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# Reference Architectures for Model Based Distributed Integration and Test

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# Topics

- **Background**
  - Definitions
  - Motivation
- **Raytheon Project**
- **NDIA DT&E/M&S Meeting**
  - Benefits
  - Barriers
  - Lessons Learned
  - Recommendations and Next Steps
- **Summary**

# Model Based Distributed Integration & Test Raytheon Definition

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## Model Based Distributed Integration and Test (MBDI&T):

**The ability to perform geographically distributed system integration and test using modeling & simulation as an enabler.**

This means that developers (who may be at other Raytheon sites, government sites, teammate sites or competitor sites) can operate a system enabled by modeling and simulation to inject realistic environmental stimuli, in order to exercise interfaces and demonstrate system behavior and interoperability.

**Use M&S as an enabler for CT, DT, and OT as a continuum for information discovery and incremental verification among distributed partners.**

# Motivation
# Voice of the Customer: "Better Buying Power"

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- **Reduce the cost of testing:**
  - Use existing government test capabilities
  - Reduce the travel required
  - Participate in Integrated Testing
- **Increase test efficiency:**
  - Improve test coverage through scientific test design (e.g., DOE)
  - Reduce number of test assets required
- **Use integrated test to reduce the overall cost of acquisition:**
  - Conduct operationally relevant contractor testing to find problems earlier in the development process
  - Provide data that can be used by OT&E for independent evaluation
- **Increase use of Modeling and Simulation:**
  - Contract Award
  - Program Execution
  - Use of government models

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# Raytheon Project

# MBDIT Workshop Summary
# Burning Platform

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- **Can improve to align with customer's affordability vision**
  - Transition from traditional paradigm where develop our systems in isolation and bring them to test events for first time integration
  - Integration risk disconnects and quality escapes can be reduced
  - Early discovery of problems can provide integration & test cost avoidance

- **Our DoD customers are also looking to engage in Integrated Testing (Integrated DT/OT)**
  - MBDI&T facilitates this by providing persistent test capability through contractor, developmental, and operational test
  - DoD has established JMETC to provide this type of capability. RFPs ask for contractors to use government test capabilities. Raytheon needs a persistent node to connect to JMETC.

# MBDIT Project
# Desired Outcomes

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- **Effective Collaboration by Distributed Teams using M&S**
  - Increased productivity
  - Reduced travel to support collaboration by a geographically dispersed team
  - Balance staffing needs across the company with less travel
- **Effective Distributed Collaboration that Includes Government Partners**
  - Increased use of government models (e.g. TENA object models)
  - Reduced schedule required to develop models.
  - Support affordability initiates to use government facilities/models (RFP evaluation criteria)
- **Successful Distributed Collaboration with Our Industry Partners**
  - Reduced subcontract management costs
  - Reduced travel to support collaboration by a geographically dispersed team
  - Mitigate perceived disadvantage when our competitors have equipment co-located.
- **Successfully Implement Integrated Testing**
  - Conduct DT&E activity with JMETC connectivity
  - Data collected is made available to OT&E for independent evaluation
  - Field systems earlier
  - Support affordability initiatives to implement integrated testing (RFP evaluation criteria)

# MBDIT Project Overview

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- **Virtual Workshop Preparation**
  - Survey and interviews with IV&V and MS&A practitioners to identify existing capabilities and programs that had engaged in MBDI&T
  - Briefings on lessons learned from implementing MBDI&T on their programs
  - Briefings on JMETC and TENA
  - Interviews of survey respondents
- **Virtual Workshop Conduct (April 2012)**
  - Process Development
  - Security Concerns
  - Reference Architecture Use Cases
- **Follow-on Workshop Conduct (August 2012)**
  - Briefings on MBDI&T programs
  - Collect benefits, barriers, and lessons learned

# MBDIT Reference Architecture
# OV-1: Operational Concept

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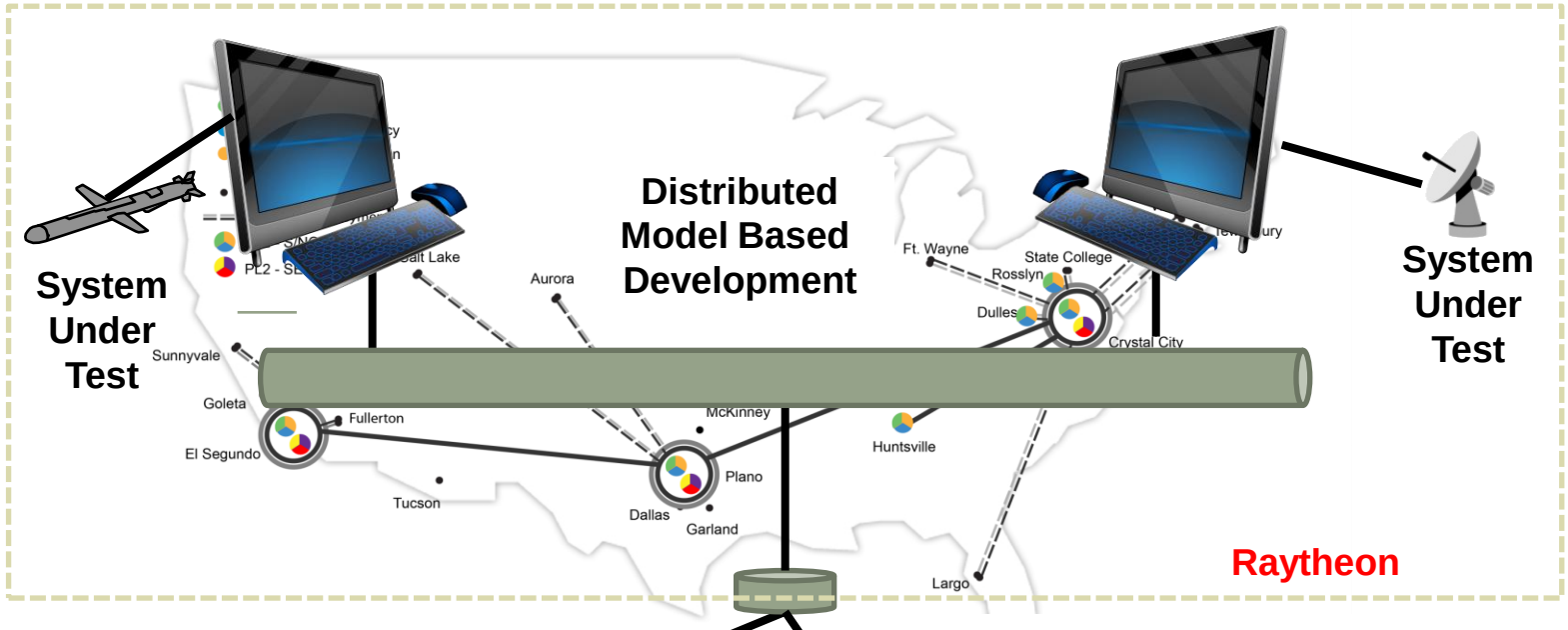
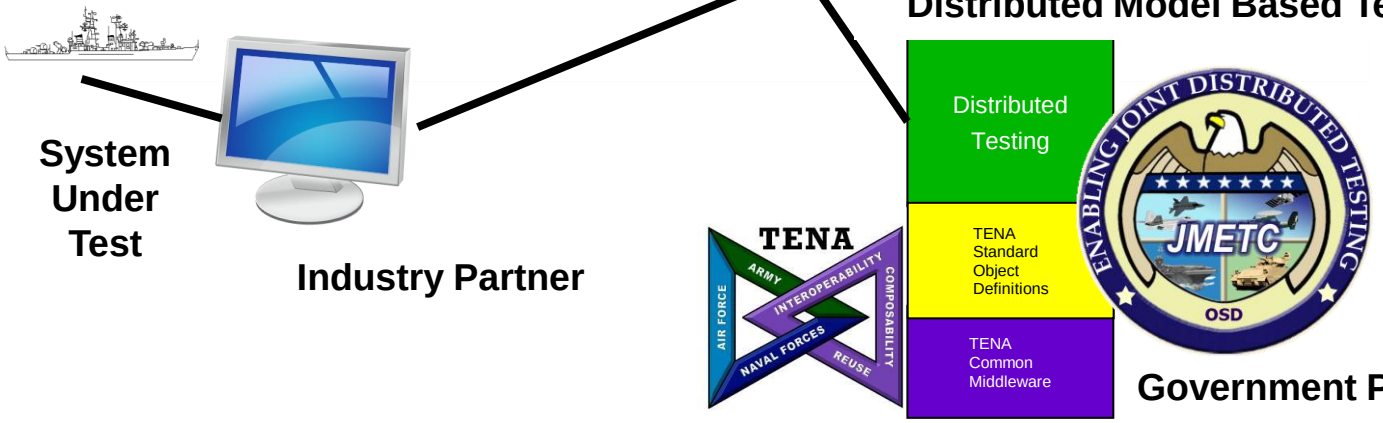
## Model Based Distributed Integration and Test (MBDIT)




### Distributed Model Based Testing



# MBDIT Reference Architecture Use Cases

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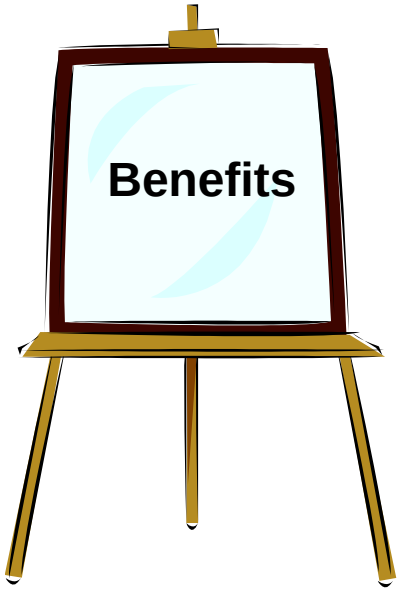
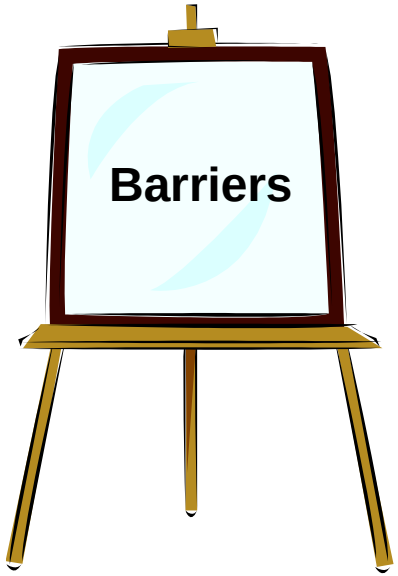
| Use Case | Description | Benefits |
|---|---|---|
| Concept Demo/Trade | Access models in distributed nodes to assess or demonstrate performance in different configurations. | Collaborative trade studies using models from different businesses, demonstrate capability of a candidate configuration |
| Collaborative Development | Geographically dispersed developers collaborate on the same program with access to models in a working and persistent environment. | Collaborative development without travel, incrementally add new capability to an existing configuration to evaluate results. |
| Distributed Testing | Configure a test environment with synthetic and actual system components to verify system requirements. | Perform distributed testing to access Hardware in the Loop (HWIL) assets in different locations, implement integrated testing so that data collected during DT&E can be made available for independent evaluation by OT&E. |

# MBDIT Workshop Results

- **Current State**
  - Pockets of 'best practice' utilize model based distributed integration and test
    - End to End Distributed Development Systems (various services)
    - Stimulation Frameworks (various programs)
    - JMETC (various demonstrations)
  - Use of MBDI&T is typically the exception not the rule!
- **Captured Discussion Results**

  *Inputs for NDIA DT&E/M&S meeting following week*

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# NDIA DT&E/M&S Meeting
# August 21, 2012

**Participants:**
Catherine Parker,
Jerry Feinberg, Alion
Paul Huang, Army Research Lab
Brandy Greenberg, Alion
Louisa Guise, Raytheon
Beth Wilson, Raytheon
Kevin Knudsen, Boeing
Thomas Holland, NAVC
Michael Bell, ATEC

# Benefits Include…

- Find integration issues earlier
- Test to learn in ‘safe’ environment
- Protect proprietary information
- Facilitate DT to OT transition
- Increase performance testing range in operating environments
- Support end to end studies throughout the program

1. Proprietary – could make a business case for sharing in a distributed test
2. Reuse and repurpose through the product model
3. Finding and injecting problems early
4. Collaboration with distributed and industry partners
5. Helps to integrate the components
6. Supports end to end studies throughout the program
7. Discover interface ambiguity and issues
8. Inject product technology earlier
9. Preflight analysis
10. Test to learn – can’t afford to fail in a test – we can fail in a simulation
11. Simplifies the transition from DT to OT
12. Use M&S to do virtual testing to reduce the physical prototype builds and test (reduce overall cost of acquisition)
13. Cost effective way to do Systems and System of Systems test
14. Full range of performance in the intended operating environments – tests the edges that are too dangerous for OT
15. Early user feedback (OT)

NDIA Meeting Results

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# Barriers Include…

- Security
- Lack of persistent network
- Early consideration of technical issues
- Perceived value
- Disconnect between the communities (M&S and T&E)

1. Security. Connecting to distributed labs/networks. Takes too much time – approvals/bureaucratic not a technical issue.
2. Lack of a persistent network. How do you get it funded? Program funded is temporary, Contractor funded needs ROI. Need planning and sustainment.
3. Education. Need awareness, framework, how to use it. Contractor test to OT&E. Communicate and understand the value.
4. What is the incentive to use M&S? Need the perceived value.
5. Reuse – proprietary, suitability, don't know how to use it "here's a model go download it", knowing that it is there, understanding its interoperability, fidelity, know the design intent
6. Need to understand the latency of the M&S in the lab/distributed test - may be different than reality – don't want to induce latency – need to know what the latencies are – depends on the data element of interest – it may not apply – need to have the discussion – design to accommodate
7. Can it operate real time – time – more than synchronizing the start
8. Decrees don't work without ROI, the enablers and the funding
9. M&S developers are not connected to the T&E stakeholders
10. Different views/understandings/perspectives of the models/simulations between M&S and T&E
11. Unsubstantiated assumptions
    1. If they use the same ICD they must be able to integrate
    2. I can pull out a model from a repository and just use it and its available whenever I need it
    3. I can get the hardware whenever I need it
    4. Use different boundary conditions and parameters
12. Interaction of models (federations)
13. Adequate time to develop M&S for design and test

NDIA Meeting Results

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# Recommendations…

- Harmonize the standards for M&S and Test for the life cycle perspective (HLA, TENA, Metadata)
- Create a framework for reusing and repurposing M&S through the product model
- Establish M&S as part of statistical test design
  - Determine what tests are conducted to acquire data for model validation.
  - Fewer test events with better models.
- Recommend the use of M&S to do I&T
- Recommend establishment of JMETC as a persistent node for industry to engage in MBDI&T

1. Harmonize the standards for M&S and Test – the life cycle perspective. HLA, TENA, Metadata
2. Create a framework for reusing and repurposing M&S through the product model – How does a model evolve from a concept to a design to a product?
3. Emphasize reuse and repurpose through the product model
4. Understand what is out there (standards) – get a baseline
5. Map fidelity to intended use – identify intended use early
6. Use M&S as part of DOE.
7. Determine what tests are conducted to acquire data for model validation.
8. Fewer test events with better models.
9. Investigate verification by simulation as a verification method
10. Investigate the use of M&S to do I&T (integrate early)
11. Evaluate the barriers and determine root cause
12. Identify successes, learn from them, pass on to community

NDIA Meeting Results

# Summary

- **Definition:** Model Based Distributed Integration and Test is the ability to perform geographically distributed system integration and test using modeling and simulation as an enabler.
- **Benefits**: Affordability through early information discovery and incremental verification among distributed partners
- **Barriers**: Security, Perceived value for investment, Disconnect between communities
- **Lessons Learned**: Early and continuous collaboration using common definitions
- **Recommendations**:
  - Harmonize standards
  - Create framework for reuse and statistical test design
  - Promote use of M&S for I&T