Amassing Information for Decisions: Automating the Developmental Evaluation Framework (DEF)

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Abstract

Is it important for program leadership to identify the information desired to make knowledgeable decisions? If not, what are decisions based on? If yes, what is the mechanism to organize the information in order to reduce the risk of unknowingly making an uninformed decision? An automated DEF can be developed to identify, tag, and trace data and information to fill a critical information gap and improve knowledge. It assures program management is both event-based and evidence-based, two key ingredients of successful acquisitions. During system design and development, the Program Manager's active use of DEF scorecards can help identify opportunities to accelerate or the necessity to slow down a program in support of the acquisition strategy. If the DEF Developmental Evaluation Objectives (DEOs) and functionality elements are populated in a timely manner, more timely information can be provided to best schedule and inform decisions. Progress-to-plan can be used to assess decision venue timing or support an incremental decision process by providing evidence to justify actions and reduce risk in support of decision making.

DEF Overview

In January 2015, the Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L), the Honorable Mr. Frank Kendall, signed a memorandum issuing a new Department of Defense Instruction (DoDI) 5000.02 "*Operation of the Defense Acquisition System*".[1] A key element of the policy requires DoD programs to implement a Development Evaluation Framework (DEF) that articulates a Developmental Test and Evaluation (DT&E) strategy that will inform program leadership with the right data as early as possible in support of intelligent program acquisition decisions.

There are many variables that DT&E must consider in formulating the DEF implementation strategy. The approach must account for the full spectrum of testing - from unit tests in the lab through final integrated system-level tests in the field. All of these sources of information can be valuable, but integrating them into a cohesive plan that will extract meaningful information as efficiently as possible requires vision, innovation and proven strategies.

Celeris Systems (Celeris) has developed and fielded an applied systems engineering methodology that tightly couples Systems Engineering (SE) and DT&E disciplines in the test planning and execution process. Underpinned by their COTS software product iRIS®, the approach gives programs the ability to efficiently define test strategies, at all levels of system development, and provides leadership with the continuous feedback needed to make sound program decisions.

DEF Background

DoD Instruction 5000.02 provides the policies and principles that govern the defense acquisition system and forms the foundation for all DoD programs. The objective of the policy is to establish a management framework for translating user needs and technology applications into stable, affordable and well-managed acquisition programs[2].

A key element of the acquisition process is the development, allocation, evolution of requirements that are reviewed through a series of key documents, decision points and milestone decisions. An overview of this methodology is shown in Figure 1:

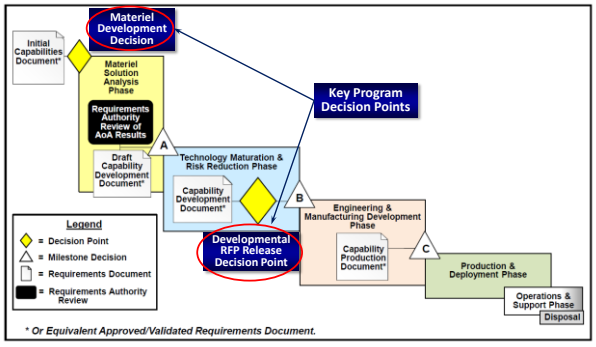

Figure 1. Interaction of the capability requirements and the acquisition process

As noted in the figure, there are two key decision points in this process: 1) Materiel Development Decision Point Milestone A (MS A) and 2) the Developmental Request for Proposal (RFP) Release Decision Point just prior to Milestone B (MS B). The Development RFP Release Decision is the point in a program at which planning for development is complete and a decision can be made to release an RFP to industry. It's the most important decision for a program since it's the point at which plans for the program must be most carefully reviewed to ensure all risks are understood and under control, the program plan is sound, and that the program will be affordable and executable.

Developing Test Measures

As a need evolves from a concept defined in the Initial Capabilities Document (ICD) into a materiel solution through the Milestones A and B, the requirements are further refined into a set of Key Performance Parameters (KPP) and Key System Attributes (KSA). DT&E practitioners work with systems engineers in developing critical system characteristics (i.e., Critical Technical Parameters (CTP)) that when achieved, allow the attainment of operational performance requirements. Technical Performance Measures (TPM), cybersecurity and cyber resiliency requirements, interoperability requirements, reliability growth, maintainability attributes, DT&E objectives, and other test measures may be defined as needed.

KPPs and KSAs are defined as part of the Capability Development Document (CDD) (or equivalent) released as part of the Developmental RFP release Decision Point. The CDD specifies the operational requirements for the system that will deliver the capability that meets operational performance criteria specified in the ICD. It outlines a militarily useful increment of capability with its own set of attributes and performance values (i.e., thresholds and objectives). The CDD is prepared during the Technology Maturation & Risk Reduction (TD) Phase to guide the Engineering, Manufacturing & Development (EMD) Phase by defining measurable and testable capabilities.

Operational testers draft Critical Operational Issues (COI), Measures of Effectiveness (MOE), and Measures of Suitability (MOS) for operational testing purposes. The goal is to ensure all measures are traceable to key system requirements and architectures, and correlate to the KPPs and KSAs. These measures drive development of the system specifications interface control documents. A program can ensure complete coverage and correlation by listing them in the DEF that becomes part of the MS A Test & Evaluation Master Plan (TEMP).

Decision Types

In addition to the two decision points discussed above (MS A & MS B), there are many other critical decisions that must be made throughout the program life cycle. The DEF identifies the series of program decisions that are informed through evaluation and establishes the logical DT&E strategy to support them. Examples of these decisions include:

Acquisition Decisions (AD) which would include: Milestone B, Milestone C, Low Rate Initial Production (LRIP), Full Rate Production (FRP), etc.

Programmatic Decisions (PD) would include: Draft and final ICD and CDD release, Technology Demonstration contract award, award/incentive fee determinations, EMD contract award, Operational Test Readiness Review, etc.

Technical Decisions (TD) would include: System Readiness Reviews (SRR), System Functional Reviews (SFR), System Design Reviews (SDR), Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), Test Readiness Reviews (TRR), Flight Readiness Reviews (FRR) etc.

Operations Decisions would include: Concept of Operations (CONOPs) development/modification, Initial Operational Capability (IOC), Final Operational Capability (FOC), etc.

In order to evaluate progress and to support these key decision points for a program, the DEF requires DT&E to develop a list of DEO and Decision Support Questions (DSQ) for both segment and system-level elements. These DEOs and DSQs form the framework that identifies the test events necessary to support the DEOs and answer the questions in the DSQs. Examples of technical DSQs might include:

- Does the system meet the environmental requirements?
- Does the system meet the technical readiness requirements?
- Is the system secure?
- Has the subsystem been successfully integrated with the system?

The DEF requires that DEOs be grouped into one of the following four functional areas: 1) Performance, 2) Interoperability, 3) Cybersecurity, and 4) Reliability. Similar to the DSQs, the DEOs are typically high-level system functions or capabilities that must be traced to the requirements that will ultimately be tested, analyzed and verified. An overview of the basic DEF workflow is depicted in Figure 2:

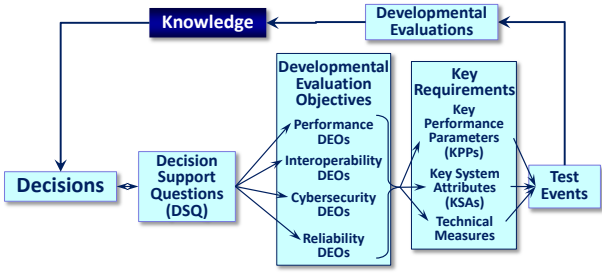

Figure 2. Basic DEF Workflow[3]

As the figure shows, the knowledge to inform decisions is acquired from the Decision-Question-Objective-Requirement-Event thread.

Business Intelligence Behind the DEF

Bringing the right data and information required for the evaluation seems simple and straight-forward, but it is in fact challenging, especially with complex systems (enterprises or systems-of-systems). It comes down to identification of the decisions, the knowledge required to inform those decisions, the questions that need to be answered, and the events used to collect the data to inform these decisions. The challenge comes from the dynamic day-to-day program execution realities that impact the ability to execute DT&E events as planned and having the flexibility to modify this plan as needed.

There are four key elements developing and supporting the DEF:

a) The first is in establishing the evaluation criteria in relation to decisions within mission context.

b) The second is in understanding system evaluation, its importance, stakeholders, and the appropriate events where capability and performance can/will be assessed.

c) The third is the DT&E schedule of events, the resources required to accomplish these events, and the risks associated with not being able to execute these events as planned.

d) The fourth is how and where to find the test data and information required by the stakeholder community to perform the evaluation.

Figure 3illustrates these considerations.

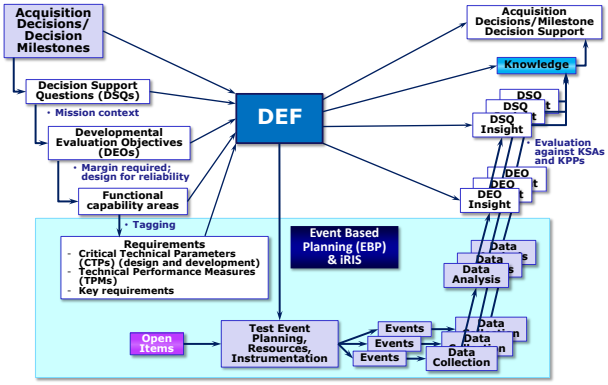

Figure 3. DEF Development Considerations[3]

The DEF identifies the set of acquisition decisions that are informed through evaluation and establishes a "knowledge development plan" to support them. Planning involves coordination of all the moving parts needed to generate the right information, but no matter how good a plan is, no plan stands first contact. To fulfill its purpose, the DEF implementation strategy must flex with the program realities throughout its life cycle.

The first challenge is understanding the milestone/decision needs. For the DEF, it is the supporting DEOs and DSQs and technical parameters that define functional capability. As defined in the DoDI, the decisions/milestones, DEOs and DSQs are defined and captured in the program TEMP. The technical parameters that support the DEOs are captured in program specific documents and maintained under configuration control. Once established, the Decision-DSQ-DEO-Requirement relationships remain relatively static.

The second challenge is understanding the evaluation criteria and how/when they will be addressed within the program life cycle. To support program capability phasing, delivery, execution and reporting, the SE process must establish a convention that identifies requirement phase effectivity (ie, Block I), and requirement verification methods (ie, Analysis, Inspection, Demonstration, or Test). KPPs, KSAs, CTPs, TPMs, and Mission Critical requirements must also be clearly identified as they may play a central role in system evaluation, depending on the DSQ.

SE works with DT&E to allocate each of these requirements to a verification and/or validation event or events (including risk reduction events). This ensures each stakeholder, both internal and external, has a clear understanding of when their requirement will be addressed and the type of evaluation data that will be made available.

The third challenge is allocating the requirements to the individual events used or data collection and the impact to the resources required to support these events. The events are typically identified in the Master Program Schedule (MPS) or Integrated Master Schedule (IMS). Each event has a plan and forecast start and completion date. Once requirements are allocated to appropriate events, and the allocation is optimized to ensure the requirements are satisfied at the right time and the correct number of times (not over/ under assessed), the DT&E schedule can then be baselined. Changes to the baseline schedule can come from any number of areas including the following:

a.) **Hierarchical requirements impacts**: The system integration sequence of events is driven by the hierarchical parent/child requirement relationships. Lower assembly issues or delays impact predecessor/successor relationships like any other critical path linkage.

b.) **Resource utilization conflicts:** The resources required for each event could be impacted by delays in development or release from a predecessor activity. Example resources are: hardware Configuration Items (CI), software CI, test equipment, sites, facilities, labs, soft products, math models and simulations, and/or personnel. Less costly resources may not normally be coordinated at the IMS/MPS level but could still impact the critical path just as much as the high-dollar items such as interface system emulators and simulators.

c.) **Open item impacts:** In order to inform decisions, the latest and most accurate data must be available. That data and information may be at risk due to the numerous types of open items that could impact event execution, such as technical issues, discrepancies, risks, hazards, requirements changes, contract actions, funding changes, etc.

The fourth challenge is in locating configuration-controlled test data in support of the evaluation. The program Integrated Data Environment (IDE) architecture can make all the difference in how efficiently data can be acquired and evaluated. It is critical for evaluators to work with the program IDE manager to ensure the test data is easily accessible and under configuration control. Not having the right data and information can lead to evaluation confusion, work-arounds or analysis of incorrect or incomplete test data. The transaction costs to manage data can dominate the DT&E planning and execution costs. By understanding the information required and then tightly managing and coordinating this data, costs can be significantly reduced.

Event Based Planning (EBP) as a Foundation for DEF Development

EBP provides the core collaboration environment to efficiently define, manage and track all the requirement verification activities for a program. EBP has the following key objectives:

a) Provides a common verification reference framework to enable collaboration across the stakeholder community.
b) Defines the verification effort in support of the entire Systems Engineering lifecycle.
c) Enhances the program test, evaluation, verification and validation efforts.
d) Clearly defines what “done” looks like.
e) Ensures the system performance will be met and operational capability delivered.

Automated correlation of requirements, events, resources, and open items, as shown in Figure 4, gives users the ability to display DT&E-related metrics and stop light charts using real time or near real time data. It ensures the knowledge being acquired is based on the most up-to-date and accurate information available.

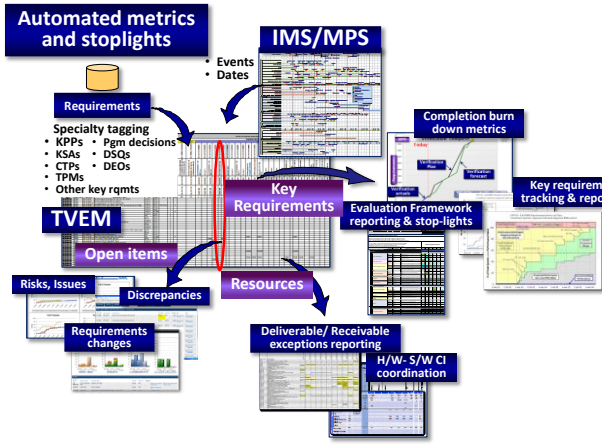

Figure 4. EBP-generated metrics and stoplight information

With the flexibility to be tailored to a specific workflow, EBP will help programs to gain early stakeholder buy-in and will guide teams through the requirement verification process as it provides the continuous feedback needed to ensure all delivery milestones are met.

EBP can be put in place early in a program during pre-milestone A, or the start of milestone B phase for programs "at risk" or already in trouble. This process has been successfully demonstrated on several programs.

DEF Automation through EBP and iRIS®

EBP and iRIS® accomplish DEF automation through the correlation of three key functions: 1) requirements to events (both risk reduction and formal verification); 2) test resources to events; and 3) open items to the requirements and/or events. (ie, issues, risks, requirement changes, contract actions, discrepancies, etc).

In order to successfully configure, execute dry runs, analyze and report on the DT&E events, numerous resources may be required and disciplined coordination of these resources is critical to successful program execution. Resources may include test sites, facilities, and/or labs, actual or operationally representative hardware and software, test hardware and software items, soft products (documentation, authorizations, etc), Models, Simulation and Analysis (MS&A) tools and the appropriate personnel. As previously stated, some of these items may fall below the threshold for tracking and reporting in the IMS/MPS. iRIS® provides the ability to coordinate utilization of ***all DT&E resources***, for each event, and provide users with real time notification in the event of a utilization schedule conflict.

It is critical for stakeholders to understand that the risk to system evaluation is driven by the event plan, execution and the capability being delivered. As a program evolves, there are several types of open items that can have an adverse impact on successful program execution. The integrated nature of the EBP architecture provides visibility to open item, at all levels of verification, giving programs increased situational awareness and the ability to respond dynamically to changing conditions.

Amassing the Data

Compiling the right data required to inform decisions in an accurate and timely manner can be labor intensive for a program using traditional methods (ie, disconnected databases and spreadsheets). EBP automated through iRIS® harnesses the power of a robust relational database management system to simplify this complex engineering challenge. Using innovative data analytic techniques, iRIS® reduces massive amounts of data to provide program leadership with ***the right*** information needed to inform decisions as shown in Figure 5.

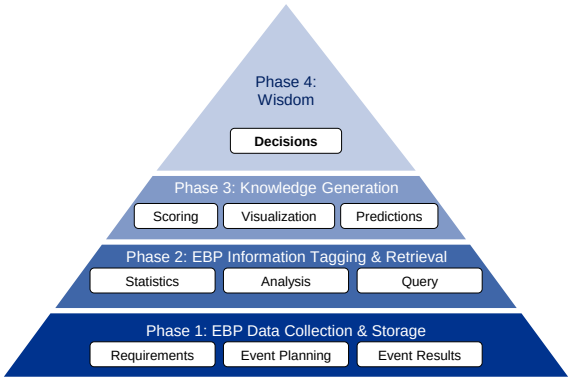

Figure 5. iRIS® Data Analytics Model

iRIS® can rapidly assimilate large amounts of EBP data to generate a wide variety of metrics and reports, one being the "DEF Scorecard" shown in Figure 6 below. Once a DEF scorecard is fully correlated in iRIS®, ***there is no recurring data management required*** since the EBP process continuously "auto-updates" the scorecard with the latest DT&E data and information available.

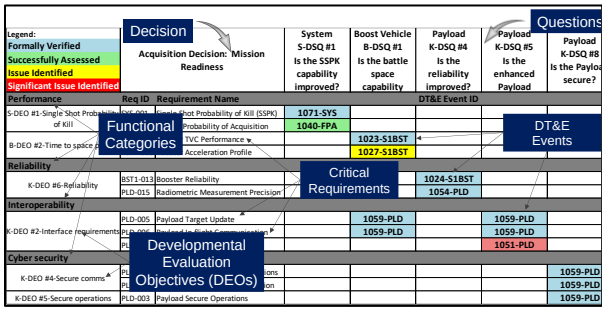

Figure 6. Automated DEF Scorecard Example

The following convention is used in the iRIS® DEF Scorecard:

a) Blue: The requirement has been formally verified by the event displayed.
b) Green: The requirement has been successfully demonstrated by the event displayed.
c) Yellow: An issue or concern exists with the event displayed. This could be in the form of a test issue, test asset contention, open discrepancy or risk item but an acceptable remediation solution exists.
d) Red: A significant issue or concern exists with the event displayed and no acceptable remediation or solution exists.

Evaluators have the ability to gain additional insight by "drilling down" (right-clicking) on each individual score to review requirement verification artifacts, open discrepancies or risks, and event resource utilization conflicts. The scorecard also identifies DEF-related requirements that have not been allocated to an event, which could then be converted to a risk and tracked to closure using the EBP process.

Benefits of Automation

If identifying, tagging, and tracing information is desired to make knowledgeable decisions, an automated DEF fills that critical information gap. The approach provides the ability to efficiently define test strategies at all levels of system development and provides leadership with the continuous feedback needed to make sound program decisions.

Finally, from a view of program assessment and root cause analysis, Earned Value Management (EVM) is limited to a few technical performance attributes and only measures schedule and cost performance. Using a DEF, enabled with EBP and a COTS product like iRIS®, the Program Manager can link technical evaluation objectives that inform decisions to program performance, in addition to EVM schedule and budget tracking. This allows the PM to track progress-to-milestones with finer granularity at the PDR and CDR, as well as MS C.

DEF Automation Summary

The combined EBP/iRIS® solution efficiently addresses the full spectrum of evaluation framework complexity, from requirement attribute identification, event correlation, resource conflict identification and resolution, to open item tracking, reporting and impact evaluation.

Not only does EBP and iRIS® meet the intent of DoDI 5000.02 DEF requirement, but it also meets the requirements of other DoD Instructions where common data sets and information are correlated across numerous stakeholders at a significantly reduced cost.

References:

1-DoDI 5000.02 January 17, 2016 USD (AT&L)
2-Acqnotes Acquisition Process DoD Instruction
3-Provided by Mr. Rick Thomas, Deputy Assistant Secretary of Defense, Developmental Test and Evaluation (DASD DT&E), Office of the Secretary of Defense