Modeling and Simulation in Support of T&E

Physics-Based Modeling & Simulation in Support of T&E Requirement Panel

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Overview

- Models and Simulations (M&S) are essential tools throughout the entire life-cycle of product development

  M&S are essential tools for:
  - Element Engineering
  - Requirements & Algorithm Development
  - Design Prototyping
  - Requirements Verification
  - Operational Planning
  - Flight Test Pre-Test Analysis
  - Post Flight Reconstruction (PFR)
  - Performance Assessment (PA)

Vital Use Cases Drive Evolving Need For Simulations as Deliverable Products
All Programs use Modeling and Simulation

- Digital (All Software), Processor-in-the-Loop, and Hardware-In-The-Loop Experience for all Major Programs

Sample LEGACY PROGRAMS
AN/TPY-2 (THAAD, Forward Based)
Patriot, JLENS, ZUMWALT, UEWR, CDU, Standard Missile, Sparrow, AMRAAM, Maverick, EFOGM, Sidewinder, ATACMS, Phoenix, IR&D, etc, etc
System Development Process

Radar Top Level Capabilities & C2BMC to Radar IRS/IDD

System Requirements Review (SRR)
System Design Review (SDR)
Preliminary Design Review (PDR)
Critical Design Review (CDR)
Test Readiness Review (TRR)

System Integration & Test Complete, Ready for System Validation
M&S Evolving as Computing Capabilities Grow

- M&S problem multi-dimensional
  - M&S requirements range from simple quick and dirty design tool to complex non-realtime models to many-on-many distributed architectures

- Design choices include trades of model complexity vs. run-time
  - Historically, running real-time or near real-time would necessitate limiting model fidelity
  - Increases to computing power have continued to “blur” the trade space allowing greater fidelity while still running real-time
    - Greater fidelity translates directly to more complex models
      - Better target modeling
      - Better environmental modeling
      - Better Airframe models
      - Physics-based modeling has merit here
    - Greater Processing Power / Higher Fidelity reduces number of discreet simulation required

Physics-based Modeling will bring more bang for the buck
Simulation Plays a Significant Role in all Phases of a Systems Lifecycle

Increased Simulation Complexity to Reflect Evolving System

Low Fidelity Digital Simulations
- Kinematic 3-DOF
- Non-Tactical Platform Non Real-Time
- Some MATLAB-based

Medium Fidelity Digital Simulations
- Missile 6-DOF
- IR Detailed Seeker
- RF Detailed Seeker
- DATCOM, Training, Logistics...
- Non-Tactical Platform Non Real-Time

Detailed One-On-One
- System & Sybsystem Design, Performance Prediction, Lethality, Training, Logistics

One-On-One Many-On-Many
- System Performance & Effectiveness

Digital System Simulations
- Emulated Code
- Non-Tactical Platform Non Real-Time

Tactical Software Checkout, Algorithm Evaluation

BM Surveillance Radar Track Radar
- Missile Launcher

Surveillance Radar
- Track Radar

SWIL Simulations
- Some Organic Capability

PIL Simulations
- BM Missle Launcher
- Surveillance Radar

Real-Time Dedicated Facility
- Drive Up

Interoperability with Tactical Test Beds, Total System Performance Exercising HW & SW in Real-Time

Interoperability
- JNTF
- Other
- National
- Tests Beds
- WSMR
- PMRF

Tactical Assets Real-Time
- Dedicated Facility
- Drive Up

Non-Tactical Platform Non Real-Time

Increased Processing Power/ Fidelity decreases number of discreet sims required

System Design & Development
Summary

- Models and Simulations (M&S) are essential tools throughout the entire life-cycle of product development.
- M&S are recognized as an integral part of Raytheon’s engineering process.
  - Virtually every project has a significant M&S component.
- Validated and Accredited M&S products can reduce program cost and risk.
  - Reduce the number of required live tests.
  - Reduce risk associated with scheduled live tests.
  - Perform parametric tests that cannot be performed in the field due to safety or cost constraints.
  - Perform Monte Carlo analysis to characterize statistical performance.
- M&S results are essential to tactical fielding & capability declarations.