Verification & Validation (V&V) / Test & Evaluation (T&E) Competencies

Sponsor: OUSD(R&E) | CCDC

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Research Need

- The discipline of systems engineering currently lacks a competency framework for verifying and validating complex systems through a test and evaluation process.

- The complexity of our systems from software enabled technologies is increasing exponentially, the methods we use to V&V and T&E these systems need a methodological framework to keep up.
Goals and Objectives

• **Goals:**
  • Develop a model of the key competencies required for the DoD acquisition workforce to support V&V and T&E.
  • Create a paradigm shift focusing on transforming engineering education and professional training in the areas of V&V and T&E.

• **Objectives:**
  • Develop an initial structure of a V&V and T&E competency framework
  • Establish the research methodology to create and validate the framework
  • Identify critical information sources
Illustration of the Problem

Significant Problems Observed in Operational Testing
DOT&E Reports 2015 - 2017

Tests Without Problems: 35.6%
Tests that Only Observed Known Problems: 27.9%
Tests that Discovered New Problems and Observed Known Problems: 21.6%
Tests that Discovered New Problems: 14.9%

36.5% of Operational Tests found new problems
"Shift Left" Targets

Percentage of DOT&E Reports
Why a Competency Model is Needed

Airborne + Support Software

Airborne Software

<table>
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<tr>
<th>Aircraft</th>
<th>LOC in thousands</th>
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<tbody>
<tr>
<td>F-16A Block 1</td>
<td>135</td>
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<tr>
<td>F-16D Block 60</td>
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<tr>
<td>P-3C</td>
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Establishing a Competency Model

• Statistical Frameworks
  — Design of Experiments (DOE) and Sequential test design
  — Scientific Test and Analysis Methods (STAT)
  — Human Testing / Experiments

• Software Verification and Validation
  — Software Engineering
  — Axiomatic Approaches
  — Formal Methods
  — Design for Testability

• Systems Engineering
  — Unit testing – potential environments in which the agents need to be demonstrated
  — Evidence generation during design - Testing needs to be carried out throughout the systems engineering and design process
  — System modeling and simulation-based testing. Need to develop standards for modeling
  — Compositional analysis

• Cyber-Physical Systems (CPS) approaches
  — Verification: model checking, theorem proving, simulation, symbolic execution
  — Validation: experimental validation, emulation

• Emerging ML/AI Techniques
  — Cognitive instrumentation and Explainable AI
  — Adversarial testing
  — Negative testing
  — Evaluating Symmetries in ML
Expected Outcomes

• **Near Term:**
  • Develop competency framework
  • Develop a validation plan
  • Identify key academic disciplines

• **Long Term:**
  • Establish an academic degree program in T&E and V&V