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Customer Success Is Our Mission

Tactics for Integration of T&E in Early Requirements Development

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Agenda

This presentation:

- Explores tools and processes along with a few success examples at Raytheon Missile Systems (RMS) to improve the state of early requirements involvement of the T&E community both within our own company and with the government T&E community

- Provides suggestions to the government community for continued partnered improvement in this area

At our best and our worst…

UNDESIRED
T&E Engagement
Post Design Phase

- Requirements Flowdown:
  - Sub-optimal attention to production or operational test capability
  - Subsystem requirements developed without overall test consideration
  - Test of margin at system level not thoroughly analyzed
- Qualification strategies that do not consider system impact of sub-system/ component changes
- Misinterpretation of test expectations relative to requirements due to limited customer test community engagement

DESIRED
T&E Engagement
Throughout Program Life Cycle

- Requirements Flowdown:
  - I&V involved during Test and Evaluation Strategy (TES) – pre-Milestone A - with customer community
  - Bi-Directional mapping of Requirements (sub-system performance tied to DT/OT Test objectives)
  - Systems test strategy tied to subcontractor test
- Design characterization - demonstrated design margin at the system level
- Performance enhancements are evaluated in the context of final test capability

Enabling Processes

Changes at RMS in recent years have driven earlier Integration, T&E Involvement in Requirements:

- Insertion of I&V checklists in the formal review process to ensure involvement at all stages
- Early (development phase) establishment of formal customer T&E working groups
  - Navy/Air Force, Army/Navy, Air Force/Navy
- Organizational constructs that drive I&V/T&E interdependence
  - Integration/ Test maintained as separate entity from requirement developers to ensure independence and objectivity
- Increased focus on test in Program Leadership Structure
  - Test Architect, Test Lead in Office of the Chief Eng

"The high value of testing comes not from verification but from discovery. The cost of discovery goes up an order of magnitude with each successive phase. The process of testing should be built around the value of testing." [1]

Early Involvement Requires Program and Customer Commitment

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Enabling Tools

- Virtual Solutions Development™
  - Architecture-driven product development protocol that virtually models, then integrates test cycles and cost of test in AoA of point-of-departure designs
- Design of Experiments (DOE) methodologies
  - For all test coverage, not just flight tests
  - Successful deployment as part of Test Strategy for a recently awarded major milestone B Air Force program
- Modeling and Simulation
  - Live, Virtual and Constructive (LVC) to evaluate full system performance
  - Increased emphasis on integrating test results into simulation predictions at all phases of test
- Deployment of Test Architecture Tools across new and legacy programs
  - System and sub-system margin analysis
  - Test Coverage Analysis (DT/OT and production testing)
  - Interface Integration Risk Analysis
  - "Test as you Fly" Gap Analysis

"M&S is only useful…if it can replicate reality to an acceptable level as required for the particular use" [2]

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Recent RMS Success Stories

PROGRAM	STRATEGIES	RESULTS
Program A Joint Navy/Air Force Block Change award	Early and Open Engagement with Customer T&E Community - influenced platform OS, target types, Data collection systems	Successfully completed first DT test against maritime target
Program B Air Force program Milestone B award	Early and Open Engagement with Customer T&E Community - worked to ensure impact of CFTs on final performance evaluation. Close collaboration on test ranges to ensure environment relevance Use of DOE tools to ensure comprehensive test coverage at lowest total test cost Deployment of Test Architecture Role and principles early in program	Successful CFTs, management of test in production
Program C Joint Army/Navy Tech Demo program	Deployment of Test Architecture Role and principles early in program Clear traceability from test objectives to subcomponent performance requirements early in program.	6 for 6 successful flight test program

Early Involvement of T&E Increases System Test Success

Specific Examples of T&E Influence on Requirements

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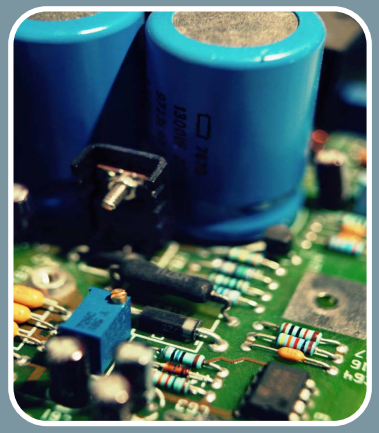
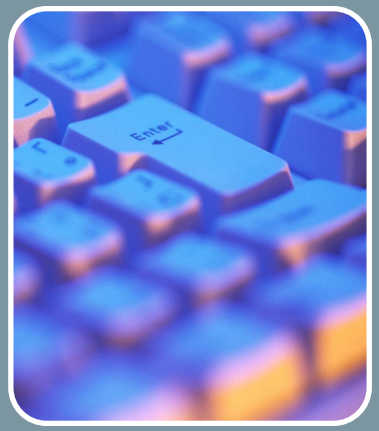


Hardware

- Issue:
  - Legacy Telemetry (TM) System designs did not allow the T&E team real-time visibility to critical missile initialization power forms, resulting in a lack of essential go/no go data prior to main missile computer power-up.
- Solution:
  - T&E team worked with the Systems & Missile HW IPTs to create derived requirements in the TM CIDS for the ability to power on (via a special external umbilical discrete) and transmit TM independent of the missile's main PCU.



Software

- Issue:
  - T&E team was not able to control the missile system in a non-tactical manner for verification and special test situations without having to load a special build of Software into the missile. Desire was to "Test as you Fly".
- Solution:
  - T&E team worked with the Software IPT to develop derived requirements in the SRS for "User Interface (UI) Messages" transmitted as umbilical (1553) messages, allowing the tester to directly control the missile and perform special tests.

Supplier Hardware Example

- T&E design-for-test requirements for supplier Statements of Work (SOWs) and Performance Specification (PS)
  - Supplier SOWs and performance specifications are generally focused on tactical configuration
  - Incremental and special test configurations may not be considered.

- Example: a Navigation system from supplier must work on rotary wing platform for captive flight test environment
  - But objective system has no rotary wing requirement

- This derived requirement is non-trivial and critical for test success
  - Rotary wing aircraft vibration
  - Rotary wing speeds and trajectory (crabbing, etc)

Full range of test environments and objectives must be considered early as part of supplier SOW/PS development and selection

Incremental Vehicle Requirements Management Gap Example

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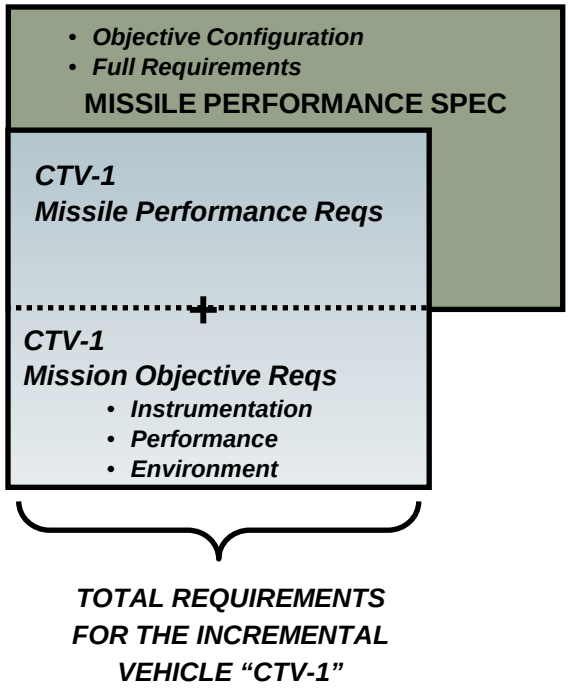
- Systems Engineering tends to be “Objective Configuration” centric

- Requirements management database typically defined for traceability to System Performance Specification
  - Incremental Vehicles not referenced in SOW or System Performance Specification
  - Incremental configurations are derived, sometimes informal requirements

- Such requirements gaps may have severe impacts on design activities and subsequent test success
  - Special instrumentation
  - TM availability and recording

- Programs that have incorporated incremental vehicle requirements documentation and management have demonstrated greater test success



Changes made to manage incremental vehicle requirements

Recommendations

- Continued focus on the early incorporation of T&E into Acquisition Contracts
  - Strong Test Strategy presence in SOO, SOW and RFP
  - Emphasis will communicate importance to Government and contractor Program Managers
- Drive expectation that T&E activities at all program stages will be a significant discriminator in overall down-select process
- Budget appropriately and staff with knowledgeable T&E resources who expect to see a comprehensive Test Strategy documented prior to Requirements & Architecture definition
  - Will drive similar behavior on contractor side

"The primary theme to remember is that if a T&E item or requirement is not in the SOW, it probably will not be in the RFP, and if it is not in the RFP, it probably will not be in the contract. If it is not in the contract, ***do not expect to get it!*** *"*

- Office of the Deputy Assistant Secretary of Defense, 2011 [3]

Questions?

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References

1. Ernest Seglie, Ph.D., Office of the Secretary of Defense; ; "DOT&E Leaders Speak Out About Past and Future Challenges and Priorities"; ITEA Journal 2009; 30: 211–215; http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA513981

2. Defense Modeling and Simulation Office; VV&A Recommended Practices Guide- T&E and V&V Integration; http://vva.msco.mil/Ref_Docs/Test/default.htm

3. U.S. Department of Defense, **Office of the Deputy Assistant Secretary of Defense for Developmental Test and Evaluation** ; "Incorporating Test and Evaluation into Department of Defense Acquisition Contracts", October 2011; http://www.acq.osd.mil/dte/docs/Guide-on-Incorporating-TE-into-DoD-Acquisition-Contracts.pdf