A Structured Approach for Independent Verification and Validation (IV&V) – An Electrosoft White Paper

Overview

Mission-oriented federal organizations face numerous challenges. Their information systems and projects are complex, often comprising a mix of government and commercial components that must interoperate with systems implemented by other organizations. The fast pace of technology, coupled with a rigid set of compliance criteria, adds even more complexity to the mix. Further, completion of these projects and systems often spans long periods of time wherein initial assumptions about the operating environment may evolve and customer expectations may change. To ensure that the resultant product, service or system meets the stated requirements and delivers on its intended purpose, a third-party (unbiased) evaluation – also called independent verification and validation (IV&V) – may be performed. The purpose of IV&V is twofold:

- *Verification* – Checking whether the product, service or system meets the stated requirements, specifications or constraints.
- *Validation* – Determining whether the product, service or system achieves its intended purpose and meets the needs of the stakeholder community.

IV&V establishes evidence and provides assurance that a product, service or system accomplishes its intended requirements and is fit to serve the needs of end users and other stakeholders. Through IV&V performance, systems developers and owners can mitigate the risk of implementing systems, services and projects that don't serve the purpose for which they were built. IV&V testing results also support program management decisions.

Across a decade of performing independent assessments and testing for a wide variety of IT initiatives, Electrosoft has developed a mature IV&V process, which we call our *Independent Evaluation Method* (IEM). Electrosoft's IEM is a structured approach based on Institute of Electrical and Electronics Engineers (IEEE) Standard 1012-2012, Department of Defense (DoD) test and evaluation (T&E) guidelines and standards, and industry best practices, but tempered with the field experience accrued by Electrosoft's seasoned practitioners. IEM comprises four major phases: Plan, Review, Assess and Report (see Figure 1). Through this four-phase approach, IEM can address all aspects of an information system or project including cost, schedule, technical, management, programmatic, process and quality characteristics.

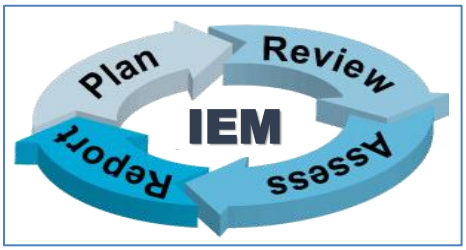

Figure 1 – Electrosoft's IEM Process Helps Reduce Risk and Support Program Decisions

For each IV&V engagement, the Electrosoft team, directed by an IV&V manager, assembles personnel with not just the specific skills and experience relevant to the business and/or technology of the project but also a focus on domain expertise in high-risk project areas. The complex nature of today's products, systems and services requires coordination with disparate stakeholders, as required.

Planning Phase

As shown in Figure 2, our planning phase focuses on identifying the objectives of the IV&V effort and gathering requirements for the target system, service or project. We work with stakeholders to develop and/or validate a Requirements Matrix identifying each IV&V

requirement, verification method (test, demonstration, simulation, analysis, etc.), verification and validation (V&V) events and V&V conditions. When we generate IV&V reports, we correlate requirements and supporting data from the Requirements Matrix to present the results.

The Requirements Matrix drives the development of the Test Analysis and Evaluation Approach, which in turn drives the preparation of the IV&V Activity Plan. This plan focuses on high-risk areas based on valid existing test results (when possible) and augments them with additional testing methods as needed. Typical questions we ask – as we develop **test plans and cases** to provide adequate test coverage for projects – include:

- Is every requirement addressed by at least one test?
- Have test suites been selected for an "average" situation as well as for "boundary" situations such as minimum and maximum values?
- Have "stress" cases been selected, such as out-of-bounds values?
- Have meaningful combinations of inputs been selected?
- Are the functions and objectives accurately reflected in the test cases?
- Have all the system interfaces been exercised in all conditions?
- Are there sufficient end-to-end tests?
- Are tests conducted with sufficient and representative data?

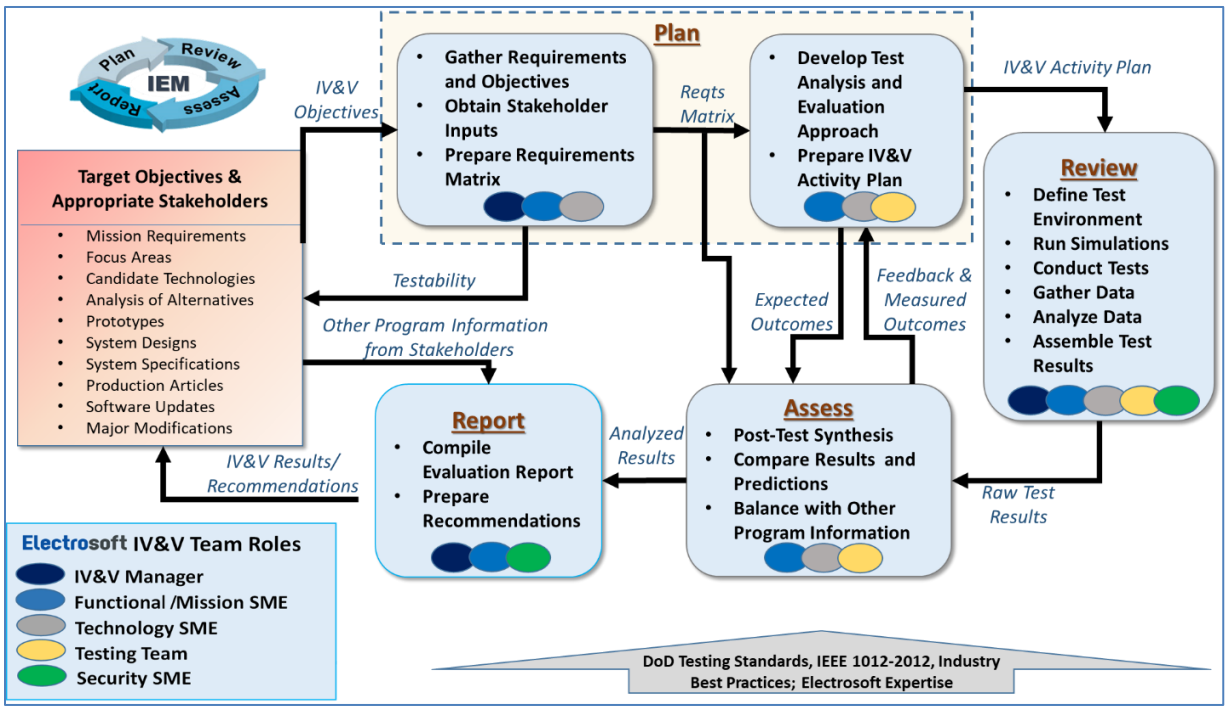

Figure 2 – Electrosoft's IV&V Phases Help Produce Consistent and Objective Results

Review Phase

During the review phase, the IV&V team evaluates the current documentation and assesses the perspectives of stakeholders across the organization. This review enables them to monitor and trace the impact of changes and dependencies throughout the development effort. The IV&V team also assesses the impact of these changes and provides an impact assessment from both an operational and maintenance perspective. Our IV&V team updates current and previous stage documentation for consistency, correctness and maintenance purposes.

During the project development phase, our verification procedures involve performing tests, as shown in Figure 2, to exercise a portion, or the entirety, of a product, service or system. Then, we review and analyze the test results. If the product, system or service is modified, our verification procedures regularly repeat tests (regression tests) devised specifically to ensure that the product, service or system continues to meet the initial design requirements, specifications and regulations. In addition to the test techniques shown in Figure 2, our verification processes include **demonstration, inspection and analysis** to evaluate and confirm whether the delivered or proposed future capability, product or system meets the intent of the stated requirement. For some projects, we use virtual and/or operational environments for testing and evaluation. For acquired services, we evaluate how well the product vendor conducted testing through a review/assessment of vendor test processes and results.

We use verification to evaluate whether a product, service or system complies with regulations, specifications or conditions imposed at the start of a development phase. Verification can be applied in development, scale-up or production.

We perform the verification, validation and testing processes as an independent, trusted agent to ensure that our activities are objective. Assembling an IV&V team that did not participate in design or development enables us to consider system aspects and alternatives that non-independent testers could overlook or disregard.

Our independent engineering validation methodology ensures that a product, service or system meets the operational needs of the user per the organization's strategic goals and focus areas. Our validation procedures include modeling and simulations to predict faults or gaps that might lead to invalid or incomplete verification or development of a product, service or system. We then use a set of user-defined validation requirements, specifications and regulations as a basis for qualifying system development. Additional validation procedures include those designed specifically to ensure that modifications made to an existing system produce a product, service or system that meets the initial design requirements, specifications and regulations. In conducting validation activities for products, systems and services, we use available operational requirements, concepts of operations (CONOPs), use cases, user stories, operations and maintenance (O&M) processes and documentation, and other user input. Where appropriate, we use IV&V subject matter experts (SMEs) for expert judgment and involve representative users to validate core use cases for high-risk areas. In these situations, our representative users execute use-cases, exercise support processes (helpdesk, continuity of operations [COOP], etc.), provide feedback and help analyze/validate process metrics. Due to its subjective nature, validation efforts may require test repetition and/or involve multiple users to obtain sufficient sample sites for the desired level of confidence in the validation test results.

Assess Phase

After completing the IV&V tests, simulations and reviews, the data must be synthesized to show as coherent a result as possible. Results that point to disparate conclusions (i.e., "The system delivers the required function" versus "The required function is not possible with the system") must be resolved to determine the correctness and accuracy of results. If necessary, we plan additional tests to resolve the disparities.

Actual results also must be compared with predicted results and expected outcomes; formal unit, integration, end-to-end and user testing are conducted to ensure compliance with requirements and achievement of objectives at each level. Anomalies must be resolved or explained. Any negative results must be fully characterized with details and context so that the team can determine the overall risk to system, service or product performance.

Report Phase

Output from each of our IV&V testing activities, at each stage of project acquisition and development, consists of reports documenting compliance or noncompliance with requirements, evidence supporting the conclusions and recommendations on deployment for developed capabilities or acquisition of a commercial service offering. In addition to performing the verification and validation activities and reporting the outcomes, Electrosoft recommends approaches for rectifying any issues or instances of noncompliance.

While we perform verification and validation activities and report the outcomes, Electrosoft recommends approaches to resolve issues or instances of noncompliance

Strengths of Electrosoft's IEM Approach

Table 1 presents the strengths and benefits of our approach.

Approach to IV&V	Strengths & Benefits
Rigorous, proven and comprehensive IV&V methodology based on IEEE standards, best practices, Capability Maturity Model Integration Level 3 processes	Process-driven IV&V methodology produces consistent, cost-effective results, with security considered at every phase
Use of tools to assess/manage: • operational risk • cost risk • delivery risk	Regular and comprehensive risk reviews ensure proactive identification of issues and speedy measures to avoid or mitigate risk to ensure projects, products and services meet functional, operational and cost objectives.
IV&V team members possess a broad base of technical, development and functional experience	Provides a perspective on tests and results. Able to assess technical and operational impact to any identified noncompliance

Table 1: Benefits of Electrosoft's IEM Approach

Contact Us

To learn more information about Electrosoft's IV&V approach, contact us at info@electrosoft-inc.com.

About Electrosoft

Electrosoft delivers a diversified set of technology-based solutions and services differentiated by thought leadership and innovation. Fueling the success of our government and commercial customers since 2001 through outstanding value and trust, we couple our domain knowledge and experience with proven, mature management practices to deliver the right solutions on time and within budget. These practices include an ISO 9001:2015 registered Quality Management System (QMS) and Capability Maturity Model Integration (CMMI) Level 3 assessed processes. Headquartered in Reston, Virginia, Electrosoft is an 8(a) certified Small Disadvantaged Business (SDB) and an 8(m) certified Economically Disadvantaged Woman-Owned Small Business (EDWOSB). For more information about Electrosoft, visit our website at www.electrosoft-inc.com.