment will be very challenging because the ability to assemble all required assets at a single test location will be nearly impossible because of scheduling constraints and resource availability. How much of this environment needs to be available for developmental testing and how much is required for operational testing? How can a realistic joint environment be constructed to enable it to meet both developmental and operational test objectives? What kinds of tests can be done during developmental testing to reduce the risk of uncovering new system deficiencies during operational testing?

To address some of these challenges as part of the larger roadmap effort, the director of operational test and evaluation chartered the Joint Test and Evaluation Methodology project in 2006. Specifically, JTEM was directed to develop, test, and evaluate methods and processes for defining and using an LVC-DE joint test environment to evaluate system performance and joint mission effectiveness.

JTEM has developed the capability test methodology, which is a collection of recommended best practices for designing a test of a system or SoS in a complex joint environment. The CTM provides a rational process that guides the program manager and test manager through the test planning process to tailor and optimize a test to demonstrate system performance within a joint context as well as system contribution to joint capabilities. It is a foundation for a series of guides, handbooks, and training courses that will ultimately be delivered to test organizations and acquisition PMs. The CTM is intended to:

- Address testing of systems, SoS, and capabilities, be they Service or joint
- Augment existing DoD and Service test processes

The capability test methodology is addressing the ways and means for designing and executing tests of complex, networked SoS in a realistic joint mission environment through its newly developed and enhanced methods and processes.

- Align test and evaluation aspects and information across multiple DoD processes, namely Analytic Agenda, JCIDS, DoD Architecture Framework, and the Defense Acquisition System
- Provide recommended best practices for a consistent approach to describing, building, and using an appropriate representation of a particular joint mission environment across the acquisition life cycle
- Reflect current acquisition policies and instructions, and eventually be incorporated into Defense Acquisition University PM and test and evaluation courses.

The CTM is designed to augment, not replace, existing test methods and processes, taking into account the unique aspects of testing joint, networked systems in an LVC-DE. As such, the CTM closely parallels existing test processes used within DoD. The CTM consists of six steps and 14 processes, which are briefly described in the following paragraphs.

The CTM Steps

Step 0 defines the test evaluation strategy. The key process in this step is describing the Joint Operational Context for Test used to define the specific elements that make up the LVC-DE. The Joint Operational Context for Test includes a detailed description of the system under test, supporting systems, the expected operating environment, threat forces, and key system interactions and information exchanges required to complete a particular task or mission. In step 1, the PM creates a program introduction document, which outlines the details of a particular test or set of tests, communicating requirements to a test range. The test range then uses that document to produce a statement of capability, which is the starting point for determining what resources will be used to conduct the test and what data will be collected. Step 2 produces distributed test plans that are compilations of current individual test plans, with the addition of distributed and joint elements. During this test planning phase, early test concepts are developed into more detailed test plans. Test planning processes include test trial/vignette selection, refining the live, virtual, constructive distributed test environment required and synthesizing these activities into a test plan.

During CTM steps 3, 4, and 5, joint mission environments are assembled and used to support multiple test plans. Step 3 is concerned with technical systems engineering activities for automatic distributed LVC-DE implementation. These processes include the design of distributed configurations, the assembly of distributed components, and the integration of components into a distributed test range that meets customer requirements. In CTM step 4, distributed tests are conducted according to local procedures and data are collected. This phase produces test data for customers and reusable information for future joint mission environments. Though joint mission environments are assembled to support multiple customers, tests are not required to run concurrently. Sometimes individual customers may separately schedule only those parts of the joint mission environment they need to meet their own objectives for testing in a joint environment. Other times, multiple customers may share a joint mission environment at the same time for convenience or other reasons. In step 5, data sets are processed, analyzed, and evaluated (including evaluations of joint mission effectiveness and contributions of individual systems to joint missions).

Supporting Measures Framework

In addition to the CTM, JTEM has developed a supporting measures framework that establishes appropriate measures to support the evaluation of a system or SoS within a capabilities context. This framework is based on the JCIDS definition of a capability: "The ability to achieve a desired effect under specified standards and conditions through a combination of ways and means to perform a set of tasks." Measures of effectiveness are established at the mission level and based on combatant commander-desired joint mission effects. The joint mission effects are documented through a compilation of products that make up the Analytic Agenda, which is a DoD-wide frame-

work for analyzing force structure requirements and other analytic studies. The products used to document desired effects include the defense planning scenarios, which are a series of scenarios that describe the range of military operations for which combatant commanders must be prepared, along with the operating forces and threats described in the multi-Service force deployment database and the current year and future year analytical baselines. The desired effects must be achieved under specified standards and conditions using systems; SoS; and the supporting doctrine, organization, training, leadership, personnel, and facility aspects, which make up the combinations of ways and means.

The systems and SoS have various performance attributes associated with them (e.g., launch range of an aircraft or time to disseminate information to the battlefield from a higher echelon headquarters), and they are ultimately are used to perform a set of joint tasks that achieve the joint mission desired effects. In the measures framework, measures of performance are used to describe the overall performance desired for each particular task. The joint tasks are described through the Universal Joint Task List and the Joint Mission Essential Task List, along with the specified standards and conditions. The Universal Joint Task List and the Joint Mission Essential Task List also have corresponding Service task lists that support them. Although mission measures of effectiveness will be difficult to capture directly during tests in a joint environment, the task-level measures of performance and the system and SoS attributes can be readily measured. Analysis and combat modeling can then be used to determine overall measures of effectiveness for the joint mission desired effects.

Testing in a Realistic Environment

The CTM is addressing the ways and means for designing and executing tests of complex, networked SoS in a realistic joint mission environment through its newly developed and enhanced methods and processes. During their 2007 test event, JTEM demonstrated application of the CTM to a notional set of network-enabled air- and ground-launched weapon systems while employed in a joint mission environment supporting a joint fire support task. This test showed the potential that can be realized from testing networked SoS in a realistic operational environment. However, it also revealed many challenges, which fall into the categories of:

- Agreed-to measures of performance and effectiveness across multiple joint missions
- Persistence of the test environment used for testing
- Analysis and data management techniques to deal with the increasing complexity of planning tests and evaluating the results of tests in net-centric systems.

JTEM continues to address these issues. In this year's test event, the CTM's effectiveness and suitability for use in a complex joint test environment was again assessed using the Army's Combined Test Organization for Future Combat Systems' Joint Battlespace Dynamic Deconfliction event as a joint capability test event. This venue provided the opportunity to identify the challenges in integrating the end-to-end CTM into existing test activity, developing and maturing the LVC distributed prototype, investigating data-requirements issues, analyzing deficiencies in the joint mission environment representation requirements, and assessing the LVC distributed environment instantiation of the joint mission environment. Test event results are driving improvements to the CTM and will provide an opportunity to gain a better understanding of what it takes to fully realize a sufficient capability to test in a joint environment across DoD. In April 2009, JTEM will deliver a version of the CTM, along with guides, handbooks, and additional supporting documents, which will prepare PM and test organization customers to effectively test as the capabilities-based approach to acquisition requires.

Continuous Learning Available

Additional work has been accomplished to facilitate our future testing needs. The Defense Acquisition University and JTEM have partnered to develop a Testing in a Joint Environment continuous learning module, now available on the DAU Web site <http://clc.dau.mil/>. The module's goal is to familiarize DoD personnel with basic principles and practices related to testing in a joint environment. This three-hour credit course will enable capability managers, PMs, requirements managers, systems engineers, test and evaluation professionals, acquisition professionals, and warfighters to:

- Recognize the need for testing in a joint environment
- Describe the key DoD-level concepts that support testing in a joint environment
- Describe the generalized methodology for testing in a joint environment
- Define the structured approach for identifying measures that support testing in a joint environment
- Recognize the features of the joint mission environment.

The future of testing in a joint environment has many challenges and many exciting opportunities. Through the work of the Testing in a Joint Environment Roadmap and the efforts of all in the testing and acquisition communities, the challenges will be met and the opportunities will be exploited. This collective effort will enable us to test like we fight and deliver the future joint capabilities needed by the warfighter.

Comments or questions? Please go to <www.acq.osd.mil/sse/dte/>.