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Tailoring to the Acquisition Test and Evaluation Process:

Learning from the Past, Looking To the Future

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Preface

Context

Government organizations currently face a multitude of challenges associated with acquisition. This paper was prepared to support a framework for discussion among selected members of the federal acquisition community at a Technical Exchange Meeting (TEM) hosted by The MITRE Corporation on 10 November 2009. The paper is designed to support a foundational understanding of challenges associated with **tailoring acquisition processes.** This paper is one in a series of papers that were prepared for this TEM to motivate dialogue regarding three prevalent acquisition challenges:

- Acquisition workforce challenges
- Requirements determination challenges
- Acquisition process tailoring challenges

Purpose of this Paper

One particular challenge to be addressed at this TEM relates to tailoring acquisition processes such as Test and Evaluation (T&E). This opportunity is leveraged to heighten awareness of possible future Acquisition T&E changes that will likely be warranted. TEM attendees and their T&E stakeholders may use the content of the paper as a starting point to focus on challenges and opportunities for T&E process tailoring, and become more attuned to technology trends that may require tailoring of existing acquisition T&E practices.

Contributing Authors

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Abstract

In learning from the past, we see how the need to conserve resources caused the bomber T&E community, for example, to tailor the acquisition process to use combined testing concepts[1]. Combined Testing is where each T&E stakeholder shares test planning and execution opportunities to collect data rather than each stakeholder conducting independent events. We also learn that changing mission needs and an acknowledgement that more flexibility was needed to accommodate inevitable changes that impacted software-intensive systems, particularly those that were heavily reliant on Commercial-of-the-shelf (COTS) and Non-developmental Items (NDI), resulted in the Command and Control (C2) mission area adopting Evolutionary Acquisition[2] approaches. This adoption led them to adjust their programs' Test Strategies[3] by:

(1) Putting in place an early test planning involvement process which required the key test stakeholders—operational testers, developmental testers and the Program's Test Manager--to engage during the Acquisition Strategy formulation phase and

(2) Guiding C2 programs to include Combined Testing approaches in their strategies with continued test involvement so that they could keep pace in shorter acquisition cycle activities.

Looming on the horizon is the likelihood that agile adversaries and subsequent changing mission operations will demand even higher rates of change for our systems; and, current development and acquisition cycles will find it hard to keep up. Emerging is a system development construct called Composable Capability on Demand (CCOD) for which a set of flexible, reusable tools and access to information/data are provided to the user environment. Users, in turn, "finish" the system to match their mission need. Who then conducts the testing in this construct and what resources will need to be applied to undertake this testing? Who evaluates the results of the test? And what are the organizational impacts to T&E and the users to support this type of time sensitive capability delivery? This paper informs T&E stakeholders by taking a quick look at the construct and resulting key issues and appeals to them to engage early in shaping T&E for CCOD by contacting TEM organizers or the author of this paper (information on cover page).

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[1] Air Force Flight Test Center Fact Sheets, http://www.edwards.af.mil/library/factsheets/factsheet.asp?id=10347

[2] Air Force Evolutionary Acquisition Strategies, 8 April 2005,

[3] Electronic Systems Command Policy Directive 99-1, 2000

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1 Background

1.1 Test and Evaluation Underpinnings and Definition Used

Test and Evaluation has historically been a risk reduction activity during system development. Test and Evaluation's key activities are described in law, guidance, regulations and best practice. For instance:

> United States Code Title X requirements direct that Major Defense Acquisition Programs (MDAPs), both systems and munitions, conduct survivability testing and lethality testing before full-scale production (part (a) Condition for Proceeding Beyond Low-Rate Initial Production),
>
> United States Code Title X requires the Director, Operational Test and Evaluation (an appointed post reporting to the Secretary of Defense) to analyze the results of Initial Operational Test and Evaluation (IOT&E) and prepare a report to Congress on the adequacy of the test, whether the results confirm the effectiveness and suitability of the system under test and other comments (part (b) Operational Test and Evaluation).
>
> Weapons Systems Acquisition Reform Act, May 2009, appoints a Director for Development Test and Evaluation to report jointly with the Director for Systems Engineering to the Secretary of Defense to ensure "…. that the developmental test and evaluation activities of the Department of Defense are fully integrated into and consistent with the systems engineering and development planning processes of the Department….."

T&E must be addressed whatever the circumstance or tailoring to the acquisition of a system. This fact acts as a foundation for examining how Acquisition T&E has changed and how it might need to change in the future.

For the purposes of this paper the Department of Defense Acquisition University definition of Test and Evaluation is used

> "Test and Evaluation is the process by which a system or components are compared against requirements and specifications through testing. The results are evaluated to assess progress of design, performance, supportability, etc. Developmental test and evaluation is an engineering tool used to reduce risk throughout the defense acquisition cycle. Operational test and evaluation is the actual or simulated employment, by typical users, of a system under realistic operational conditions."

1.2 Early Acquisition and Test and Evaluation (T&E) Process

In the early Acquisition Process, as shown in *Figure 1 (Test and Evaluation over a System Lifecycle – General)*, T&E was expected within three key phases in a system's life cycle—

during development under primary responsibility of the contractor that was building the system; at the end of that period when there was a government developmental testing period; and then before the system was officially handed over to the users when there was an operational test. Each of these test periods, typically occurring so as to provide information to a very significant programmatic event or milestone, lasted for multiple months. Each phase was conducted by different parties and at different facilities, with independent results and conclusions dictated by respective stakeholder focal concerns. The contractor was interested in meeting his contractual testing obligations, the developmental testing organizations were concerned with technical underpinnings of the developed system in conditions that were closer to how the system would be used and the operational community was the champion of the user ensuring that the system was suitable and effective in realistic operational settings.

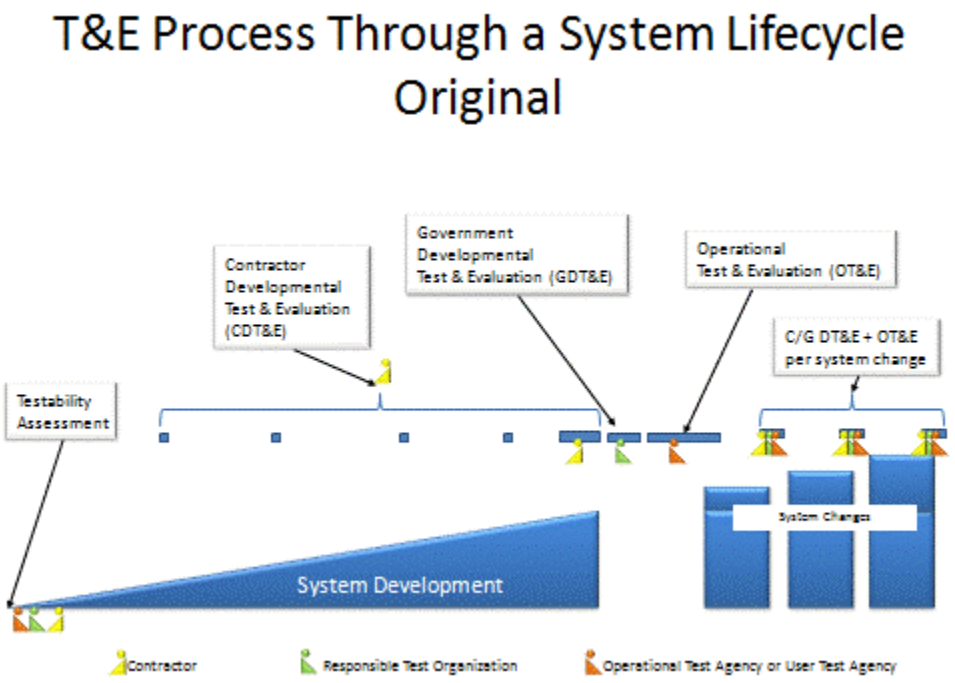


Figure 1 Test and Evaluation of a System's Life Cycle - Original

This process worked well for large industrial era systems especially when the military industrial complex was at its peak, but as the systems became more and more complex and correspondingly more expensive and the Defense budget was not getting larger, it became

important to find ways to reduce costs. For Test & Evaluation, this manifested itself as the first major tailoring of the T&E process.

2 Driving Tailoring to T&E in the Aircraft Development Process: Resource Sensitivities

A major tailoring to T&E processes came in the aircraft acquisition environment at this time. Since items like the B-1 and B-2 Bombers were either very expensive to build or had severe cost constraints, the program could not afford to have each test stakeholder own their own test aircraft. Since only a single test asset would be available during development, the test stakeholders had to share flights to collect data. This resulted in the stand up of Combined Test Forces (CTFs) in a single location with representatives from each stakeholder co-existing in shared facilities and test conduct and analysis infrastructure. The impact was that the process had to be tailored to look like *Figure 2, T&E Process in System Development Lifecycle – Tailored (1)*, in which all stakeholders distributed their test collections and observations across the development phase based on appropriate maturity levels of the system when test collection opportunities were planned. Planning was done cooperatively, and objectives were negotiated so that all participating stakeholders could maximize their collections from each event. Other than the Assessment for Testability that occurred early in the requirements assessment phase, operational testers would actively monitor activities, and continuously interject operational viewpoints to influence the development. Later on, government developmental and operational testers would have combined test events in which flights were planned to include Operational Test (OT) and Government Developmental Test (DT) objectives. Operational testers would again participate to gain more in depth knowledge of the systems and in some instances collect data for independent analysis. At the end of the primary development period -- before Low Rate Initial Production[4] (part ***(a)*** *Condition for Proceeding Beyond Low-Rate Initial Production*) -- an Initial Operational test is conducted to meet Title X requirements. Finally, testing continued and at the end, there was a completely realistic independent-of-developer operational test conducted that met the Title X requirement for an impartial system evaluation (part (d) *Impartiality of Contractor Testing Personnel*). All of this streamlining occurred to accommodate resource shortcomings, yet it still held to best

[4] TITLE 10 > Subtitle A > PART IV > CHAPTER 139 > § 2366

practice and met the law. After initial fielding, the Combined Test Forces remained standing to address Block[5] upgrades to the system using the same modified process.

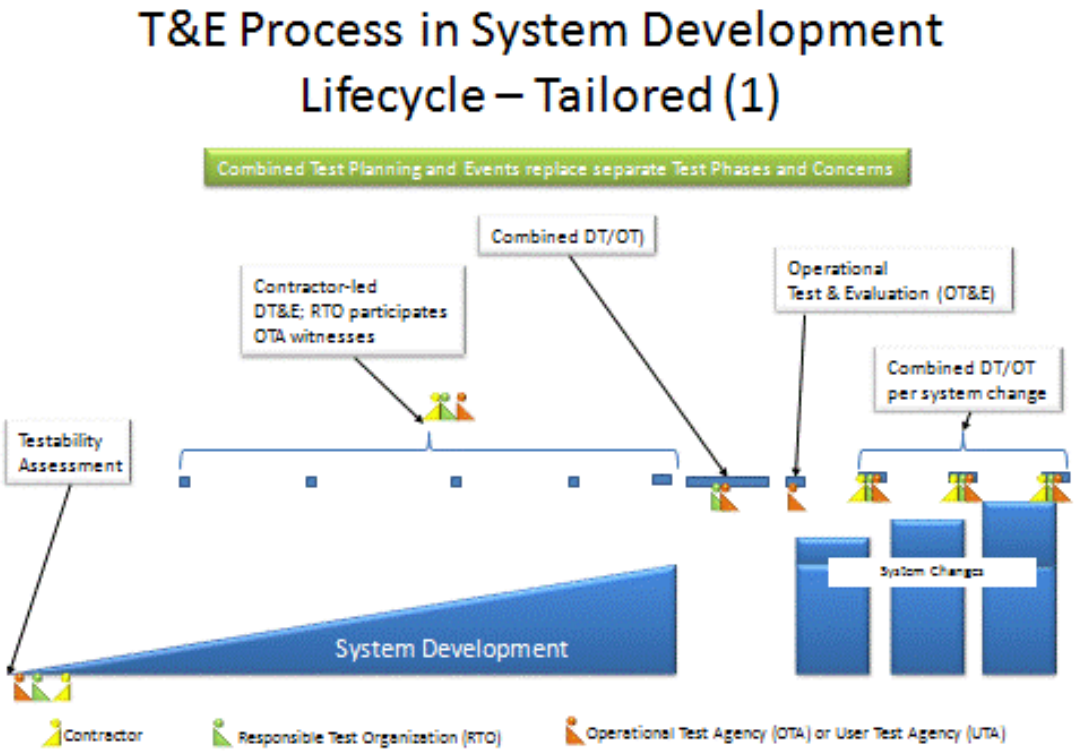


Figure 2 T&E Process in System Development Lifecycle – Tailored (1)

[5] Major aircraft systems use a block approach to upgrading systems. Subsystems' deficiencies were fixed and deferred to a single upgrade so as to reduce interruptions to aircraft and fleet operations.

3 Driving Tailoring to T&E of Command and Control Systems: Mission and Information Technology Changes

For Software-oriented systems in Command and Control, several factors drove change:

- DoD missions shifting from cold-war era doctrine to smaller conventional-oriented missions and humanitarian missions simultaneously occurring in multiple theaters,
- Networks becoming more widespread,
- The government shifting from leading technology development to using more Commercial-of-the-shelf (COTS) and Non-Developmental Items (NDI) solutions, and
- The availability of cheaper, high refresh rate computing power and software tools to the public at large
- User feedback to the acquirers pointed to the fact that they could personally get to the latest SW tools; yet at work they were dealing with old systems that were seemingly taking forever to refresh.

As it relates to the last bullet above, users were becoming disillusioned with the provided system. In some cases, they would not use them and instead would build, easy-to-manipulate tools based on commercially available MS Excel, for situational awareness and decision support functionality. Additionally, as more systems used easy-to-procure infrastructure SW (e.g., Commercial-of-the-shelf (COTS)), acquirers were facing having operating systems and other common infrastructure software modules become unsupportable if they did not keep pace with upgrades. It then became important to embrace concepts such as Evolutionary Acquisition which provided a venue for system acquisition flexibility by accommodating more frequent changes. This meant that technology refresh could be accommodated, and new requirements emerging from needing to use systems in different ways could be allowed to mature during development based on discovery and learning. This drove Test and Evaluation process changes for software intensive systems in the command and control mission area to adopt the CTF concepts to help streamline testing. The Command and Control Center of Excellence--Electronic Systems Command (ESC), the 46th Test and Evaluation Wing, the Air Force Test and Evaluation Center (AFOTEC) jointly created and published a Command and Control Test Blueprint against which all C2 Test Programs were to model their Test Strategies.

The activity resulted in a Command and Control Test Partnership function whose goal was to jumpstart C2 programs' T&E strategies during acquisition strategy development and shepherd the process change uniformly across all C2 programs. This partnership consisted of the C2 Single Face to the Customer function for Government Developmental Testing who

recommended a Responsible Test Organization, Air Force Test and Evaluation Center Liaison, who recommended operational test objectives and an independent government Test Focal point from ESC, who hosted the Test Partnership, provided test expertise and guidance to the System Program Offices (SPOs) and trained SPO Test Managers. The purpose of this partnership was to ensure that C2 SW intensive systems were tested using a Test Process tailored to accommodate smaller development cycles and were using combined test principles to the fullest extent possible as shown in *Figure 3, T&E Process Through Development Lifecycle – Tailored (2)*. The focus of the strategy was that T&E stakeholders would need to be involved early, be more closely aligned with and involved in the development of the system in all test-like opportunities, such as prototyping efforts, since increments were short and test planning and readiness needed to be complete when the increment was ready for test. Every opportunity to learn about the system and get data on performance had to be leveraged which dictated that the test community be more integrated in to the development process. All of these changes were done with close regard of and adherence to the law, guidance and best practice.

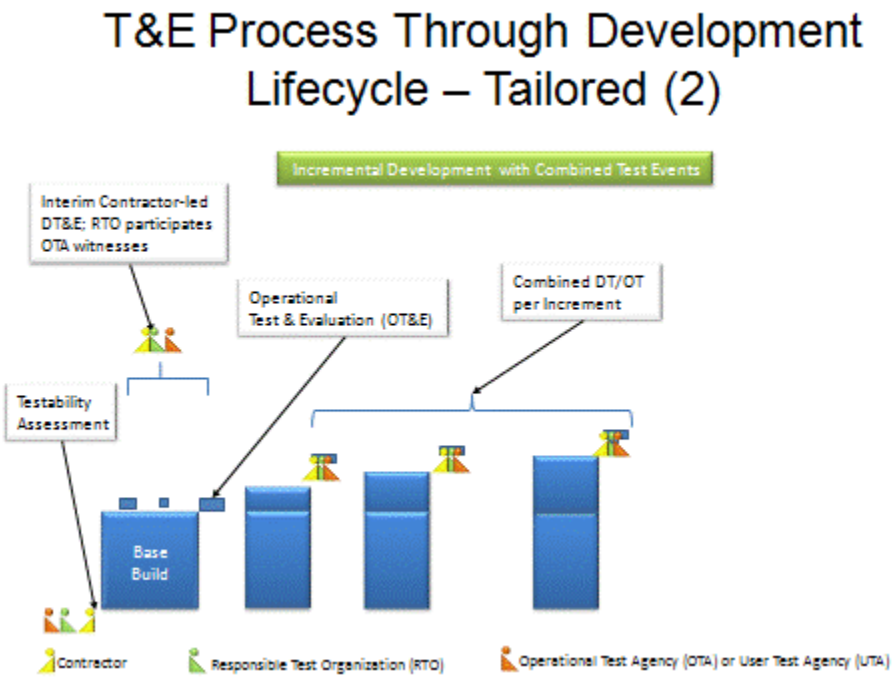


Figure 3 T&E Process through Development Lifecycle – Tailored (2)

4 A Future Concept Driving Tailoring to T&E Processes

4.1 Composable Capabilities on Demand (CCOD) Defined

Yet another change is probable in T&E of SW intensive systems, this time based on the construct of following Mash Up technologies that are being used largely by commercial developers. The construct being examined is termed Composable Capabilities on Demand (CCOD), which seems to be a good match for capabilities that cannot be entirely anticipated and can then only be assembled when the true need is known. Situations that occur in counter-insurgency operations, Homeland Defense and Disaster relief type scenarios are examples of where CCOD could apply because of unanticipated, newly emerging information needs

The construct assumes that conventional and non-conventional information feeds are available and can be combined to form situational awareness by techno-savvy users and/or operators rather than a traditional developer. The traditional acquirer would make the feeds available in the form of services and offer tools that can be used to combine the services into a situational awareness system. In the construct, the complexities of the underlying system are masked and the interface used to compose the system is intuitive. A key feature of the CCOD construct is that the capability-building environment is highly flexible and can accommodate a range of time sensitive needs. If so, what would be a matching flexible, time sensitive T&E process?

4.2 CCOD T&E Issues

Some key CCOD Test and Evaluation questions that emerge from the CCOD construct are:

Who conducts testing?

Is testing a shared responsibility between formal organizations and the users/composers that are assembling the system?

How much testing should be done even though there may be time pressure?

How much can be done before hand (pre-qualification/certification)?

Would the operational community have to consider actively accepting more risk than is normal with a more traditional systems approach and then consider driving the risk down concurrently and in a non disruptive manner?

Can all of this be done within the T&E framework of the laws, guidance and risk reduction objectives?

As shown in *Figure 4, CCOD Test and Evaluation*, a proposed amount of testing done on a capability might have to embrace many dimensions, one such being scope of use: Is this command-wide use or is it just for a single person for this instance in time? Also one might consider when the capability is needed and how trusted the capability needs to be. If the capability is to be used to support critical decisions such as those involving loss of life or other sensitivities, then the tension of time sensitivity and criticality of use would need to be very carefully balanced. How is that done quickly?

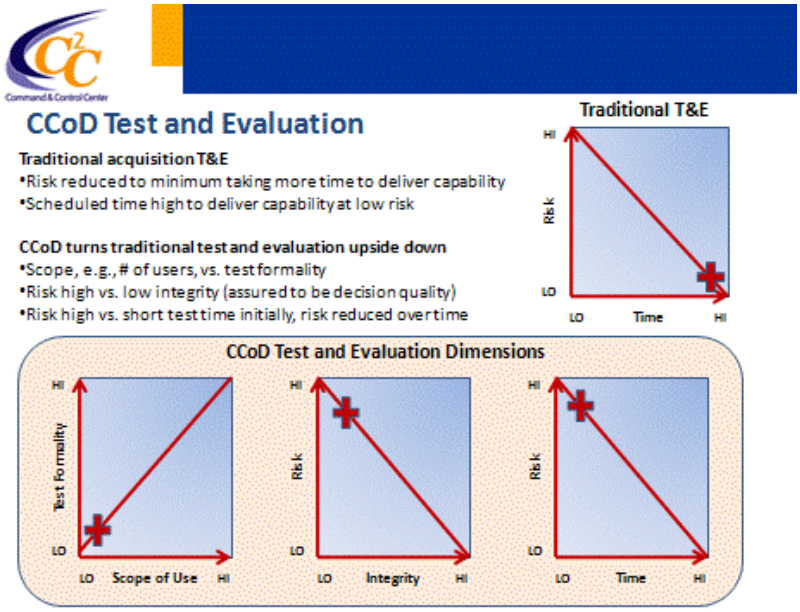
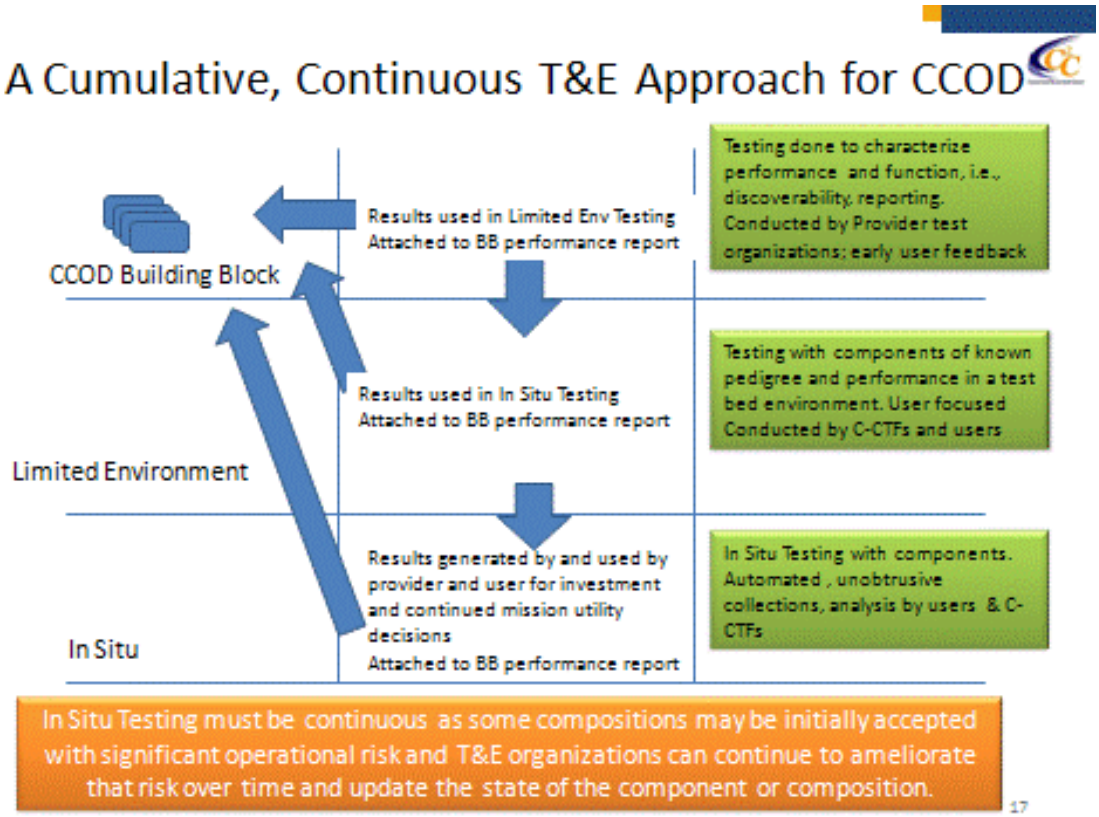


Figure 4 CCOD Test and Evaluation

Because these dimensions map out an important tradespace, and both the warfighter and capability provider want to minimize risk while adequately and practically addressing the other tradeoff dimensions, five key needs seem to be emerging as extremely important for CCOD T&E:

(1) Precertification of components, that is inherited into a larger test framework
(2) The need for Agile Integration Testing
(3) The need for Continuous Testing
(4) The need for quick test determination
(5) Much heavier user, as in operator, involvement in determining appropriateness of the composed system

Figure 5, *Cumulative, Continuous T&E for CCOD,* shows a proposed T&E approach.



BB=Building Block

C-CTF=CCOD Combined Test Force

Figure 5 Cumulative, Continuous T&E for CCOD

This Cumulative, Continuous approach is a proposal to explore. There are aspects of social networking SW concepts that could apply especially since there might be heavy user involvement and all users' feedback on composition performance could be useful to other CCOD participants. Test infrastructure may need to be distributed not only among testers but to the user base and a strong element of reliance on and trust of test results from many different stakeholders might be the key to success. How do you set up the content of test results and feedback on system performance to be *usable across a wide range of test stakeholders?* The proposed tailoring to the current T&E process is perhaps large enough to consider it to be revolutionary, rather than evolutionary. As such, this concept or others need to be immediately broached with T&E stakeholders to ensure that CCOD's flexibility benefits preserved while still meeting the guidance and risk reduction objectives of the user and T&E community.

The paper leaves off at this point and seeks to encourage stakeholders to learn more about this new wave of SW cultural changes and examine its impacts to the current T&E processes.

5 Summary

Those addressing resource constraints in test can look at the bomber T&E community and learn how to tailor the acquisition T&E process and embrace combined testing concepts. Combined Testing is where each T&E stakeholder shares test, planning and execution opportunities to collect data rather than each conducting independent events. For those challenged with using and keeping up with commercial technologies with high refresh rates, resource constraints and pressures to deliver time-sensitive information systems, we recommend looking at the command and control (C2) mission area and understanding how the early and continuous test involvement model may help to address systems that require incremental deliveries.

Looming on the horizon is the likelihood that the adversary and changing mission profiles will demand even higher rates of change for our systems and that current development and acquisition cycles will not be able to keep up. Composable Capability on Demand (CCOD) is now emerging as a system development construct where a set of flexible, reusable tools and access to information/data are provided as capabilities to the user. The user/operator in turn employs the tools to produce the functionality they need. As broached by this paper, the following are emerging as items for attention and may justify consideration of an overall T&E construct of continuous, cumulative testing:

- precertification of components that fit into a larger test framework,
- the need for Agile Integration Testing,
- the need for Continuous Testing,
- greater user (operator) involvement and
- the need for quick test determination

The discussions, suggestions, and questions within this paper are designed to highlight an emerging approach to C2 systems development that impacts the overall acquisition process, and to raise issues about how it may drive T&E tailoring. The author urges the T&E community to engage as quickly as possible to help shape how Acquisition T&E would need to be tailored by contacting the TEM organizers or the author of this paper (information on cover page).

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