Ground Segment Test Like You Fly (TLYF) Simulation and Testbed Acquisition

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25 March, 2009
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Agenda

- Purpose
- Introduction
- Modeling and Simulation (M&S) Acquisition
  - *Policy*
  - *Guidelines*
- Summary

Purpose

- Identify acquisition guidelines for modeling and simulation (M&S) used to support LYF testing of ground systems
  - *Guidelines can become requirements or part of acquisition, modeling and simulation, or TLYF philosophy*
  - *Guidelines in most cases can be applied to the general acquisition of M&S across the life cycle*

Introduction

- Every Phase of the Acquisition Life Cycle uses M&S to help define, develop, test, produce, operate, and sustain defense systems and system-of-systems

  - *Before Acquisition Reform and "Better, Faster, Cheaper" space programs acquired complete flight or flight like hardware and flight software in the loop testbeds, Quals, Proto Quals, or Hanger Queens*

- M&S Acquisition Benefits

  - *M&S can improve design, integration, and evaluation*

  - *M&S can speed up the design-evaluation cycle, and save time, money, and resources, reduce risk, and improve the quality of the systems being acquired*

  - *VV&A required for M&S used to support programs or major DoD decision-making*

Introduction (cont'd)

- M&S Acquisition Impediments
    - *Most M&S acquisition is stove-piped*
    - *One of the first things to be cut when program budgets are reduced*
    - *No requirement to document planned M&S support to acquisition*
        - Temp requires documenting the use of M&S, but needs more and should be included in Systems Eng Plan and T&E Strategy
    - *Contractual guidelines that exist for M&S and data needs are weak*
    - *Lack of agreed standards for sharing info and interoperating M&S tools*
    - *M&S validation often weak or non-existant*
    - *Programs often leave M&S planning, use, and ownership to prime contractors*
    - *Rarely is early consideration and contractual direction specifically intended to provide access to, or reuse of, models and data across the life cycle*

M&S Acquisition: Policy

- Acquisition
    - *"It is DoD policy that: 4.1 M&S is a key enabler of DoD activities."*
        - DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management", August 8, 2007

    - *"Models and simulations shall be used to reduce the time, resources, and risks of the acquisition process and increase the quality of the systems being acquired*
        - DoD Directive 3100.10, "Space Policy", July 9, 1999

M&S Acquisition: Policy

- IT&E
  - _"Integrated Test and Evaluation… The conduct of test and evaluation, integrated with modeling and simulation, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities as described in the system threat assessment."_
    - DoD Directive 5000.01, "The Defense Acquisition System", November 20, 2007

  - "2. T&E Planning … (6) Appropriate use of accredited models and simulation shall support DT&E, IOT&E, and LFT&E."
    - DoD Instruction 5000.02, " Operation of the Defense Acquisition System", December 8, 2008

M&S Acquisition: Policy

- Verification, Validation, &Accreditation
  - *"Models and simulations used during the course of the program are subject to Verification, Validation, and Accreditation (VV&A) in accordance with DoDI 5000.61 prior to use for program decisions or delivery to customers.*

    …

    Program Manager (PM) …

    10.8 Assume responsibility for V&V of models and simulations developed within the program in accordance with DoDI 5000.61…

    10.9 Assume responsibility for accreditation of all models and simulations used in support of the program office…"
    - AF Instruction 16-1002, "Modeling and Simulation (M&S) Support to Acquisition", 1 June 2000

- Accreditation is generally not a requirement on the contractor building the model or simulation

M&S Acquisition : Guidelines

Guideline •Benefits	System Cost, Time, & Risk Pro's and Con's
Have M&S Requirements on Contract •Not letting contractor dictate what M&S is done •Will have a deliverable	•Cost: Reduced cost since done at start of acquisition. The farther into the life cycle you get the more expensive. •Time: Will discover design issues earlier with early integration and test. Quicker recovery time. Ability to find work-arounds. •Risk: Risk is reduced by ensuring you have a delivered capability, that will allow early integration and test
Well Defined Requirements •M&S will have desired capability	•Cost: Cost will increase some as you are adding requirements or capability, but the earlier in the cycle the less costly. •Time: Less time spent by the contractor trying to determine what the customer wants, or making incorrect interpretations/assumptions •Risk: Reduced risk to system because more likely to get what you asked for

M&S Acquisition : Guidelines

Guideline •Benefits	System Cost, Time, & Risk Pro's and Con's
VV&A •Establishes the credibility of M&S in supporting program decisions.	•Cost: There is cost involved and can be expensive, but if planned in at start of acquisition cycle will be much cheaper than if suddenly realize at some later time that it needs to be done •Time: Generally should be a fixed amount of work that if spread over the acquisition cycles should be minimal. If not planned for can be very expensive and impact the schedule. •Risk: Decreases the risk of using the simulator. If don't do a VV&A then it might actually increase the risk of using the simulation. VV&A also reduces the risk to the system as it provides a reliable source for decision making
Configuration & Data Management •Gives credibility to M&S •Provides for safety of the system	•Cost: Increases cost some, but lowers acquisition life cycle cost •Time: Adds to development time, but increases the system life •Risk: Lowers risk to system, and lowers probability of system damage or loss

M&S Acquisition : Guidelines

Guideline •Benefits	Cost, Time, & Risk Pro's and Con's
Hardware in the loop •The more flight or flight like hardware in the loop the more fidelity and capability M&S brings to the program	•Cost: Can be a significant cost if buy actual flight hardware that is space qualified. Flight like is not as expensive. If extra parts are part of the plan early on then can significantly reduce the life-cycle cost •Time: If planned for should not add any time, but if not then could have schedule impacts as delivery is awaited for. •Risk: The more flight like hardware in the loop the more like the system the M&S will be, and the more risk will be reduced to the system.
Flight Software in the loop •The more flight software in the loop the more fidelity or more flight like the simulator is	•Cost: Minimal; Operational software already exists and only cost should be to modify the software if he M&S hardware used is different than the flight hardware •Time: Minimal: Installation times with regression testing , and any modification to SW since HW is not the same as the flight hardware. •Risk: Reduced the more flight like the software is

M&S Acquisition : Guidelines

Guideline •Benefits	Cost, Time, & Risk Pro's and Con's
SV to GS interface modeling •Increased capability and fidelity	•Cost: Some increased development cost, proportional to the complexity of the SV to GS linkage •Time: Increased development time proportional to complexity •Risk: Decreased risk to system having a casualty and being able to recover from a casualty due to additional capability during development and operations
Simulator Physical Location •Increase/Decrease response time •Increase/Decrease Fidelity	•Cost: More widely spread the more people needed and the more costly the support over time or the more expensive to connect the separate units together with comm lines or a network. •Time: More widely dispersed the simulation the less responsiveness. •Risk: The more widely dispersed the less timely and less fidelity of simulation which increases risk

M&S Acquisition : Guidelines

Guideline •Benefits	Cost, Time, & Risk Pro's and Con's
Data Sources and Rights •Real data	•Cost: If data considered proprietary there may be some cost involved to acquire it. V&V of data will add cost •Time: V&V adds time for additional work •Risk: V&V of data sources is necessary for establishing credibility of data and reduce risk of the system by using a simulation
IA Certification and Accreditation •Allows connection of simulation to whatever network it is needed to connect to.	•Cost: Will cost to go through certification and accreditation process. This can take a long time and will cost more if not planned out in advance. •Time: Takes a long time to accomplish. Needs to be put in system planning, else will cause a schedule impact. •Risk: If no IA C&A then will not be able to connect the simulation and will lose the benefits of having a simulation.

M&S Acquisition : Guidelines

Guideline •Benefits	Cost, Time, & Risk Pro's and Con's
Time Control of Simulation •Added Fidelity •Increased	•Cost: Added capability will cost more, proportional to the amount of effort to introduce the new capability •Time: Added capability will require additional time to implement based on how much and how complex the added capability •Risk: Added time control can increase fidelity, but need to be sure it meets requirements. Added capability does not necessarily mean that you can meet requirements. Such as if the scene injection of the sensor is very processor resource consuming then could bog down the simulation so it cannot run real time or as fast as requirements state the simulation needs to.
M&S Includes Environment •Increases fidelity of simulator	•Cost: Increases acquisition cost •Time: Increases acquisition time, but should increase satellite life •Risk: With environment simulation risk will decrease the possibility that the satellite lifecycle will be truncated

Summary

- Existing guidance is fairly general and broad but does emphasize:
  - *Use with Integrated Test and Evaluation (TLYF?)*
  - *VV&A*
  - *M&S capability to use for training*
- M&S provides tremendous capability and utility that is essential for TLYF:
  - *Need to plan for early in the acquisition life cycle*
  - *Need to understand what you questions you want to answer and to what level of fidelity with the M&S capability*
  - *There are several logisitical issues that need to be considered*

References

- DoD Directive 5000.01, "The Defense Acquisition System", November 20, 2007

- DoD Instruction 5000.02, " Operation of the Defense Acquisition System", December 8, 2008

- DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management", August 8, 2007

- DoD Directive 5000.61, "DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)", May 13, 2003

- DoD Directive 3100.10, "Space Policy", July 9, 1999

- AF Instruction 16-1002, "Modeling and Simulation (M&S) Support to Acquisition", 1 June 2000

- DoD 5000.59-P "Modeling and Simulation (M&S) Master Plan", October 1995

- "Department of Defense Acquisition Modeling and Simulation Master Plan", April 17, 2006

Questions?

BACKUP

M&S Acquisition: Policy

- Verification, Validation, &Accreditation
  - *Verification: The process of determining that a model implementation and its associated data accurately represents the developer's conceptual description and specifications.*

  - *Validation: The process of determining the degree to which a model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model.*

  - *Accreditation: The official certification that a model, simulation or federation of models and simulations and its associated data are acceptable for use for a specific purpose.*

    - DoD Directive 5000.61, "DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)", May 13, 2003

M&S Acquisition: Policy

- Verification, Validation, &Accreditation
  - *"Models and simulation used to support major DoD decision-making organizations and processes shall be accredited… Models and simulations used to support joint training and joint exercises shall be accredited… Accreditation requirements of models and simulations used to support all other applications shall be determined at the DoD Component level."*
    - DoD Directive 5000.61, "DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)", May 13, 2003
  - *"Program Manager (PM) …*

    10.8 Assume responsibility for V&V of models and simulations developed within the program in accordance with DoDI 5000.61…

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