

Raytheon

Customer Success Is Our Mission



Air
Land
Sea
Space
Cyberspace

Innovation. In all domains.

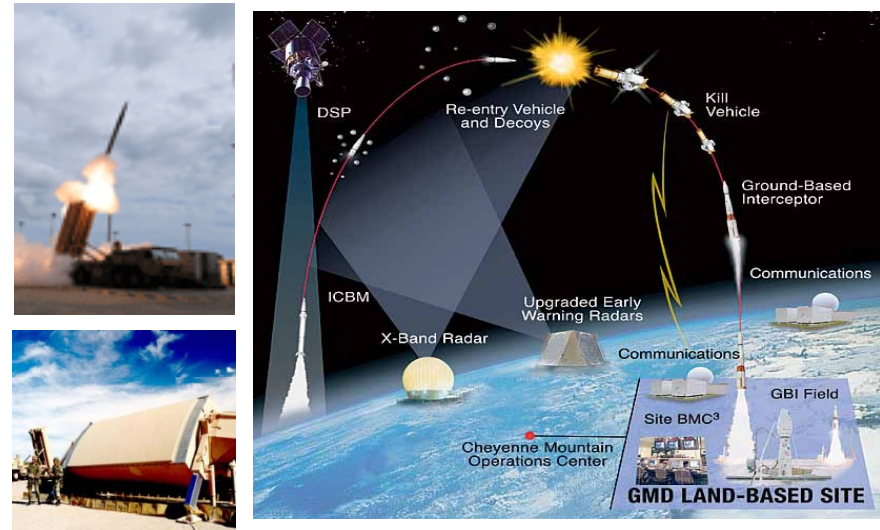
A Modeling and Simulation Overview at Raytheon

**NDIA SE M&S and DTE
Committee Meeting**

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10 August 2011**

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

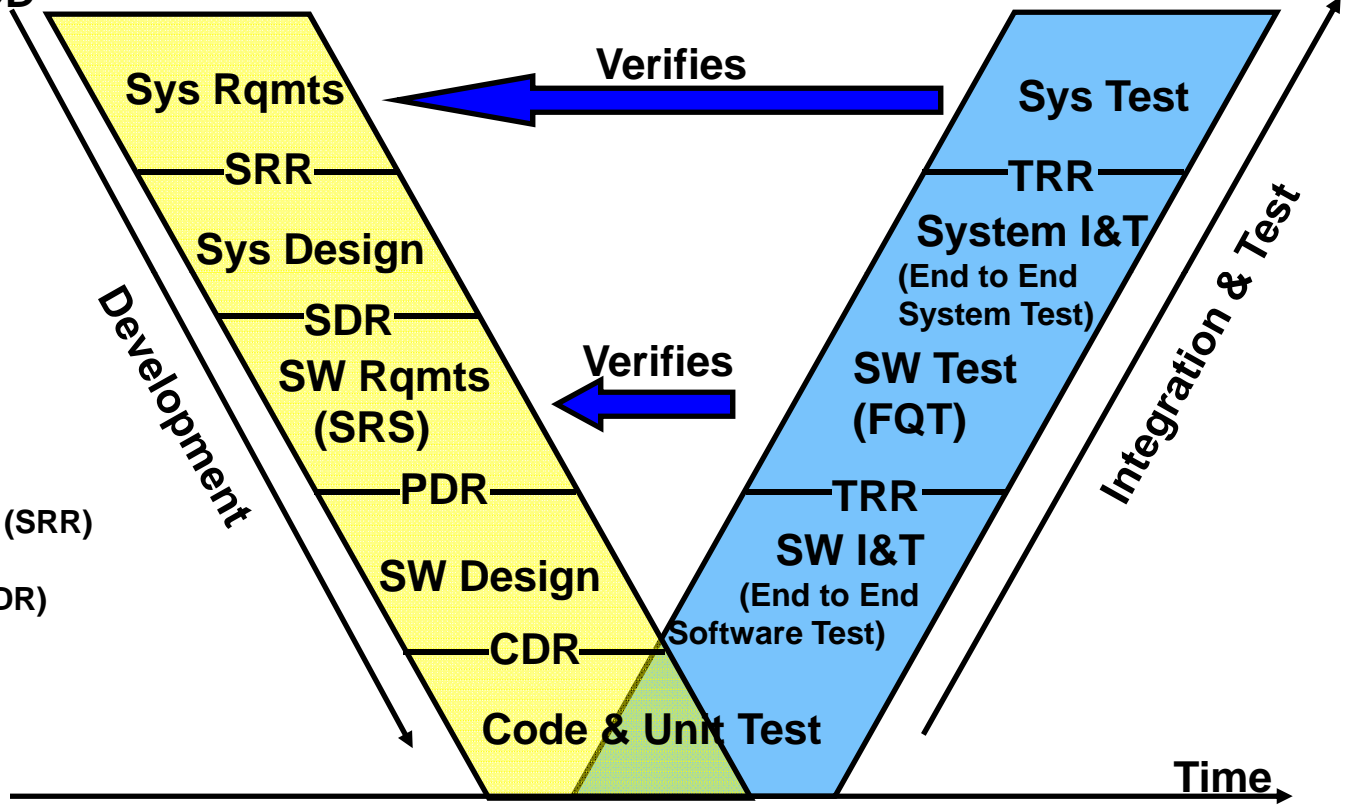


Recent Engineering Simulations

- Digital or Processor-in-the-Loop Simulations have been developed for the following:
 - Hawk
 - Patriot (PAC-2, PAC-3, PACM)
 - Standard Missile
 - Sparrow
 - AMRAAM
 - AIM
 - EFOGM
 - Maverick
 - ATACMS
 - IRTGSM
 - XBR
 - AN/TPY-2/THAAD
 - UEWR
 - CDU
 - JPSD
 - JLENS
 - ZUMWALT
 - IR&D Programs
- Hardware-in-the-Loop Simulations have been developed for the following:
 - Hawk
 - Patriot
 - ANTPY-2 (THAAD, Forward Based)
 - SBX
 - UEWR
 - Standard Missile
 - Sparrow
 - AMRAAM
 - AIM
 - EFOGM
 - Maverick
 - IR&D Programs

System Development Process

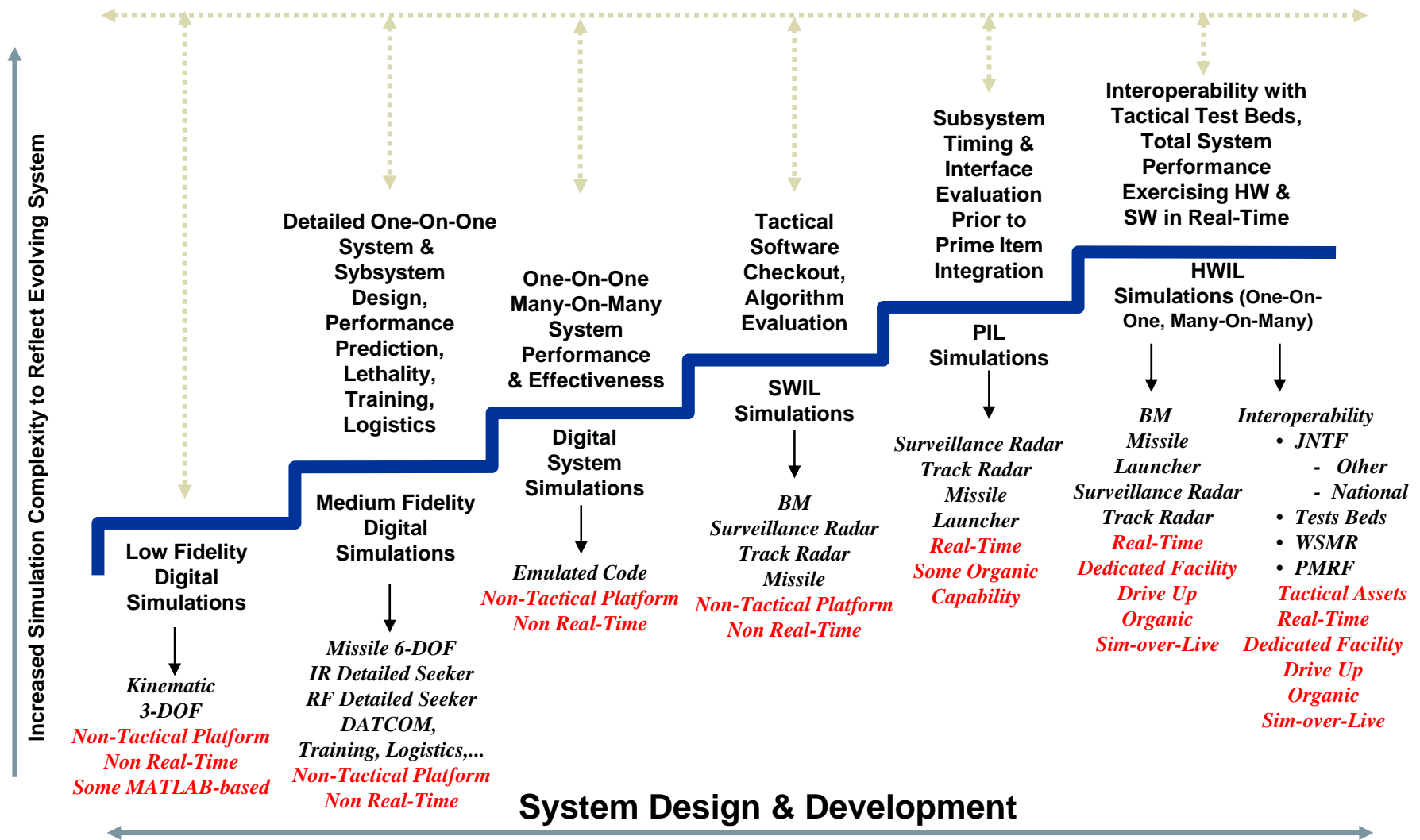
Radar Top Level Capabilities
&
C2BMC to Radar IRS/IDD



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

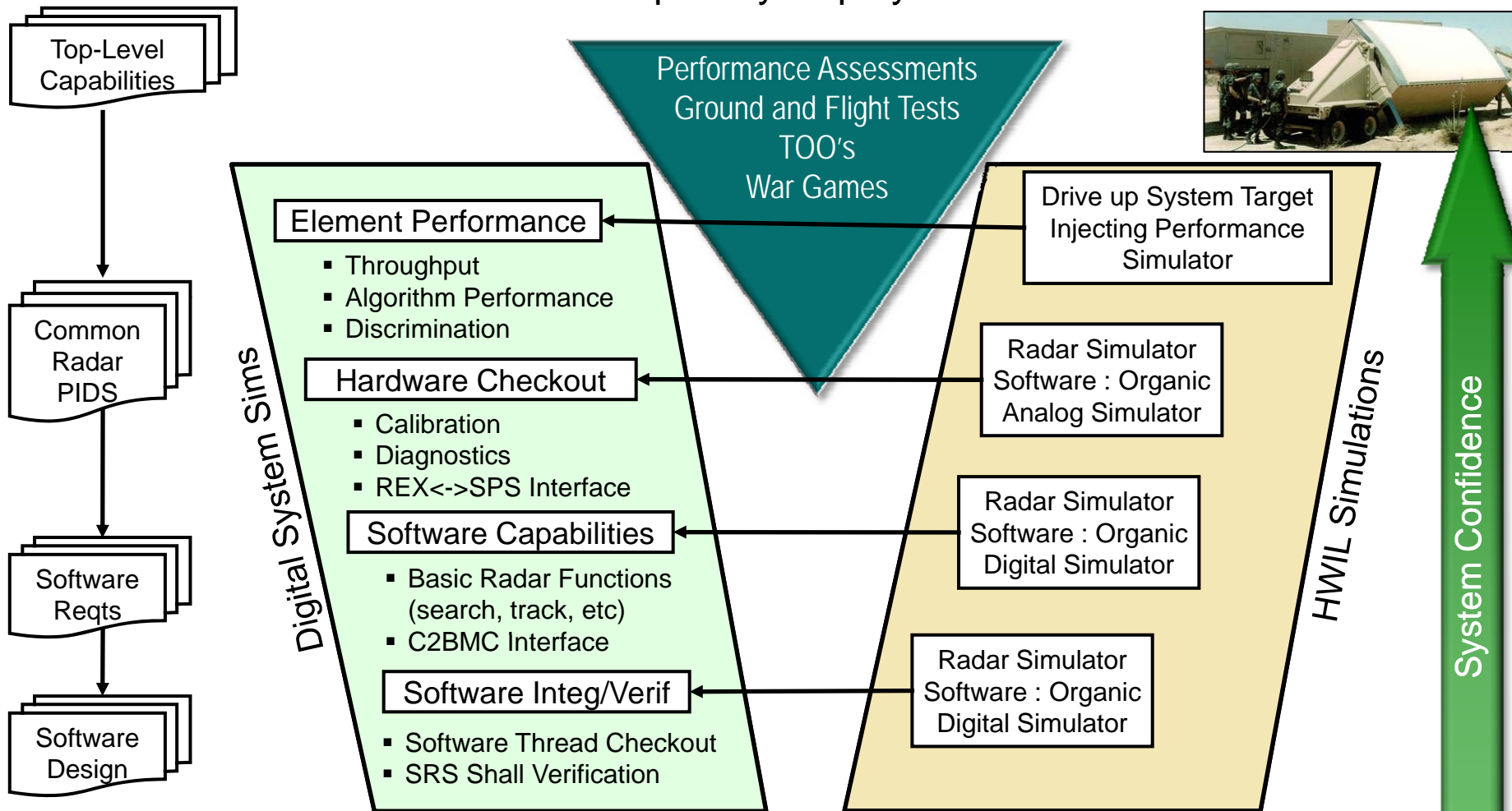
System Integration & Test Complete, Ready for System Validation

Simulation Plays a Significant Role in all Phases of a Systems Lifecycle



Simulation use for Development and Sustainment

Capability Deployment



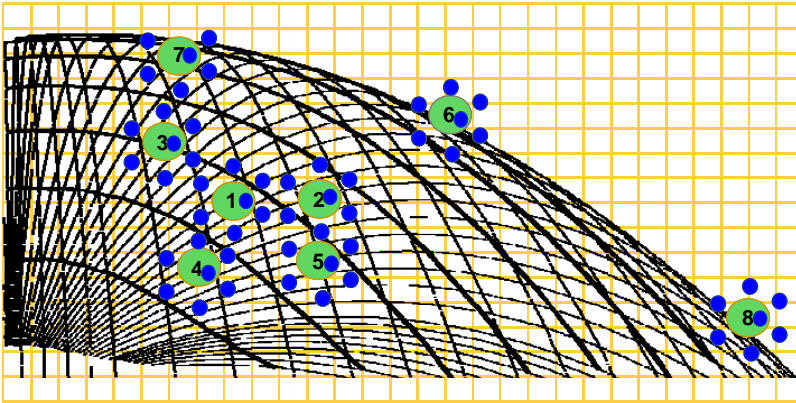
Each simulation is used to support different phases of Integration, Test, and Verification & Validation to increase overall system confidence.

Raytheon Use of M&S for T&E

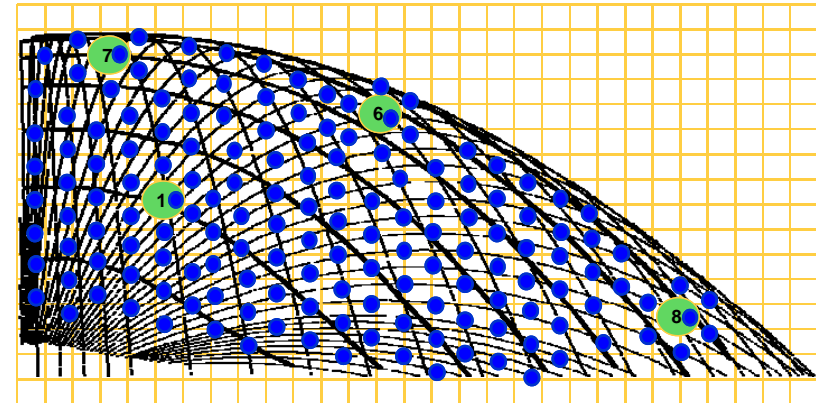
Summary of Use Cases and Capabilities

- **M&S for Integration & Test**
 - Distributed test beds allow real-time integration of distributed components across team mates
 - Software-in-the-loop (SWIL), computer-in-the-loop (CIL) and hardware-in-the-loop (HWIL) provide for integration of the components in increasingly realistic environments
- **M&S for Requirements Verification**
 - A large percentage of our requirements are verified via simulation due to the complexity of the scenarios and the systems (all-digital, SIL, CIL, and HWIL)
 - T&E supports model & simulation validation in order to provide confidence in these models
 - Design of Experiments is applied to both the test scenarios and simulation scenarios to cover the requirements space
- **M&S for Developmental / Flight Test Support**
 - Modeling and simulation is used to prepare for test events
 - Use “shooter boxes” around the test conditions to perform the Monte Carlo analysis for pre-flight predictions
 - Design of Experiments is applied to both simulation scenarios and flight test scenarios to support scenario definition
 - Flight test emphasis is on model / simulation validation to support requirements verification
- **M&S for Qualification Support**
 - Formal Qualification Tests use SWIL, CIL and HWIL environments
 - Models and simulations are used to perform weapons effectiveness / functional configuration audit to sell off system
- **M&S for Operational Test Support**
 - Models and simulations that have been appropriately validated through test events are used to support OT&E analyses.
- **M&S for Production Test Support**
 - DSleXpress is a corporate approved modeling tool to evaluate test coverage, fault detection and fault isolation in production environments
- **M&S for Operational Availability and Logistics Support**
 - DSleXpress is also used to evaluate BIT effectiveness (in conjunction with reliability tools)

Sim-over-Live (SoL) Operations



- SoL operations add to the overall system operational confidence via off-nominal testing



- SoL operations enable system testing otherwise unachievable with flight tests alone

- Flight Test Operating Point (Expensive Live Targets)
- SoL Operating Point (Inexpensive Synthetic Threat Suites)

SoL Operations Reduce Need for Costly Flight Tests

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 can not 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