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IDA's Recommendation on an Alternative Methodology and Approach for Joint Staff/J26's 'Enterprise Resolve'

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Executive Summary

Background

For the last three years, the Joint Forces Command (JFCOM) has conducted the Empire Challenge exercise, an annual joint multinational intelligence, surveillance, and reconnaissance (ISR) live-fly interoperability demonstration, under Office of the Under Secretary of Defense for Intelligence (OUSD(I)) sponsorship. The Empire Challenge events provided a venue for addressing ISR problems or shortfalls identified by Combatant Commands (COCOMs) by testing capabilities (i.e., technologies, processes, procedures) that offered near-term resolution. A key element of these events was the focus on *rapidly* identifying solutions to COCOM ISR shortfalls, particularly Central Command's, in order to determine ones that could be immediately deployed to improve combat operations.

To assist with decision-making on deployment, JFCOM attempted, with varying degrees of success, to use some elements of operational test and evaluation (OT&E) practices in the planning for and analysis of Empire Challenge exercises. Using a traditional OT&E methodology to add rigor and structure to the results, JFCOM sought to provide OUSD(I) with an objective assessment of the ability of the participating capabilities to solve COCOM-identified problems and to integrate into current Department of Defense (DoD) networks. Their success, however, was limited, principally because most of the traditional DoD functional organizations and OT&E processes are not supportive of expeditious technological development and confirmatory testing.

Beginning in 2012, the responsibility for planning and implementing the Empire Challenge 2011 follow-on, now called Enterprise Resolve, resides with the Joint Staff, Intelligence Directorate (J2/J26). The objective of this report is to build on Empire Challenge lessons learned and recent commercial sector strategies to formulate alternative exercise-based approaches for timely solutions to high-priority COCOM ISR shortfalls. To that end, IDA examined approaches and methodologies employed in the commercial world (and some specifically focused for application within DoD) to address the unique requirements of a rapid development cycle that could respond swiftly to changing customer needs. In addition to reviewing numerous commercial writings on 'agile' development methodologies, we also considered:

- A recommendation published in the open literature by the Test and Evaluation Executive for the Defense Information Systems Agency[1]
- Related reports produced by the Defense Science Board and the National Academy of Sciences[2,3]
- Previous IDA assessments of Empire Challenge exercise design, execution, and assessment methods[4,5]
- Familiarity with the fast-track acquisition processes utilized by the Joint National Intelligence Development Staff at the Office of Naval Intelligence in the late 1980s.

Findings

IDA identified the 'agile' methodology currently used in the software development community as an approach that could be applied effectively by the Joint Staff J2 organization to design and conduct future Enterprise Resolve and related events. Of the many different versions of the 'agile' methodology implemented over the years, the most common one, and the one specifically addressed in this report, is called 'Scrum.'

There is a great degree of commonality within the experiences reported in and the recommendations provided by the sources that IDA studied. A synthesis of their key elements most suitable for application to the Empire Challenge/Enterprise Resolve context follows:

- Use of multiple, short developmental iterations called 'Sprints' = rapid release of capability
- Continuous user involvement = relevant solutions for customer
  - Customer = COCOM or coalition partner, not the 'capabilities'
  - Customer involved in multiple stages: specification of ISR shortfalls, provision of 'user stories' to describe functions to be performed,

[1] Hutchison, S. 2010. "Test and Evaluation for Agile Information Technologies," *ITEA Journal* 31 (4): 459-465.

[2] Defense Science Board. 2009. *Department of Defense policies and procedures for the acquisition of information technology*. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf.

[3] National Academy of Sciences. 2010. *Achieving effective acquisition of information technology in the Department of Defense*. Washington, D.C.: The National Academies Press. http://www.nap.edu/catalog.php?record_id512823

[4] Fries, A. and Effemey, D., IDA Document D-3971, *IDA Recommendations for EC10*, October 2009

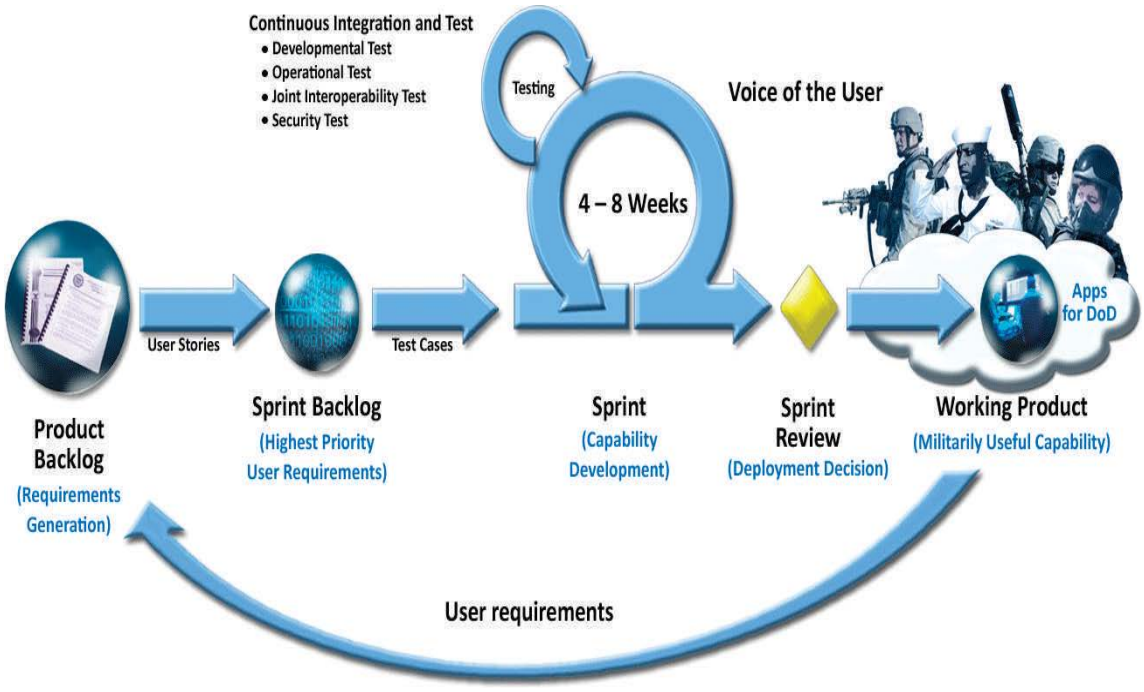
[5] Fries, A., Effemey D., and Mills, K., IDA Document D-4254, *Report on Empire Challenge 2010 (EC10), IDA Analytical Support to Joint Forces Command – Exercise Planning, Execution, and Assessment*, January 2011

development of initial list of desired solutions (Product Backlog), input and course correction at the end of each development 'Sprint' during the 'Sprint Review.' (The figure below portrays the repetitive nature of the iterations in the development progress.)

- Functionally integrated team comprising Scrum Master (methodology expert and facilitator), product owner (customer rep), the development team (vendors proposing solutions), and test and evaluation (T&E) leads (Developmental Test (DT), Operational Test (OT), Joint Interoperability, and Information Assurance (IA))
- Integrated T&E = comprehensive, rapid assessment
  - Combine DT, OT, Joint interoperability, and IA
  - 'Testing' or evaluation by all four elements occurs continuously during the development 'Sprint'
  - Easier for different elements of the testing team to see which technical or operational changes are needed to better achieve the customer's desired result
  - Users for testing = either COCOM/coalition individuals with specific, recent experience in the ISR shortfall to be addressed (so that input has relevance and credibility) or a dedicated team of users experienced both in the functional area being addressed and familiar with operations in-theater.
- Focused T&E
  - Early concurrence on the purpose of the event is required to ensure a dedicated focus on a select few ISR shortfalls and one customer voice to which the functionally integrated team has to respond. Prior Empire Challenge events had too many objectives and served too many different customers.
  - **'**Buy-in' from the customer provides the needed front-end input on the ISR shortfall and desired types of solutions, as well as the continuous inputs at each 'Sprint Review.'

Recommendation

The 'agile' methodology outlined above, with suitable tailoring (e.g., extending the nominal 4- to 8-week 'Sprint' cycle), offers the opportunity for the Joint Staff J2 to implement development and acquisition processes supporting rapid, relevant solutions to urgent COCOM customer needs. Implementation would entail establishing new types of organization structures and a different 'battle rhythm' than used in the past.



Iterative Cycles Comprising the 'Scrum Agile' Methodology[6]

[6] From: Hutchison, S. 2010. "Test and Evaluation for Agile Information Technologies," *ITEA Journal* 31 (4): 459-465.

Contents

1. Introduction

For the last three years, the Joint Forces Command (JFCOM) conducted the Empire Challenge (EC) exercise, an annual joint multinational intelligence, surveillance and reconnaissance (ISR) live-fly interoperability demonstration, under Office of the Under Secretary of Defense for Intelligence (OUSD(I)) sponsorship. The EC events provided a venue for addressing ISR problems or shortfalls identified by Combatant Commands (COCOMs) by testing capabilities (i.e., technologies, processes, procedures) that offered near-term resolution. During these three years, JFCOM attempted, with varying degrees of success, to use some elements of operational test and evaluation (OT&E) practices to provide OUSD(I) with an objective assessment of the ability of the participating capabilities to solve COCOM-identified problems and to integrate into current Department of Defense (DoD) networks.

The Institute for Defense Analyses (IDA) participated in all three of the JFCOM-sponsored EC events as a member of the JFCOM Assessment Team, both assessing selected capabilities[7,8] and evaluating the overall exercise design, execution, and assessment processes[9,10]. In the evaluation role, IDA provided the JFCOM intelligence leadership real-time and post-exercise feedback on the assessment processes during each event. Recurrent problems centered on testing designs and the difficulties of attempting to apply rigorous OT&E criteria and practices to a very uncontrolled environment. These affected the ability to provide comprehensive assessments of warfighter utility and deployability for the participating capabilities. The reported assessment limitations included the following:

- A lack of rigor – few if any quantitative measures
- A lack of technical performance data – technical assessment limited to net ready and basic Distributed Common Ground Station (DCGS) integration

[7] Fries, A., Effemey, D., Fore, D., Henderson, D., Mills, K. and Whittier, G., IDA Document D-3972, *Report on Select EC09 Initiatives – Emerging IDA Observations*, October 2009 (FOUO)

[8] Fries, A., Effemey D., Mills, K. and Keller, R., IDA Document D-4420, *Assessment of Select Capabilities Participating in the Empire Challenge 2011 Exercise*, September 2011 (FOUO)

[9] Fries, A. and Effemey, D., IDA Document D-3971, *IDA Recommendations for EC10*, October 2009

[10] Fries, A., Effemey D., and Mills, K., IDA Document D-4254, *Report on Empire Challenge 2010 (EC10*), *IDA Analytical Support to Joint Forces Command – Exercise Planning, Execution, and Assessment*, January 2011

- Limited warfighter utility assessments that primarily became usability assessments
- Limited assessment of other areas of suitability needing to be addressed for deployability decisions – e.g., maintainability, reliability logistics requirements
- Lack of comparative analysis or assessment of similar capabilities needed to provide OUSD(I) a way to decide between competing capabilities. Although EC exercises were not designed as 'bake-offs' between competing capabilities, there were opportunities to compare capabilities providing similar functionality.

The objective of this report, supported by internal IDA funding as a Central Research Project, is to build on EC lessons learned and recent commercial sector strategies to formulate alternative exercise-based approaches for providing timely solutions to high-priority COCOM ISR shortfalls.[11] To that end, IDA examined processes employed in the commercial world (and some specifically focused for application within DoD) to address the unique requirements of a rapid development and acquisition cycle.

The remainder of this report comprises four chapters and two appendices. Chapter 2 elaborates on EC assessment limitations. Chapter 3 explores the origins of the EC structure and assessment approaches implemented by JFCOM. Chapter 4 reviews relevant existing approaches in DoD and the commercial world that address testing processes aimed at rapid acquisition. Chapter 5 offers recommendations on how to apply them to future EC-like events. Appendix A provides a copy of a published article outlining a proposed new acquisition process for DoD information technology (IT) systems. Appendix B is a list of acronyms used in this report.

[11] Beginning in 2012, the responsibility for planning and implementing the EC11 follow-on, now called Enterprise Resolve (ER), resides with the Joint Chiefs of Staff (JCS) Joint Staff of Intelligence (J2) J26.

2. Empire Challenge Assessment Limitations

Although EC assessment processes improved over the last three years, there are still many areas that could be improved – mostly external problems affecting the quality of assessment processes. These external issues include:

- Combining conflicting types of events together in one event
- Including a wide range of capabilities with varying degrees of maturity
- Inability to guarantee the participation of the customer (COCOM)
- Event planning and execution conducted in a stove-piped fashion by separate functional teams.

Each of these issues is addressed in turn below.

A. Combining Conflicting Events

Each EC exercise attempted to accomplish too many things in one event. There were too many different participants with diverse and conflicting goals, and far too many ISR shortfalls were addressed. This resulted in events that combined technical integration efforts with robust, vignette-driven operational exercises, and included as many as 30 to 50 technology solutions to assess. This combination reduced the value of EC for each participating capability, because of the differing testing requirements for each and the conflicts they introduced in event design and the ability to assess comprehensively.

For example, some participants were most interested in obtaining operational training for troops preparing to deploy or were seeking an operational environment to test the latest enhancement to their systems. These kinds of events ordinarily occur *after* rigorous system integration tests and are the final operational venues before deployment. They also require extensive and robust vignettes in a completely representative environment in order to provide the final operational test of gear or operation preparation of troops – something not usually desired or available in a technical integration test. Additionally, the nominal assumption during these kinds of events is that network and system integration issues already have been identified and addressed. For all three JFCOM-run EC exercises, the network and integration issues had not been fully resolved nor comprehensively tested prior to the operational event. Thus, considerable time was spent in the exercise fixing network problems while vignettes played out. This reduced

much of the operational coordination to voice, Voice Over Internet Protocol (VOIP), e-mail, and SharePoint sites.

In other instances, some participants were more interested in testing the ability of one or more of their systems to exchange data with other systems – a technical or system integration test. This kind of integration effort is best conducted in a lab where technicians, combined with a few experienced users, have the opportunity to conduct a wide range of functional and technical tests, as well as to repeat processes and functions, as needed, to identify integration problems. In this environment, the technician (programmer/developer) frequently is able to make some changes to the system to improve integration. The highly controlled environment in a lab allows the technician to retest implemented changes, while also supporting the ability to easily track data on the network for a technical performance assessment.

There is a significant challenge when these sorts of integration tests are to be conducted in a simulated operational environment, where there are far too many competing network issues and participating systems, and where a substantial number of operational vignettes must play out in order to provide the operational setting desired for training. With a large number of systems on the network, it becomes extremely difficult to track the specific data flows being tested, or to identify specific problems preventing the data being exchanged as planned between individual systems – precluding the collection of comprehensive quantitative assessment data and technical performance information. Additionally, in order to maintain the operational flow to provide needed deployment training, it becomes almost impossible to stop the events in order to repeat a test to better identify an integration problem or to retest once a programming change has been implemented.

Where participants were somewhat successful in accomplishing their integration goals during previous EC exercise, it was in spite of this environment and their efforts were sub-optimized because of the lack of a controlled environment. Other successes usually occurred during the final days of the EC exercise when the operational focus had diminished.

As a result of some of these conflicts and challenges, both the technical and warfighter utility assessments typically were very narrow and limited. Furthermore, JFCOM's ability to collect significant quantitative data to complement collected qualitative data was hampered severely. The operational tempo precluded frequent retesting of functionality in order to obtain adequate sample sets to evaluate additional suitability criteria, e.g., reliability, maintainability, and supportability. The technical assessment consisted only of a 'net-ready' evaluation and a very basic DCGS interoperability check. It did not assess performance in terms of measuring speed, accuracy, or completeness of data; nor did it assess performance relative to the current (deficient) capability in-theater. Additionally, given the wide range of operational events

and the complexity of supporting data flows, it was extremely difficult for the Assessment Team members to be physically present in all the needed locations to observe and to record adequately the ways in which data were being utilized and contributed to warfighter utility. For select capabilities, the Assessment Team was able to compensate by employing reservists to provide a 'utility' assessment when the observer assessor was not present.

In addition, many of the participating capabilities conducted their own external assessments, rather than relying on the designated JFCOM Assessment Team. This raised the question as to who was 'the Customer' – was it the COCOM whose Joint Urgent Operational Needs Statements (JUONs) and Immediate Warfighter Needs (IWNs) were supposedly being addressed, or was it the capability itself? If it was the COCOM, then the question became whether the capability requirements being assessed had any applicability to specific COCOM ISR shortfalls.

B. Broad Range of Participating Capabilities

There was variation in maturity levels of technologies participating in EC. Many were actually programs of record looking for an operational environment in which to test out and publicly showcase their potential. Others, especially Service systems, already had completed or were scheduled to experience formal OT&E, and did not need the JFCOM assessment stamp of approval. A third class of participating capabilities included not yet full programs of record that had already been deployed in-theater. They too were just looking for an operational venue in which to try out some new enhancement before deployment. Their status was not going to be affected by the results of the assessment process used in these events, but the assessment results might at least provide them some feedback on specific issues they need to fix before deployment. Yet another set of participating capabilities were commercial developments that might have significant applicability to the military problem; however, they did not belong to any Service or Agency. A few were not even familiar with basic DoD requirements for integrating into a classified network. In many cases, they fit the category of a 'state-of-the-art' demonstration, but their challenge was their ability to integrate this commercial capability into a DoD operational environment. While these capabilities hoped that EC might allow them an opportunity to showcase their functionality, the venue often did not serve them well. So much time was spent in attempting to resolve a myriad of fundamental network problems, that, frequently, this kind of capability did not get enough operational exposure to even determine whether they could solve the military problem.

Impacts on the EC assessment process included:

- There were too many capabilities to assess adequately, especially given the number of assessors. Normal OT&E would require assessment and tracking of

data flows at a number of physical locations, but this was not feasible in EC, often resulting in dependence on secondhand, anecdotal information concerning the success or failure of data receipt and follow-on operational use.

- Many of the participants were programs of record simply looking for an operational venue in which to try out their latest enhancement for final feedback before deployment. This group would not be affected significantly by JFCOM's assessment since they already were adhering to Service OT&E processes. Additionally, EC setting did not have the controls to permit the kind of rigorous assessment that could have complemented or substituted for Service OT&E.
- Other groups with innovative solutions, but not a part of any Service's program of record, were unable to achieve adequate exposure to determine fully their level of military utility. The best the JFCOM Assessment Team could do was to provide a cursory evaluation of utility and usability, and to recommend these capabilities for further evaluation.

C. Lack of COCOM Participation

JFCOM, despite its best efforts, was not able to get the United States Central Command (CENTCOM) to participate in the EC exercise – even though JFCOM was attempting to solve ISR shortfalls related to CENTCOM's theater. This was probably due to CENTCOM heavy preoccupation with various actual combat circumstances; however, this meant that it was very difficult for JFCOM to be confident they were addressing CENTCOM's top in-theater priorities. The COCOM had a minimal role in the initial selection of ISR problems to be addressed, and none were in the capability selection process. Additionally, there was no COCOM presence in the assessment process. This lack of involvement was at the choice of the COCOM, not JFCOM.

This inability to guarantee the participation of the Customer (COCOM) had several repercussions for the JFCOM Assessment Team.

- First, lack of focus on specific ISR shortfalls forced JFCOM into a 'shotgun' approach. While they did use COCOM JUONs and IWNs, they attempted to address far too many of them in one venue.
- Second, because of a lack of specificity, the JFCOM Assessment Team was not always able to determine the exact criteria on which to evaluate the applicability of a capability to a shortfall. They were thus reduced to relying on the Assessment Team member's previous ISR experience (i.e., what he thought the ISR shortfall description meant) or a description by the capability of the ISR shortfall specifics in-theater and their approach to a solution. Consequently, the JFCOM Assessment Team in many areas was unsure of the applicability of their assessment criteria to the exact problem in-theater, and this lack, despite their

best efforts to redress it, likely affected the credibility of the assessment from the COCOM's perspective.

- Third, there was no easy way to obtain Customer (COCOM) assessment of the value of a particular capability is solving a specific shortfall. Participation in the assessment process would have meant that CENTCOM (the ultimate Customer) would have had experienced representation on the JFCOM Assessment Team, and would have provided a credible assessment as to whether a particular capability truly provided the needed solution to a specific ISR shortfall. Frequently, the warfighter utility assessment became more of a 'usability' evaluation than an overall assessment of a capability to fix a specific ISR shortfall. JFCOM attempted to redress this lack by employing military reservists and, where possible, matching their backgrounds to the capability being evaluated. The same approach was used for JFCOM Assessment Team members assigned to particular capabilities. This kind of 'match-up,' however, could not substitute for real-time input by a true COCOM-assigned individual with recent in-theater experience in the specific subject problem. As a result, the credibility of the conclusions reported by the JFCOM Assessment Team likely would be viewed with some skepticism by the COCOM.

D. Stove-piped Planning and Execution Organization

JFCOM's EC planning teams were divided into functional organizations: e.g., networks/architecture, operations, logistics, assessment. The focus on performing individual team functions rather than accomplishing goals as an integrated team led to frequent duplication of effort and many instances of conflicting information regarding capability functionality, CONOPs, and requirements that had to be rechecked all the way up until the final EC live-fly event. JFCOM sought to facilitate the sharing and coordination of information across functional teams – by having each team invite the others to listen in on a particular team's teleconference with each capability, and by holding a Technical Exchange Meeting (TEM) every three months. Nonetheless, the issue of duplication and conflicts in comprehension of capability needs and Concept of Operations (CONOPs) remained. This caused significant frustration on the part of the capabilities who felt they were spending an inordinate amount of time providing the same information to multiple teams.

Additionally, due to lack of participation in the teleconferences, teams often missed the chance to hear everything at the same time and to resolve any misconceptions or confusion. For example, it would have been helpful for the network/architecture team to have listened in on the descriptions of capability CONOPs provided during Assessment Team interviews, since a capability's CONOPs determines which networks they plan to use as well as the origin and destination of their data, among other things. Likewise, it

would have been beneficial for the Assessment Team to have been actively aware of each capability's discussion with the network/architecture team on the networks they planned to use. This information would have assisted the Assessment Team in determining where to extract quantitative data on the flow of the capability's information, as well as where to place observers to cover origination and destination user sites.

IDA previously had recommended the use of an Integrated Process Team (IPT) for future EC exercises. JFCOM did not, however, change its EC organizational structure – perhaps because it was just too difficult to learn and execute an entirely different organizational approach given all the other demands, including short timelines between the completion of and reporting on an executed EC exercise and the initiation of planning for the next EC event. The solution to this organizational issue remains fundamentally the same – adoption of a type of integrated oversight team where each functional organization participating in EC has a member on the critical 'integrated' team. This integrated team should be the one that works all key EC areas concerns (e.g., capability selection, architecture design, Master Scenario Events List (MSEL) development, assessment process), ensuring that all parts of the planning and execution processes are integrated from the start, not just at a few periodic meetings. The remainder of each functional team could implement the detailed steps supporting the concepts and approaches developed by the 'integrated' team for each critical area.

3. Origins of JFCOM's Organization for Empire Challenge

During the research underlying this report, IDA sought to determine the genesis of the structure and approach JFCOM adopted for its EC activities. Of particular interest was which causes were external to JFCOM (and thus beyond their control) and which were internal to JFCOM (and thus likely more amenable to change).

The following were key characteristics of the JFCOM-hosted EC exercises:

- A focus on rapidly finding solutions to in-theater COCOM ISR shortfalls
- Hosting an event open to participation from innovative companies, even if a technology was immature or not part of a Service program of record
- Attempting to address as many of the COCOM ISR shortfalls in one event as possible.

Although these EC characteristics are not inherently bad, the organizational structure and processes adopted by JFCOM did not facilitate these goals. The reasons behind JFCOM's choice of approach appear to have been twofold. First, JFCOM simply might have been expanding from the National Geospatial-Intelligence Agency (NGA)[12] approach, which also focused on finding solutions rapidly and inviting innovative participants. A fundamental difference, however, was that NGA considered a narrow set of geospatial shortfalls vice a wide range of multi-int ISR shortfalls. Second, JFCOM was supporting OUSD(I) as the major sponsor. OUSD(I) interests spanned a broader range of ISR problems than those germane to NGA. Additionally, OUSD(I) likely also was focused on responding to the Joint Rapid Acquisition Cell (JRAC) process, which required a faster acquisition process for critical shortfalls and mandated participation of innovative companies outside of the DoD complex.

The JRAC process started in 2004 when the Deputy Secretary of Defense (DEPSECDEF) directed the implementation of a new acquisition approach, augmenting the Joint Requirements Oversight Council (JROC), especially designed to address critical warfighter shortfalls encountered in active combat environments. Emphasis was to be placed both on speed of resolution (within a few months, but less than two years) and on a broadened range of solutions (including commercial solutions not yet in DoD). Each

[12] Previous lead agency for the EC series of exercises.

Service was directed to develop a process to 'speed up' acquisition of solutions to critical COCOM shortfalls (i.e., IWNs).

In response, each Service and the Joint Staff developed and implemented supporting sets of specific procedures and directives:

- U.S. Navy – Rapid Deployment Capability (RDC)
  - Incorporated into SECNAVINST 5000.2 on overall acquisition system
- U.S. Air Force – Combat Capability Document (CCD)
  - Takes the place of the traditional initial capability document to speed up development in support of an immediate combat need.
- U.S. Army – Rapid Equipping Force (REF)
- U.S. Marine Corps – Urgent Universal Needs Statement (UUNS)
- USSOCOM – JRAC process
- Joint Staff – CJCSI 3470.1

On the joint side, OUSD(I) participated in the JRAC process as the ISR subject matter expert (SME), and DOT&E was given the responsibility for developing a test and evaluation approach to support this rapid acquisition process. As the sponsor of the EC series, OUSD(I) likely encouraged JFCOM to design the event to support the dual JRAC requirements of rapid evaluation and inclusion of leading technologies from outside DoD. This meant that JFCOM had no control over whether to maintain two of the three key EC characteristics noted at the beginning of this chapter (i.e., rapid identification of solutions and inclusion of innovative companies – capabilities – not part of DoD). Further, any approach used or recommended would need to incorporate these characteristics. Although OUSD(I) probably also encouraged the expansion of ISR shortfalls to be addressed from only geospatial to multi-int, they did not necessarily require such a large number of shortfalls to be addressed at one time. That may have been an issue that JFCOM could have controlled.

In addition to the JRAC requirements, OUSD(I) directed that an assessment process be put in place that could provide them with a rigorous and objective evaluation of each capability to support decisions on deployability and future investment. IDA recognized that the current EC strategies entail *rapid* testing of a *large number* of potential ISR solutions (not all of which are currently programs of record) *all at the same time* and is in direct conflict with the way that rigorous OT&E is conducted.

As part of this CRP study, IDA searched for and reviewed existing alternative approaches that support rapid development and testing for customers who need solutions much faster than the normal 3-5 year (and longer) cycles typical in DoD. The challenge is that traditional OT&E and the type of EC-like event that OUSD(I) desired are not

compatible. An emphasis on rapidity and innovation dictates different types of design, testing, and assessment processes. This is the topic of the next chapter.

4. Existing Rapid Acquisition Processes

IDA conducted a literature review search for existing viable approaches within DoD and the commercial world that could support rapid acquisition. One notable find was a recently published paper, authored by the Test and Evaluation Executive for the Defense Information Systems agency (DISA).[13] It outlines a commercial approach called 'agile software development and testing,' discusses its suitability for DoD IT systems, and reports on related findings from studies produced by the Defense Science Board and the National Academy of Sciences.[14,15] A reprint of the paper (the 'DISA paper') appears in Appendix A. Additional references we examined include a number of other publications[16,17,18] as well as various commercial websites[19,20,21,22].

These many sources suggest that 'agile' methods better fit the requirements of the JRAC process and OUSD(I) for the EC event than the approach that JFCOM had adopted. Elaboration follows below. The discussion goes beyond considerations of testing, the principal focus of the DISA paper, to encompass all of the EC limitations previously identified in Chapter 2.

A. Industry IT Approach

The IT industry has been using 'Agile Software Development and Testing' since the 1990s to address the need for rapid software development that could be responsive to changing Customer requirements as development progressed. This approach originated

[13] Hutchison, S. 2010. "Test and Evaluation for Agile Information Technologies," *ITEA Journal* 31 (4): 459-465.

[14] Defense Science Board. 2009. *Department of Defense policies and procedures for the acquisition of information technology*. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf.

[15] National Academies of Sciences. 2010. *Achieving effective acquisition of information technology in the Department of Defense*. Washington, D.C.: The National Academies Press. http://www.nap.edu/catalog.php?record_id512823

[16] Meyer, T. 2008. "Essential Scrum – A Short Introduction to Scrum and Its Underlying Agile Principles," Briefing, Baldwin-Wallace College Professional Development and Cleveland Scrum Alliance.

[17] Northern, C., Mayfield, K., Benito, R., and Casagni, M. 2010. *Handbook for implementing Agile in Department of Defense information technology acquisition*. MITRE Technical Report 100489.

[18] Alberts, D.S. 2011. "Rethinking Test and Evaluation for a New Age," *ITEA Journal* 32 (2): 123-125.

[19] www.agilemethodology.org

[20] www.agiletesting.com/au

[21] www.scrummethodology.org

[22] www.planit.net.au/wp-content/uploads/2011/08/Agile-Why-the-Fear.pdf

in the mid-late 1980s in reaction to the limitations of the traditional, sequential IT development approach emplaced since the 1970s. In the traditional sequential approach, software development was broken up into phases (requirements, architecture and design, code writing, and testing). Each phase had to be finished before the next phase could start. During the development process, there was little to no interaction with the Customer, and frequently, because of the length of the development process, the software delivered was essentially irrelevant at the time of delivery since business requirements had changed during that period. This process did not allow for much, if any, mid-course correction or adjustment to respond to evolving requirements or to refine requirements that had been too general at the beginning.

In the mid-late 1980s two Japanese university professors – Hirotaka Takeuchi and Ikujiro Nonaka – sought a process that would be more flexible to changing requirements. They identified a new product development approach implemented in some manufacturing sectors to 'increase speed and flexibility.' This approach was based on the concept of *one cross-functional team* developing software through *multiple iterations*. Each iteration focused on requirements that had been prioritized and *revised by the Customer at the start of each iteration*. At the end of each iteration, a working version of the software was developed according to the most recent priorities of the Customer. The Customer stayed involved through the entire set of cycles. This process is in many respects the exact opposite of the one used by JFCOM. The latter employed stove-piped functional teams, did not have multiple iterations or even spirals to work out a progressive set of solutions or network integration, and finally, was unable to engage the Customer (the COCOM) within the process.

1. Tenants and Principles

This agile approach comprised a set of practices, specific roles, and a process for rapid and responsive development and testing. Its four basic tenants, articulated in the 'Agile Manifesto' crafted by several leaders in the IT community in 2001, are given in Table 4-1.

Table 4-1.Four Basic Tenants of the 'Agile Manifesto'

1. Individuals and interactions *over* processes and tools
2. Working software *over* comprehensive documentation
3. Customer collaboration *over* contract negotiation
4. Responding to change *over* following a plan

These tenants flowed into 12 principles essential in implementation for IT development. The 12 principles are listed in Table 4-2, accompanied by JFCOM/EC analogies (in parentheses and red font). Many variations of this agile methodology were formulated over the years: Crystal Clear, Extreme Programming, Feature-Driven Development, Dynamic Systems Development Method (DSDM), SCRUM. The most

well known is the SCRUM methodology, whose name is traced to the comparison of the integral processes to a scrum in rugby – one cross-functional (multiple positions) team progressing to final software development through multiple iterations (i.e., scrums).[23]. The remainder of this report focuses only on the SCRUM variant of the agile methodology, which is also the one endorsed within the 'DISA paper.'

Table 4-2. 'Agile Manifesto' Principles for Agile Software Development (with JFCOM/EC analogies)

1. Our highest priority is to satisfy the Customer ***(COCOM and/or Coalition Partners)*** through early and continuous (***rapid iterations***) delivery of valuable software (***ISR solutions***).
2. Welcome changing requirements (***changes to JUONS/IWNs as warfighting environment evolves***), even late in development. Agile processes harness change for the Customer's competitive advantage.
3. Deliver working software ***(ISR capabilities)*** frequently ***(through frequent iterations),*** from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people ***(COCOM and/or Coalition Partner SMEs)*** and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software ***(ISR solutions, even if somewhat immature)*** is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

2. Processes

A simplified depiction of the agile process used by the SCRUM methodology is shown in Figure 4-1. Keep in mind that this process is repeated over and over many times until the final product is developed or a solution is provided. Further, note that, within each of these iterations, development and testing occurs, a working version of some part of the software or an interim solution is developed, and, at the end of the development iteration (Sprint), the Customer reviews that version for usefulness and usability.

[23] http://en.wikipedia.org/wiki/Scrum_(development)

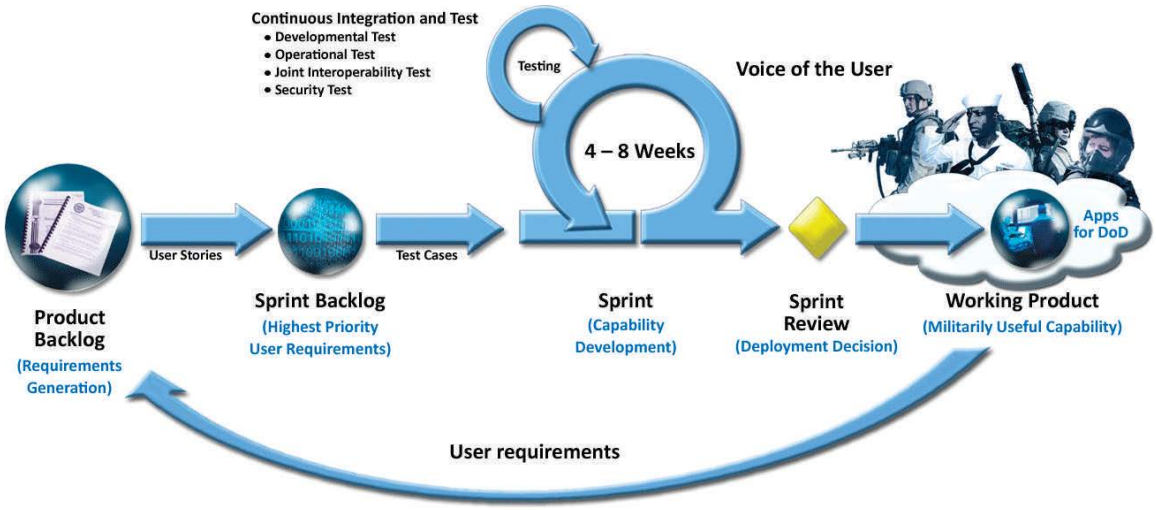


Figure 4-1. Depiction of the SCRUM Methodology[24]

The process starts with the development of the 'Product Backlog,' a list of the Customer's software/product requirements. These *requirements are actually written as 'user stories,'* so that the desired functionality or capability is described in the context of *how it will be employed by the users,* rather than just as a list of bullet-statement requirements lacking operational context. The Product Owner (Customer representative on the development team) puts this list/user stories together in conjunction with the Stakeholder or customer. The user stories are prioritized, so that the development team knows which functions to work on first. For any future EC-like events, this part of the process would be something like a small, focused Joint Warfighter Advisory Group (JWAG) where key Customer SMEs (COCOM and/or coalition partner reps with familiarity with the most critical in-theater ISR shortfalls) would meet with an individual or team from the exercise lead to capture the initial 'user stories.' These 'user stories' would describe the ISR shortfall in detail: how they performed their job, the existing problems in attempting to execute this function, how they would like the situation improved, and so forth. The exercise lead Customer representative would be assigned to represent the Customer(s) during development and would be responsible not only for capturing the initial 'user stories,' but also for coordinating with the Customer on a regular basis. Note that this process identifies the Customers as those groups that will be using the solutions in their combat environment (COCOM and coalition partners), not the developers (known in previous ECs as initiatives or capabilities) providing the solutions. The commercial vendor selected to respond to the Customer requirements would actually be part of the development team and not a Customer per se. Unfortunately, in previous ECs it appeared that both the COCOM and the capabilities were Customers in their own right, as evidenced by the use of 'external' assessment teams that unilaterally evaluated

[24] From: Hutchison, S. 2010. "Test and Evaluation for Agile Information Technologies," *ITEA Journal* 31 (4): 459-465.

whatever the capability was hoping to accomplish. While the JFCOM Assessment Team endeavored to connect the capability requirements to COCOM shortfalls, sometimes the linkage was tenuous.

Additionally, allowing only the COCOM and coalition partners to be the Customer(s) ensures that the 'user stories' are operationally focused and are taken from the perspective of an in-theater military member experiencing the ISR shortfall. In the past, some capabilities with little experience in the particular shortfall they aimed to solve attempted to provide 'user stories' or their CONOPs, but the products they provided were simply vague descriptions of possible problems or guesses at the intended CONOPs. At this point, there is a difference between the standard agile process and the JFCOM situation. In the commercial world, the developer already is selected and is just now attempting to get enough detail to start software development. On the other hand, JFCOM and the Customer(s) may have captured the key elements of the ISR shortfalls, but they have not yet selected the developers.

Selection of developers would almost be like selecting the functional SMEs for a development team. For example, imagine that one of the Customer requirements was that the software be web-based and another that it also be able to import data from particular Customer databases and export it to either headquarters or other labs for evaluation. Then the development team would include a SME on web-based software and another SME familiar with the database structure of the Customer and intended recipients. For the lead organization and the Customers, this would mean that the selection of their 'development team' would start with the 'Request for Proposal' (RFP) or Broad Agency Announcement (BAA). In reviewing the proposals returned in response to the RFP or BAA, the lead organization and the Customer would select only those developers that appeared to have either the expertise desired or a unique solution proposed for the ISR shortfalls described. The Customer(s) would be a critical part of the vetting and selection process, and the capabilities selected would need to know that they will be assessed during every iteration as to whether they are progressing toward the needed solution for the Customer. There would no longer be the 'external assessments' used by capabilities to determine whether they were happy with their own enhancements. The only assessment of import would be that of the Customer as to whether, at the end of each iteration, a selected capability was providing or getting close to attaining a useful and suitable solution to those specific ISR shortfalls identified.

The next phase is the development phase or the 'Sprint.' This is one of the unique aspects of the SCRUM approach to the Agile Methodology – the use of a succinct, and time-limited, development iteration normally between two and four weeks long. In preparation for a 'Sprint' in a development iteration, a subset of the Product Backlog (Customer requirements) is selected for focus. This is called a 'Sprint Backlog.' During the Sprint, code is developed by a small development team (usually six or seven people)

in order to provide a working version of the software at the end of the Sprint. This version focuses on the subset of the Customer requirements selected as the Sprint Backlog.

For the EC/ER setting, this portion of the process would correspond to a 'working spiral' and the overall approach would be a progression of 'working spirals.' These could be developed in different ways. If one ISR shortfall is selected and a limited number of capabilities participate, they could select elements of the shortfall to work on in separate iterations or focus on progressive integration of several capabilities. If a larger scale is desired, initial working spirals could focus on individual functional elements of the operational environment, and progress to a larger operational, exercise-like event. For instance, in this case, one working spiral might be integration of U.S. and coalition common operating pictures (COPs), followed by a few others to either work integration problems or to practice operational exchange, display, and use of COP data. A second series of working spirals might be integration and sharing of full-motion video (FMV), progressing to the practice of using the shared video in limited operational scenarios such as tracking or targeting. Eventually, if a full-blown operational in-theater exercise event is desired, then these functional working spirals would have to come together in a few operational exercise spirals. With this kind of approach, intermediate solutions to specific ISR shortfalls can be found and deployed even before conducting a full-blown operational exercise event. One requirement, however, when conducting these working spirals is that the development team use a true representation of the Customer's environment to include network architecture, processes, and users familiar with the current processes and technologies.

At the end of this short development cycle, the Customer user reviews and employs the software providing feedback on the usefulness (ability to meet their IT need) and usability – called the 'Sprint Review.' It is at this point that the Customer can reprioritize his requirements or change the direction entirely based on his experience using the new software, or as a result of a change in the external environment (change in business practices or change in the warfighting environment) that may necessitate a different direction. This Customer feedback and reprioritization, in conjunction with the development team's determination of feasibility, form the next Sprint Backlog list for work by the development team in the next iteration. It is this frequent user involvement, feedback, and refinement of requirements throughout the development cycle that makes the agile process, and the SCRUM methodology in particular, so flexible and responsive, ensuring that the solution delivered at the end is exactly what the Customer ordered.

For EC/ER, this portion of the process would entail bringing in the COCOM personnel to use and comment on what had been identified or developed as a solution. The demonstration(s) should be conducted in an environment that closely resembles that used in the COCOM's theater and used by COCOM personnel familiar with the in-

theater ISR shortfall. This way they can see whether the 'developing solution' will work in-theater and the experienced users can validate (or not) whether the process is headed in the right direction towards finding an acceptable solution. The development team would then take any COCOM user comments, recommendations, or new requirements on the identified solutions, and incorporate those changes (if feasible) in the next development 'Sprint.' Before finalizing this list, however, the development team would discuss prioritization of recommendations so that if time and funds are limited, they know where to place the emphasis for the next development 'Sprint.'

This iterative process repeats several times until a final set of software is developed or, in the EC/ER case, an acceptable ISR solution is achieved. Full Customer participation in all aspects of this 'Sprint' process ensures that even interim solutions are vetted by the Customer, resulting in a relevant solution for the COCOM.

B. Simplified DoD Version (used in the late 1980s)

In the late 1980s, the Joint National Intelligence Development Staff (JNIDS) at the Office of Naval Intelligence (ONI) implemented a version of agile processes.[25] Their approach addressed a limited number of very specific and focused intelligence analysis shortfalls identified by COCOMs and rapidly provided leading edge software/hardware solutions. The remainder of this chapter describes the JNIDS approach, compares it to the SCRUM methodology, and illustrates potential applications to future event planning and execution of EC follow-ons.

1. Description of the JNIDS Process

The JNIDS process started with the COCOMs submitting specific intelligence analysis problems that required sophisticated technical solutions, ones that were usually beyond the capability of the current programs of record to address rapidly. In effect, JNIDS was acting as a conduit to the most innovative and leading edge technologies available. One to two COCOM shortfalls were selected a year. Normally, there were three to four small teams each working a separate COCOM shortfall area. The development and iterative process for each COCOM shortfall project normally lasted between two and three years, with each iteration within the COCOM project lasting approximately three months.

Once a specific COCOM shortfall was selected from detailed submissions provided by the COCOMs, a JNIDS team (a Functional Lead and a Technical Lead) was assigned and a COCOM user was selected. The COCOM user would interact with the JNIDS team and developers during the entire course of the project to ensure the product

[25] The primary author participated directly in these activities.

delivered was what the COCOM needed. An RFP then was issued, describing the analytical problem to be solved and asking for leading edge solutions. After vendor submission of their proposals, the small JNIDS team and the COCOM user travelled to each vendor to gain a better understanding of their proposed approach. After the in-person visits, the JNIDS team and the COCOM user selected the individual vendors – usually comprising a small group of vendors, typically two or three, with each one handling a different portion of the analytical problem.

The JNIDS development process that followed closely resembles that of the agile development process with its emphasis on short prototype development iterations, much like the 'Sprints' described in the SCRUM methodology. These development iterations were three months long and culminated in a week-long software review session at the user site. During this review, the COCOM analyst assigned to the project employed all elements of the software developed up to that time and provided his/her input and feedback on the usefulness and usability of what had been developed so far (similar to the 'Sprint Review'). This software review session also provided the user the opportunity to further clarify his requirements and potentially make changes in requirements. As the analyst utilized the software, frequently he was better able to articulate how he performed his analysis and how he used the software, providing more detail for the vendor. This ability to have frequent and immediate user feedback during development, vice at the end, is a critical piece of the agile methodology.

All of the vendor developers participated in the one-week session and were involved intimately in the user testing and comment sessions. Where possible, the vendors recoded and made changes immediately. When a solution would entail more extensive work, the user comments and needs were noted and they formed the list of initial changes (Sprint Backlog) the vendor had to focus on once he returned home. Additionally, the COCOM user could provide more guidance on the priority of the initial requirements for inclusion in the next iteration.

This iterative, three-month cycle continued for approximately two to three years. Upon completion, the final product, fully vetted by the COCOM user, was provided to the COCOM and integrated into their network.

2. Characteristics of the JNIDS Process

The JNIDS process was very focused on a specific problem outlined by the Customer. Involvement of an actual COCOM analyst experienced with the problem set being addressed ensured that specifics of the ISR shortfall were retained and not lost (as sometimes happens when requirements become consolidated up the chain of command and are then handled by a disassociated Requirements Working Group).

The JNIDS process was extremely responsive to COCOM needs and changes. Multiple short iterations that included the COCOM user's review and input provided frequent opportunities for the COCOM to make mid-course corrections and enabled the vendors to focus on the right priorities. The culmination was a product that was truly relevant to the COCOM's shortfall.

The use of a cross-functional team (functional and technical leads from JNIDS, a COCOM analyst representative, and developers) was a critical part of the JNIDS approach. It made sure everyone was focused on the same analytical shortfall and accomplishment of a common set of tasks.

One of the main differences between the JNIDS process and the SCRUM methodology, and one of the difficulties JNIDS repeatedly encountered, concerned follow-on funding to support new, innovative hardware and software developed for each COCOM. In the agile development process, the customer is paying for the development and establishes funding to provide life-cycle maintenance of newly purchased software. Within DoD, however, most of the IT was funded either by a Service or by an Intelligence Agency (e.g., the Defense Intelligence Agency (DIA)). If this new hardware and software did not fit into the Service or Agency budget plan, it became difficult to sustain the new systems.

C. Roles in SCRUM and JNIDS Methodologies

There are specific roles in the agile methodology. The following paragraphs outline the agile/SCRUM methodology roles and compare those to the roles used in the DoD process implemented by JNIDS.

The roles in the SCRUM methodology include:

- Scrum Master – Ensures that the SCRUM process is used as intended, much like a Parliamentarian in a club, checking to see that activities do not revert back into the traditional ways of undertaking software development. He can be considered to be like a Project Manager, but his priority is on facilitation and making sure that obstacles to the process are removed.
- Product Owner – Is either the Customer or someone closely connected to the Customer that can reliably speak for the Customer in identifying priority requirements and assessing whether software (or a product) meets the Customer's requirements.
- Team – Cross-functional group of 5 to 9 people who are responsible for the actual development and testing of the software.
- Stakeholders – Customer, or one whose requirements are being met in the development of the software. They are involved in the process during Sprint

reviews. Otherwise, the Product Owner represents them on a daily basis. That is why it is critical that there be a very close relationship between the Stakeholder and the Product Owner.

The roles in the JNIDS methodology include:

- There were very small teams each assigned a specific intelligence analysis shortfall problem.
- Within each team, there was a Functional Lead (much like the Product Owner) who had intelligence experience and expertise and could functionally understand the COCOM's analytical shortfall. He was responsible for frequent interaction with the COCOM's designated analyst (the Stakeholder).
- This dedicated analyst (Stakeholder) was part of the COCOM's staff and was familiar with the particular intelligence analysis problem needing resolution. He was assigned to work with the JNIDS team and developers during periodic development reviews (or Sprint Reviews) to ensure the software being developed was functionally what was needed to fix the analytical shortfall. An additional requirement was that this individual had at least two, and possibly three, years remaining on the COCOM staff to ensure personnel continuity in requirements and assessment of usefulness. The commitment by the COCOM of this dedicated analyst was critical to the success of the project and to ensuring that the final product was what the Customer wanted.
- There was a JNIDS Technical Lead (probably similar to a technical expert on the development team in the SCRUM methodology) who had in-depth technical knowledge and was able to identify realistic leading edge technical solutions for the COCOM's problem
- Vendors/developers (The Development Team) – This was a small group of normally two or three vendors that had been selected for their ability to address and solve the COCOM's analytical shortfall in an innovative and leading edge way. These individual companies were selected after a formal review of vendor submissions to the initial RFP describing the COCOM's analytical shortfall. Emphasis was placed on selecting companies with a leading edge or innovative approach – in order to make unique solutions available quickly to the COCOM to solve the intelligence analysis problem, and hoping to provide a leap forward in analytical capability vice just incremental improvements using traditional, program of record enhancements.

D. Differences Between Methodologies

There are a number of differences between the commercial used Agile (SCRUM) methodology, the JNIDS approach, and the processes used by JFCOM in the EC context:

- Both the Agile and JNIDS methodologies focused on developing a solution to a very specific shortfall, vice JFCOM's attempt to conduct a large-scale event that fluctuated between an exercise-like event, a science fair demonstration, and a technical OT&E event.
- Both the Agile and JNIDS methodologies used an iterative development process. JFCOM, in contrast, did not conduct any progressive iterations (or Sprints), but focused on one large final event at the end of an annual planning period.
- Both the Agile and JNIDS methodologies were able to obtain continuous Customer involvement to ensure that the solutions developed were consistently vetted by the Customer.
- Both the Agile and JNIDS methodologies used the Customer's/COCOM's actual environments and analysts for software testing and review following any development iteration. JFCOM attempted to build an entire representation of an existing environment, but experienced limitations because of limited funds and the fact that they were not a 'combat' environment. JFCOM also sought experienced military users, but had limited success. They generally had to rely on reservists, vice analysts/ISR users from the COCOM.
- Both the Agile and JNIDS methodologies used small, integrated functional teams while JFCOM had a legion of personnel handling the event. This was probably because they were building and simulating an entire in-theater environment and attempting to execute an exercise-level event.

Additional differences exist in the testing and assessment environments. In both the agile and the JNIDS processes, the 'testing' portion occurs continuously during the Sprint (development iteration) and the Sprint Review (software/solution demo, Customer use and comment on software, and/or solutions). Technical and performance assessments usually are done during the Sprint. Additionally, operational testing is conducted during the Sprint as well, employing dedicated users with some experience in the functional area being addressed. The final input on user (warfighter) utility, however, does not occur until the Sprint Review during which the Product Owner and Stakeholder (Customer) receive a demo, use the software/ISR solution if desired, and provide final input on suitability and any changes to be made to that iteration's development.

In contrast, the JFCOM Assessment Team only had one chance at an assessment, since no development iterations (Sprints/Sprint Reviews) were conducted. The JFCOM

assessments were based on 'a moment in time,' with no ability to assess at later instances as improvements were made. If they had used a Sprint-based iteration approach, they would have had that opportunity. Additionally, in the EC exercises there was no Customer involvement from the COCOM, only the coalition members. Lacking was the key element of continuous Customer inputs on the developing solutions during a Sprint Review-like period to ensure that the final product would be relevant to the Customer. Despite the best efforts of the JFCOM Assessment Team to provide users with some experience in the ISR shortfall being assessed, the lack of a dedicated experienced COCOM individual hurt the credibility of the assessment.

The 'DISA paper' on the agile process (found in Appendix A) recommended changes to the OT&E process that would include combining all elements of the OT&E community into one integrated testing team. The consolidation of the Development Team (DT), Operational Team (OT), Information Assurance (IA) testers, and Joint Interoperability testers would reduce duplication and provide more comprehensive findings at a faster pace. In this area, JFCOM appears to have been ahead of the rest of the community, because they did structure their Assessment Team accordingly. Their four elements included:

- Warfighter Utility (OT)
- Technical Assessment (limited aspects of DT)
- Joint Interoperability (as it applied to DCGS)
- IA.

Additionally, in concert with the agile process, the 'DISA paper' recommended forming dedicated user cadres specializing in different functional areas to be developed or solved. These groups would use the software/ISR solution and provide inputs during the operational testing conducted in the Sprint period. This is very similar to the concept IDA endorsed following EC10, recommending that JFCOM attempt to 'control variables' related to 'users' by establishing a dedicated and full-time group of experienced ISR users familiar with multiple systems employed in functional areas and aware of the COCOM's in-theater shortfalls.

JFCOM attempted to accomplish this by recruiting reservists as users, but their success was limited. Not all reservists had the requisite experience in the functional area to be assessed, so the inputs devolved into 'usability' assessments rather than warfighter utility/suitability assessments. Additionally, there was no continuity in the user participants. Most had not been previously involved with EC events and were not necessarily familiar with how to use some of the systems involved in the functional area being assessed. This meant that they lacked the ability to compare qualitatively a new or enhanced capability with that currently used in-theater.

The goal is to ensure that user inputs for the operational testing portion are credible and provide adequate direction to the development team, facilitating their achievement of an ISR solution that approaches or fully achieves the Stakeholders intent. To this end, it is critical that a dedicated team of experienced users familiar with COCOM ISR functionality and shortfalls be employed during the Sprint portion of this process.

Finally, the processes that embody the agile, 'DISA paper,' and JNIDS methodologies all mandate a Customer review of what had been developed. While the Product Owner (Customer representative) and the Stakeholder (Customer) are not involved in the actual Sprint (development and testing period), they are critical to the Sprint Review during which the development team demonstrates the solution, allows the Customer to use the solution, and solicits final Customer comments, inputs, and recommendations on changes. The Customer feedback on the relevance of the developing solution is the ultimate 'test' determining the relevance and utility of the evolving solution.

5. Recommendations for Applying Agile Processes to Future EC-Like Exercises

A. Decision on Purpose of Event

In the commercial application of the agile development methodology, in the JNIDS approach, and in all of the approaches described in the 'DISA paper' (see Appendix A) a specific problem set, defined by a particular user, is being addressed. Conversely, JFCOM's approach had been to establish a venue that tries to satisfy too many different Customers (multiple ISR shortfalls from a COCOM, Coalition Partners looking for a final training site for deploying military, and vendors looking for a way to showcase a new capability). The very first priority for a new EC/ER lead organization must be to decide what kind of venue they are going to support. In order to provide true value to a Customer such as a COCOM or Coalition Partner, the COCOM/Coalition Partner must see this event as his own – a place/environment that addresses a select number of his critical issues, not an entire replication of every ISR shortfall in-theater. The next generation of EC/ER events should:

- Focus on solving specific COCOM/Coalition shortfalls
- Not be a demonstration event
- Not be an exercise event.

Additionally, the Customers are the COCOM and coalition members, not the vendors bringing their technologies and their proposed solutions. Although both the COCOM and coalition members probably experience many of the same shortfalls in-theater, during previous EC events their goals were not always the same. In order to ensure coalition members and the COCOM see value and support participation, the EC/ER event would need to be tailored to incorporate both of their sets of issues. The event could be designed so that the invitation highlighted the COCOM JUONs/IWNs to be addressed, while encouraging the participation of coalition members who shared the same issues. Another way to construct such an event would be to host a JWAG prior to event design and before event invitation, including coalition members and COCOM representatives, and aiming at achieving concurrence on the specific ISR shortfalls to be addressed in the event.

In order to make future events capable of providing a tested and vetted solution within an environment that the COCOM recognizes to be valuable, the number and types of vendors participating likely would need to be far less than in the past. In both the agile

and JNIDS methodology, only a small number of vendors participate in the iterations and the focus in each is a small set of prescribed shortfalls. One potential advantage of having a narrow focus is that the participants might be more leading edge and innovative.

An example of a way to construct the iterative events follows. It focuses on the central theme of COP integration. The first iterations might emphasize technical integration issues introducing 'bleeding edge' companies for which current DoD solutions are not available to achieve the requisite integration. Later iterations would then focus on the operational exchange and use of the COP data in a 'vignette' type of event. Both the COCOM and coalition members should be included as full participants in identifying the exact ISR problem sets to be addressed – in the technical integration and in the operational events.

B. Obtain 'Buy-in' from Customers (COCOM, Coalition Members)

The second priority would be to secure active participation from the Customer (COCOM and coalition members). JFCOM attempted to form a relationship with the COCOM, but was unable to obtain their direct involvement. To identify ISR shortfalls for inclusion in EC, JFCOM received guidance on high priority items from staff of OUSD(I) and reviewed COCOM submitted JUONS. JFCOM could not, however, obtain directly from the COCOM much feedback on whether exercise planning was proceeding along the right track. Likewise, JFCOM could not secure any commitment from the COCOM to provide COCOM staff to participate in any aspect of the event. This precluded the inclusion of a validating authority for capability selection and warfighter utility assessment. Since the Customer, the warfighting COCOM or coalition partner, may be busy conducting operations, it can be difficult to obtain a robust personnel commitment from their ranks. Nonetheless, even with the warfighting commitments, a COCOM's/coalition partner's continuous involvement is necessary to arrive at ISR solutions that are operationally relevant and acceptable.

C. Establishment of a Cross-Functional Team

The composition of the cross-functional team supporting future EC/ER events should include:

- Product Owner (Functional Lead) – Someone with recent experience in the ISR shortfall to be addressed, and someone who can form a close relationship with the Customer (COCOM)
- Stakeholder(s) – A small group, perhaps slightly larger than described in the agile methodology and the JNIDS process discussions, comprising a COCOM ISR shortfall representative and coalition partner representatives who have some

part in the ISR shortfall(s) identified by the COCOM. These representatives would function as follows:

  - Assignment to Task – COCOM and coalition staff members assigned to work this project (at least part-time) for the duration of planning and executing the multiple iterations needed to develop a solution for the given ISR shortfall.
  - Background – Experience in the ISR shortfall area.
  - Location and Communication – Even if they remained at the COCOM and coalition partners' sites, they would be in constant communication with the EC/ER Product Owner.
  - Roles – Stakeholders key in helping the Product Owner develop the user 'stories,' selecting the vendors most likely to possess a solution to the ISR shortfall, and participating in the Sprint reviews. The reviews would entail receiving demonstrations of and using any of the capabilities or hardware/software determined to be a solution.

- The Team – The Development Team comprising a combination of vendors selected to solve the ISR shortfall and dedicated representatives from the EC/ER organizational lead responsible for the architecture, testing, and assessment.

D. Initial Identification of the ISR Shortfall(s) to be Addressed and Desired Outcomes

Once the specific ISR shortfall(s) has (have) been selected, then details are required in order to clarify the particular kinds of solutions needed and to develop assessment criteria with the Customer users. This detailed clarification of the shortfall and the desired outcomes is the beginning of the development of the Product Backlog. Essential steps include:

- Elicitation of 'user stories' – user descriptions of what they do, how they do it, and how it supports a particular ISR or operational mission
- Preparation by the Product Owner on the EC/ER lead team in conjunction with the Stakeholder or COCOM/Coalition Partner representative/user
- Formalized articulation. Illustrative examples include the following kinds of statements:
  - "I perform the following ISR function (_____) in the following way currently (_____), but am having problems with the following (_____)." "I would like to be able to do/accomplish the following

(_____) in order to support the following ISR/Operational mission."

- "I currently monitor the movement of suspicious vehicles or persons along a road using video cameras mounted on masts, aerostats and Unmanned Aerial Vehicles (UAVs) in order to track potential threats to coalition forces for either identification of weapons caches or safe houses. However, I cannot currently share the video directly with other coalition partners nearby. This results in time delays and confusion in passing along locational and identifying information to a nearby coalition partner that may either be at risk or could assist in tracking. I would like to be able to share, in real-time, my video, from any of my 3 to 4 sensor systems with nearby coalition partners in order to improve timeliness and accuracy of identification, tracking and, if need be, destruction of the moving enemy force."

E. Selection of Vendor Participants

Key elements of the vendor selection process include:

- BAA or RFP should describe the specific subject ISR shortfall(s)
- Responses from vendors should include not only a white paper and quad chart, but an actual presentation to the cross-functional team (including the most critical participant – the Stakeholder) of their proposal to address/solve the identified shortfall
- Cross-functional team reviews proposals and selects the vendors with the most likely solutions
- Selected vendors then become a part of the EC/ER cross-functional team

F. Iteration Process

The iteration process consists of developing the Sprint Backlog (those elements to be worked during the Sprint), the actual development process (the Sprint itself), and a review with the Customer of the software developed or ISR solutions worked (the Sprint Review).

- Sprint Backlog
  - The original Product Backlog is developed earlier between the Product Owner (Customer rep on the JFCOM team) and the Stakeholder (Customer). The next step in preparing for the first Sprint or iteration is to develop the Sprint Backlog.

- The Sprint Backlog is compiled by the Development Team (defined in the next bullet) who take the larger Product Backlog and determine which high priority items reasonably can be addressed during the upcoming Sprint. That smaller list comprises the Sprint Backlog.

- "The (Development) Team," comprising participating vendors attempting to provide the ISR solutions, EC/ER lead team architects, and EC/ER lead team assessors (all four components of testers – DT, OT, Joint Interoperability, IA), take the 'user stories' from the Product Backlog and begin to decompose these stories into tasks, and then into test cases.

- The assumption at this point is that the Customer (COCOM/coalition partners) has provided all that is needed initially regarding the description of the ISR shortfall to be addressed and a detailed description through 'user stories' of the operational CONOPs currently used and desired. Therefore, neither the Product Owner (Customer representative) nor the Stakeholder (Customer) participate in the development of the Sprint Backlog or the upcoming Sprint iteration.
  - Initially involve, as needed, the Product Owner who helped build and understands the user stories (but not the Customer himself) in the decomposition of the user stories into actual tasks – especially if these are first functional tasks.[26] Once the *functional* sub-tasks are understood, then 'The (Development) Team (without the Product Owner) can begin to characterize these functional tasks into types of technical development or technical solution tasks.
  - The Product Owner likely would need to be involved in the development of the functional portion of the tests. They, along with the Stakeholder, would know best what kind of result would functionally define success.

- Executing the Sprint iteration
  - The Sprint is one of several time-phased development or working cycles. In the commercial world, it may last just a few weeks or a few months. For EC/ER events, the length of these Sprints could depend on what was being worked.
  - Unlike traditional software development, EC/ER efforts may need to concentrate more on integrating disparate systems to enhance overall operational functionality. For instance, the focus of several Sprints might be the integration and operational use of information from various

[26] This is contrary to the recommendation made in the 'DISA paper' that did not involve the Product Owner at this point.

coalition/U.S. COPs. Some alternative ways to design these Sprints from the EC/ER perspective were provided previously (in the Chapter 4 descriptions of the Sprint process within the agile methodology).

  - The participants for the Sprints would be the same as for the compilation of the Sprint Backlog: the Development Team, dedicated/experienced users, and the testing team.
  - During a Sprint for EC/ER, the testing of the integration (both technical and operational) would in the initial stages provide information to the Development Team on changes that need to be made to improve integration, performance, and operational use. It would not initially be employed as a grade for 'pass or fail.' That approach would completely hinder the rapid development and integration taking place in the Sprint.

- Conducting the Sprint Review
  - Once the Sprint is over and the Sprint Backlog has been worked, a Sprint Review is scheduled to review with the Customer (Stakeholder – COCOM/coalition partners) the development, integration, or solutions that have been accomplished to date during the Sprint. This is not a one-time review of a final solution, but rather is a review of what has been developed so far. During the review, the Customer could receive a full-blown demo with users who have worked during the Sprint, or the Customer could have his own users participate and try out the developed solutions. This part of the agile process gives the Customer the opportunity to provide input and course corrections on development and solutions accomplished up to now. It ensures that the process will not get too far afield from what the Customer wants.
  - The Customer inputs and course corrections are then folded back into the Product Backlog for further work in later Sprints.

Appendix A. Reprint: "Test and Evaluation for Agile Information Technologies"

Invited Article

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Test and Evaluation for Agile Information Technologies

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Section 804 of the FY2010 National Defense Authorization Act directed the secretary of defense to develop and implement a new acquisition process for information technology (IT) systems. The law requires the Department of Defense (DoD) to base the new acquisition process on recommendations of the March 2009 Defense Science Board (DSB) Report on DoD Policies and Procedures for the Acquisition of Information Technology. The DSB recommended an agile model for acquiring IT similar to successful commercial practices. Agile software development is a high optempo process that delivers working software at "speed of need." It is highly collaborative, documentation light, and change resilient. Agile focuses short development iterations on priority needs of the customer; in the DoD, the customer is the warfighter. In this model, an iteration is typically 8 weeks or less in duration. This article proposes a means to adopt the DoD IT test, evaluation, and certification (TE&C) process to an Agile model that will ensure TE&C continues to be an enabler of rapid acquisition of enhanced IT for the warfighter.

"Agile Information Technologies"—what does that mean? Agile (with a capital "A") refers to a software development practice that follows the principles of the Agile Manifesto, of course. At this point, everyone with a smart phone should launch the browser and try that slick voice-command feature and check out what comes up. With a little luck, you'll find yourself at agilemanifesto.org. Looking down at the fine print at the page bottom, you'll notice that Agile is not a new idea—at least not new to industry; signed back in 2001, the principles of the Manifesto have been shaping software development for nearly 10 years. If that were only true of software development in the Department of Defense (DoD), I probably wouldn't be writing this article! By the way, there's a good chance that the apps you so readily find to enhance the capabilities of your smart phone were developed using Agile processes; I say that only because if they were developed using more traditional "waterfall" processes, they might not have been there for you to download when you needed them.

Steven J. Hutchison, Ph.D.

And that's the point, right—the capability is there when you need it. In this author's opinion, Agile is about delivery of capability at "speed of need." Agile focuses short development iterations on the *priority needs* of the customer. For those of us in the DoD acquisition arena, the customer is the warfighter, and there should be no doubt that our objective must be rapid fielding of enhanced capabilities to the warfighter. Hence, Agile would seem to be a "no-brainer" for the new DoD information technology (IT) acquisition process.

What *new* DoD IT acquisition process? By the time this article is published, it will have been over a year since the Congress directed the DoD to develop a new acquisition system for IT. The National Defense Authorization Act for FY2010, Section 804, directed the secretary of defense to implement a new acquisition process for IT and report back to Congress in 270 days (which would have been July 2010) with the Department's plans to implement the new process. Section 804 had some remarkably specific language, citing Chapter 6 of the Defense Science Board Report on Acquisition of IT (DSB-IT) (Defense Science Board 2009), published in March of 09, as the model to follow.

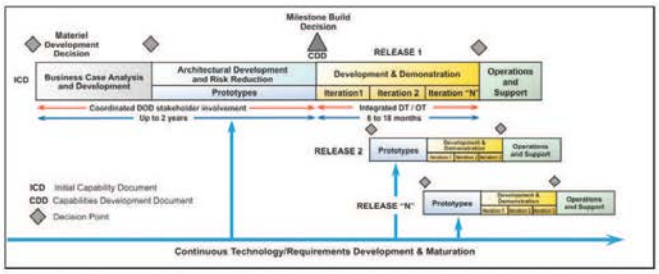

Figure 1. New acquisition process for information technology (Defense Science Board 2009).

So what did the Defense Science Board have to say? The DSB-IT concluded that current acquisition policies and processes (as defined in the DoD 5000 series directive and instruction) "cannot keep pace with the speed at which new capabilities are being introduced in today's information age—and the speed with which potential adversaries can procure, adapt, and employ those same capabilities against the United States" (Defense Science Board 2009). As we marvel at the pace at which new electronic gadgetry shows up in stores, in our cars, and even in our living rooms, it is clear that technological advancements are far more readily available in the commercial sector than in the DoD. Let's face it, if we could push blue force tracking data to the iPhone®, there would already be "an app for that™," and our digital generation soldiers, sailors, airmen, and marines would be using it on the battlefield right now. The DoD *can* improve agility in delivery of IT products. To that end, the DSB-IT recommended a new IT acquisition process that "… is agile, geared to delivering meaningful increments of capability in approximately 18 months or less, and leverages the advantages of modern IT practices" (Defense Science Board 2009). *Figure 1* depicts the DSB-IT model.

The DSB-IT model features are as follows:

- multiple, rapidly executed releases of capability,
- early and continual involvement of the user, and
- integrated testing.

These are all good and necessary features of an IT acquisition system and are at the core of Agile processes. But change is never easy in the DoD, so before we jump in with both feet and say "let's do Agile," we should first take measure of the potential obstacles, so we can successfully overcome them on the road to Agile IT.

Rapidly executed releases of capability are the objective. We hear a lot about rapid acquisition these days; in fact, the wars have been the source of greatest pressure to speed the process, since nothing can get to troops in harm's way fast enough. Our acquisition system today is characterized by cumbersome processes beginning with lengthy, over-specified requirements, which require lengthy, complex development efforts, followed by long, complex test events. We can't just substitute "rapidly executed releases" into the middle of this sequence and expect to have fixed the problem. To achieve rapid releases, we must have a requirements process that acknowledges and fosters evolving user priorities, and an equally agile test process. In other words, we can't focus only on the middle; we have to fix the whole process, end-to-end. Rapidly executed releases must have an underpinning in an agile requirements process; likewise, evolving requirements (read "user priorities") will demand more from our testers than we are currently structured to support. For IT capabilities, getting to Agile will stress the existing testing processes; in fact, the current approach will not work in the Agile IT environment. More on that later.

Early and continual involvement of the user is essential. However, this can be problematic for a Department at war—we simply may not be able to routinely task operating forces to support testing. We are going to have to be imaginative in how we conduct testing; leveraging exercises, experiments, and other venues. We will have to find ways to overcome the tension between testing and training to ensure mutual achievement of objectives. For Agile IT, we will need a user base (beta testers) from each IT community of interest that we can routinely draw from to conduct testing. With a sufficiently large pool of users to draw from, and leveraging other nontraditional test venues, including virtual testbeds, we should be able to overcome the challenges of high optempo deployments and test support.

Integrated testing has been a topic of discussion for decades. Some argue that we've been doing integrated

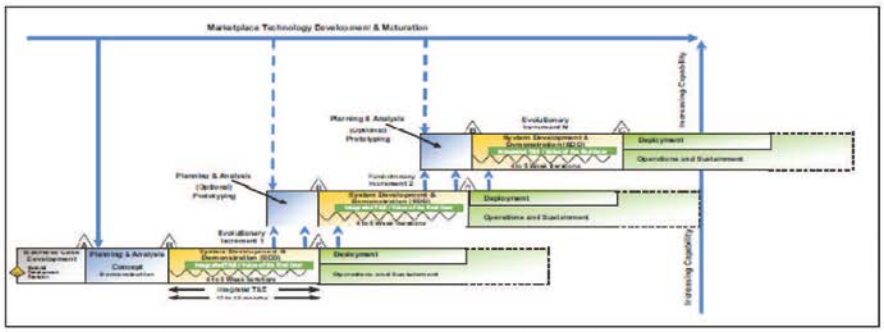

Figure 2. Information technology acquisition management approach (National Academies of Sciences 2010).

T&E all along, others that we need to start doing it. Unfortunately, we have not defined what integrated testing means for IT capabilities. In early 2008, the DoD defined "integrated testing" as, essentially, collaboration between the developmental test (DT) and operational test (OT) communities (https://acc.dau.mil/CommunityBrowser.aspx?id=215765). For IT, that's only half the testers needed; integrated testing of IT involves not only DT and OT but also must include joint interoperability testing and security testing (information assurance). But why do we place all this emphasis on integrated testing? The motivation behind integrated testing is "early involvement" *of the OT community*; as the perception is that the OT folks begin T&E planning late in the process, so developers don't understand how their product is going to be tested once OT starts, and this often results in late discovery of key failure modes, causing further cost and schedule delay. Early involvement is the key to reversing this trend; hence, the mandate for "integrated testing." Integrated testing is really about *testing the capability as it is intended to be used*, and the sooner this starts, the better. In Agile software development, understanding how the capability will be used and tested is the motivation behind the practice known as "test driven development" (Beck 2002). For the DoD to adopt this approach, all of the test, evaluation, and certification (TE&C) organizations (DT, OT, interoperability, and security) will have to bring their needs to the table and make every test event a shared resource. There are, however, strong cultural barriers to this in the DoD, and it is clearly one of the obstacles we must remove to be successful at Agile.

The National Academies study

The DSB wasn't the only group looking at acquisition of IT. DISA sponsored a study by the National Academies of Sciences who released their final report in June 2010 (National Academies of Sciences 2010). *Figure 2* is the study committee's version of an acquisition management approach for IT. The study committee refers to the overarching process as "iterative, incremental development," and their model is generally consistent with the DSB-IT, including the three central points just reviewed: rapid release of capability, continuous user involvement, and integrated T&E. Yet there are also some notable differences. *Figure 3* shows the central part of this model in detail. Notice the green banner "integrated T&E/Voice of the End User." The committee is making an important distinction between integrated testing (as described in the DSB-IT report) and integrating testers and users; that is, it is not enough to know that the system meets requirements, it is equally important to know whether the user thinks the iteration delivers militarily useful capability. Another distinguishing feature of the model is the "sine wave" with the words "4 to 8 Week Iterations" written beneath. Each peak-to-peak transit of the wave represents a complete software development iteration, or "sprint." These sprints are obviously considerably shorter than the DSB-IT's nominal 6-month iterations, and a lot closer to commercial Agile practices. *Figure 4* shows the details of the wave, and as described in the report, "Each iteration will include analysis, design, development, integration, and testing to produce a progressively more defined and capable,

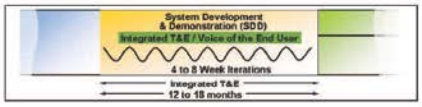

Figure 3. Capability increment in detail (National Academies of Sciences 2010).

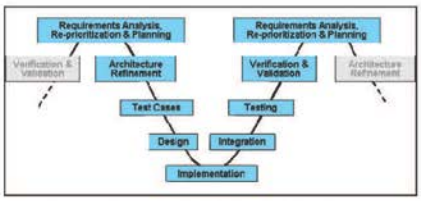

Figure 4. Key elements of the iteration (National Academies of Sciences 2010).

fully integrated and tested product" (National Academies of Sciences 2010). The wave is obviously very similar to what we know as the systems engineering "V," but with several key differences. As we begin following the process down the left-hand side of the V, the iteration begins with requirements analysis and architecture refinement—the latter being an essential consideration for IT. This model then inserts "Test Cases." Note its placement on the left-hand side of the V, before design and coding begins. Here testers translate "user stories" (a description of how the capability is used) into executable test cases. This is "test driven development" and is by definition "early involvement" when *all* testing stakeholders participate in writing the test cases.

Continuing through the iteration, design and build begin, and then "Testing" occurs on the right side. This is *independent* testing with users, not developer testing, but should be understood to be a team effort of all TE&C stakeholders. In the words of the study committee (National Academies of Sciences 2010),

> *"Therefore, an integrated approach to T&E to include the voice of the end user; traditional [DT&E]; [OT&E]; interoperability certification; and information assurance certification and accreditation equities is a fundamental element of this modified acquisition management approach for IT programs. As was the case with the requirements process, this implies a profound change in the T&E process used for such programs."*

Complete integration is the key to T&E at the speed of need.

The current DoD information technology TE&C environment

Our current test and certification process does a good job at helping users and decision makers understand capabilities and limitations, but it can be lengthy, costly, and duplicative. It is not agile. *Figure 5* depicts a high-level view of the Plan-Test-Report (PTR) cycle for IT TE&C. This PTR cycle can take 6 months, although it can be shorter or longer. As the diagram indicates, DT, OT, interoperability, and security testing can and often do occur as separate events, with their respective test teams performing separate analyses and producing separate reports. The process concludes as the various reports inform the milestone decision authority's acquisition (procurement) decision, the Joint Staff J6 interoperability certification, and the designated approving authority's information assurance accreditation. It is a kludge of IT considerations overlaid on a weapons-based acquisition system—but—just as for weapons and major platforms, when it takes years to develop and deliver a new IT capability, this process works. It is just not well suited for Agile IT. What we need is a TE&C model that is fully integrated, less duplicative, less costly, and ultimately one that fuses all test information into a coherent evaluation, so that decision makers better understand capabilities and limitations when making decisions about deploying the capability. What we need is an Agile testing model.

Agile for DoD

So what might an Agile IT acquisition process look like, aside from the DSB-IT's notion of "18-month releases subdivided into iterations"? Agile software development is a high optempo process that delivers working capability at speed of need. It is highly collaborative, documentation light, and change resilient. *Figure 6* depicts an Agile capability development life cycle adapted from the "Scrum" framework for iterative, incremental development. There are many

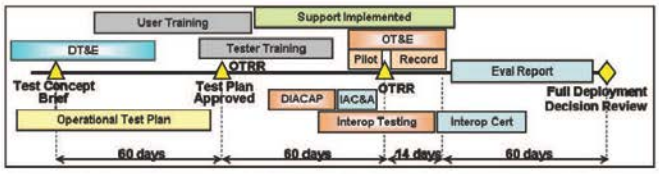

Figure 5. Test, evaluation, and certification of Department of Defense information technology.

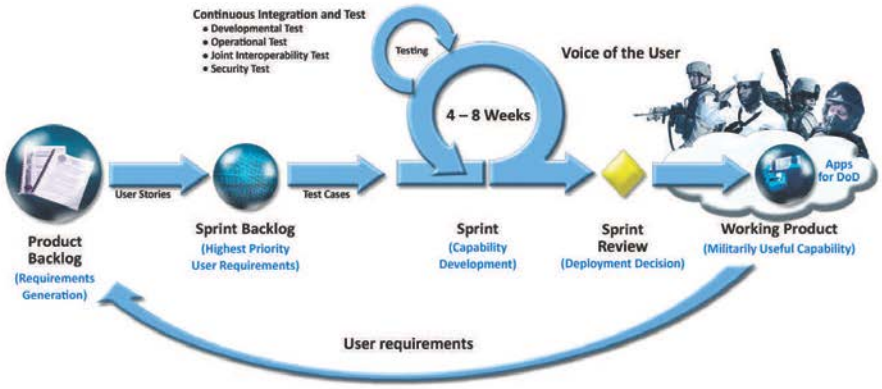

Figure 6. An agile development life cycle adapted for the Department of Defense.

sources of information on Scrum (www.scrum.org) and the Agile life cycle (www.ambysoft.com). Scrum succeeds through team member commitment and by removal of impediments; it enables The Team (a cross-functional group with necessary expertise to deliver a potentially deployable product at each sprint) to self-organize and achieve "hyper-productive" results.

In the model depicted in *Figure 6*, the key stages are "time-boxed," so that development can be accomplished at a sustainable pace. The "product owner" is responsible for articulating the product vision and identifying features in priority order (the commercial sector refers to this list of features as the product backlog). In the DoD, the operational sponsor would likely fill the role as product owner. In Agile, the product backlog evolves over time with priorities updated as features are added and removed to reflect the emerging needs of the customer. This is a critical distinguishing characteristic of Agile software development; resilience to change means that a change in the warfighter's priorities or needs could be just *one sprint away* from delivery.

The Agile process values working software over lengthy documentation (per the Agile Manifesto); therefore, to follow this development practice, we will need to revise the DoD requirements generation process to shift away from rigid requirements definition expressed in capability development documents written years before a product is delivered,[1] to a flexible, priority-driven process responsive to the changing needs of the warfighter. Our interoperability and information assurance certification processes also have to be revised for Agile IT. Likewise, since test activities will be responding to prioritized requirements at each sprint, it is unlikely that we can adequately describe test objectives, scope, and resources as we currently do in a Test and Evaluation Master Plan (TEMP), so we will need to shift the emphasis on detailed descriptions in the TEMP (objectives, scope, and resources) to well-crafted test cases in each sprint.

In the next step, The Team, not the product owner, selects the features from the product backlog that they can commit to develop during the sprint (keeping in mind that the duration of the sprint is a fixed period of time), taking the highest priority items and working down the list. Before The Team can make the commitment, they have to translate user stories into tasks and test cases to better understand the level of effort required to deliver each feature in the product backlog. In this way, The Team takes ownership of the development effort, while assuring the product owner that the highest priority items are included. This short list of priority features constitutes the sprint backlog.

A user story can be described by the simple statement, "As a "role", I want to "what", so that "why"." For example, "As an operator, I want to display current blue force locations, so that I have better situational awareness." In the DoD, a "mission thread" is likely to contain numerous user stories. The user story is further decomposed into tasks, and test cases are written before the sprint begins. This is the "test driven development" practice referred to earlier. Test driven development has shown that when developers understand how the capability will be tested, the resultant code has fewer defects. For the DoD, this is the type of early involvement we have been struggling

to achieve; if we can get the complete team of government testers (developmental, operational, interoperability, security) involved this early, we should be able to significantly improve the quality of the product and reduce time to deployment.

In this model, a sprint is typically 8 weeks or less in duration. Once the sprint begins, the product owner cannot change the priorities; any changes will be addressed in the next sprint. During the sprint, items in the sprint backlog are developed and continuously integrated and tested. In the commercial sector, this typically includes unit testing, acceptance testing, and exploratory testing. For the DoD, "Agile Testing" must accommodate the functions performed by government developmental testers, operational testers, joint interoperability testers, and information security testers—but these efforts are integrated and continuous, not separate and serial. When the sprint is complete and working software is ready, a sprint review is conducted at which all stakeholders are present, the capability is demonstrated, and the decision made whether or not to deploy the product.

Agile testing

To shift the DoD IT test and certification paradigm to be responsive to Agile IT programs, we need to move away from the "who does what, when" process (e.g., program manager does DT, the OTA does OT) to a collaborative model built upon shared data and reciprocity of test results that is ultimately an enabling process for delivering working capability. Let's take what's good from our process shown in *Figure 5* and collapse it into a responsive, on-demand, "testing as a service" construct. In other words, let's test smart.

To set the conditions for success of Agile Testing, we must first move away from the linear, serial processes that characterize development and test today. The Agile environment is iterative and collaborative; it exploits the principles of the Manifesto to achieve desired effects. An empowered team can reduce lengthy coordination cycles for document approvals, readiness reviews, etc. Likewise, a team approach will reduce duplication during test execution and publish more comprehensive findings on capabilities and limitations. Empowerment is critical to rapid development and deployment of working capability.

Next there are three key elements in our current *(Figure 5)* process that we must make *persistent* resources in the Agile life cycle; these include user training, tester training, and support structure (help desk). The help desk, as it is intended to support operations, must be in place during every development iteration. Also, since early and continuous involvement of the users is fundamental to success in the Agile environment, we will need to establish a pool of knowledgeable users (beta testers) from each community of interest (C2, business, intel, etc.) to ensure that we can obtain an adequate number of users to test. Likewise, to support the high test optempo, we must be able to draw from a cadre of testers knowledgeable in the systems and services in the capability area, representing all TE&C disciplines. This cadre must be able to engage early, be responsive to evolving user priorities, and execute the PTR cycle in highly compressed time lines.

Not shown in *Figure 5* are additional factors required to support Agile projects, including training our acquisition workforce, providing an enterprise knowledge management capability, and implementing a persistent integration and test environment. As part of improved training for the IT workforce, we need to update our curriculum in the Defense Acquisition University to better prepare our program managers and testers for IT programs in general, and Agile practices in particular. We need a project dashboard for IT programs that provides comprehensive and transparent knowledge management capabilities for all stakeholders. The DoD has spent considerable dollars funding programs in a way that allows them to build their own program-specific system integration labs (SILs). This strategy has failed; in fact, the plethora of SILs has only aggravated the Department's interoperability crisis. A new approach is needed. For example, instead of funding new programs to build more SILs, let's fund a select few SILs across the DoD to serve as a common development, integration, and test environment, and federate them together to ensure access as a shared resource. DISA is providing one such environment in Forge.mil (www.forge.mil), and within this virtual environment, the TestForge.mil will provide robust capabilities for users and testers to ensure capabilities perform as desired. The degree to which we can provide a common environment, common test tools, common methods, data collection, etc., will help all phases of the development process become more agile. A common development, integration, and test environment may eventually provide the foundation for "apps for DoD," similar to the app stores we see supporting our favorite gadgets.

The traditional PTR activities depicted in *Figure 5* can be adapted to the Agile environment, and each has a role; we don't sacrifice rigor in Agile testing. The Capability Test Team (CTT)[2] merges and consolidates these PTR activities but does so in a manner that enables each stakeholder to accomplish their evaluation objectives. The CTT is engaged from the outset; so as requirements are prioritized for each sprint, the team translates user stories into test cases. Test cases are risk

based and mission focused, and they address relevant technical parameters, operational issues, interoperability measures, and security measures. In Agile processes, test execution relies more heavily on automation, such as load simulators. Defects that cannot be corrected during the course of the sprint are returned to the work stack; working software is eligible to be fielded. Following the test, the CTT posts the evaluation report to the dashboard, with findings that state whether the capability is effective, suitable, interoperable, and secure. In 8-week iterations, the PTR cycle should be completed in 6 weeks. A single evaluation report could support the acquisition decision, interoperability certification, and the information assurance certification and accreditation. Last, we should modify the deployment decision. Rather than a "full deployment decision review," we should adopt one where we "start small and scale rapidly," with testers in a continuous monitoring role. In this way, we can ensure the capability effectively supports operations at scale, or take corrective actions should a problem arise.

Summary

A new IT acquisition system is coming to the DoD that will feature much higher optempo in development, testing, and fielding. As we evolve our acquisition process to deliver capabilities at the speed of need, test, evaluation, and certification will need to adapt processes to this new environment. The Agile environment will require a capability test team that is empowered to execute the plan-test-report cycle and provide objective assessments of key technical, operational, interoperability, and security metrics necessary for decision makers to understand capabilities and limitations. Key to the approach is to treat all test activities as a shared resource, while being mindful of each test organization's roles and responsibilities. Continuous user involvement, combined with appropriate risk-based, mission-focused testing will ensure TE&C is an enabler of rapid acquisition of enhanced information technologies for the warfighter, and this in turn will help ensure the critical apps that warfighters need are there when they need them. ❑

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Endnotes

[1]The Defense Science Board Report on Policies and Procedures for the Acquisition of Information Technology, March 2009, reported "... an average of 48 months to deliver useful functionality from the Milestone B decision...."

[2]The capability test team members are empowered representatives of all test and certification organizations and the user community.

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Appendix B. Acronyms

BAA	Broad Agency Announcement
CCD	Combat Capability Document
CENTCOM	United States Central Command
COCOMs	Combatant Commands
CONOPs	Concept of Operations
COPs	Common Operating Pictures
DCGS	Distributed Common Ground Station
DEPSECDEF	Deputy Secretary of Defense
DIA	Defense Intelligence Agency
DISA	Defense Information Systems agency
DoD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
DSDM	Dynamic Systems Development Method
DT	Developmental Test
DT	Development Team
EC	Empire Challenge
ER	Enterprise Resolve
FMV	Full-Motion Video
IA	Information Assurance
IA	Information Assurance
IDA	Institute for Defense Analyses
IPT	Integrated Process Team
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
IWN	Immediate Warfighter Needs
J2	Joint Chiefs of Staff
J26	Joint Staff of Intelligence
JFCOM	Joint Forces Command
JNIDS	Joint National Intelligence Development Staff
JRAC	Joint Rapid Acquisition Cell
JROC	Joint Requirements Oversight Council

JUONs	Joint Urgent Operational Needs Statements
JWAG	Joint Warfighter Advisory Group
MSEL	Master Scenario Events List
NGA	National Geospatial-Intelligence Agency
ONI	Office of Naval Intelligence
OT	Operational Test
OT	Operational Team
OT&E	Operational Test and Evaluation
OUSD(I	Office of the Under Secretary of Defense for Intelligence
RDC	Rapid Deployment Capability
REF	Rapid Equipping Force
RFP	Request for Proposal’
SECNAVINST	Secretary of the Navy Instruction
SME	Subject Matter Expert
T&E	Test and Evaluation
TEM	Technical Exchange Meeting
UAVs	Unmanned Aerial Vehicles
USSOCOM	United States Special Operations Command
UUNS	Urgent Universal Needs Statement
VOIP	Voice Over Internet Protocol

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14. ABSTRACT

A number of rapid acquisition approaches employed in the commercial world (and some specifically focused for application within the Department of Defense) enable fast-paced development cycles that can respond swiftly to changing customer requirements. A tailored version of the 'agile' methodology, currently used in the software development community, offers the opportunity for the Joint Staff J2 to implement timely development and acquisition processes responding to urgent Combat Command needs. These processes can support flexible and effective test and evaluation planning activities for future Enterprise Resolve exercises (formerly known as Empire Challenge).

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