

INCOSE IW 2015 MBSE Workshop

- **Session Title:**
 - Open Services for Lifecycle Collaboration (OSLC)
- **Talk Title:**
 - Raytheon's Experience with OSLC
- **Speaker:**
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Taken from

Session 1282, Model Based Engineering Automation and Design Connectivity

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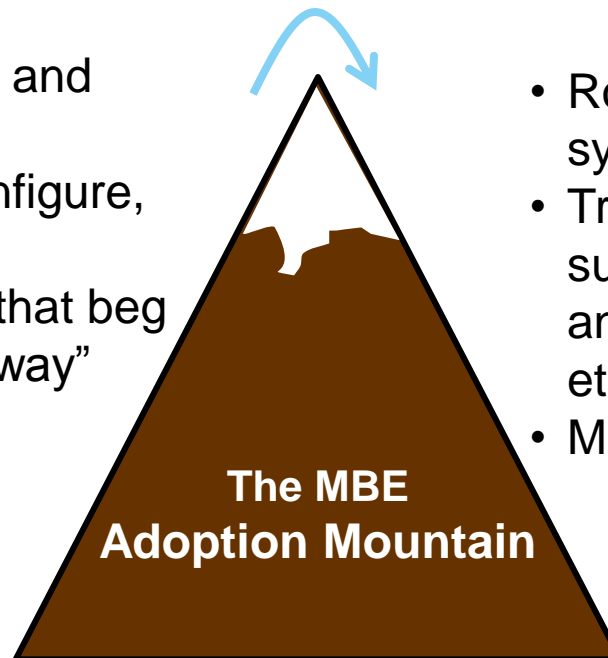
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Motivation

- Adopting Model Based Engineering can be challenging for an organization
- Requires **INVESTMENT** with unproven **PAYBACK**
- Demands an approach to “get over the adoption mountain” quickly and effectively

- New processes to define and learn
- New tools to acquire, configure, deploy, and learn
- Legacy artifacts in hand that beg to be leveraged “the old way”
- MBE needs to be proven

INVESTMENT

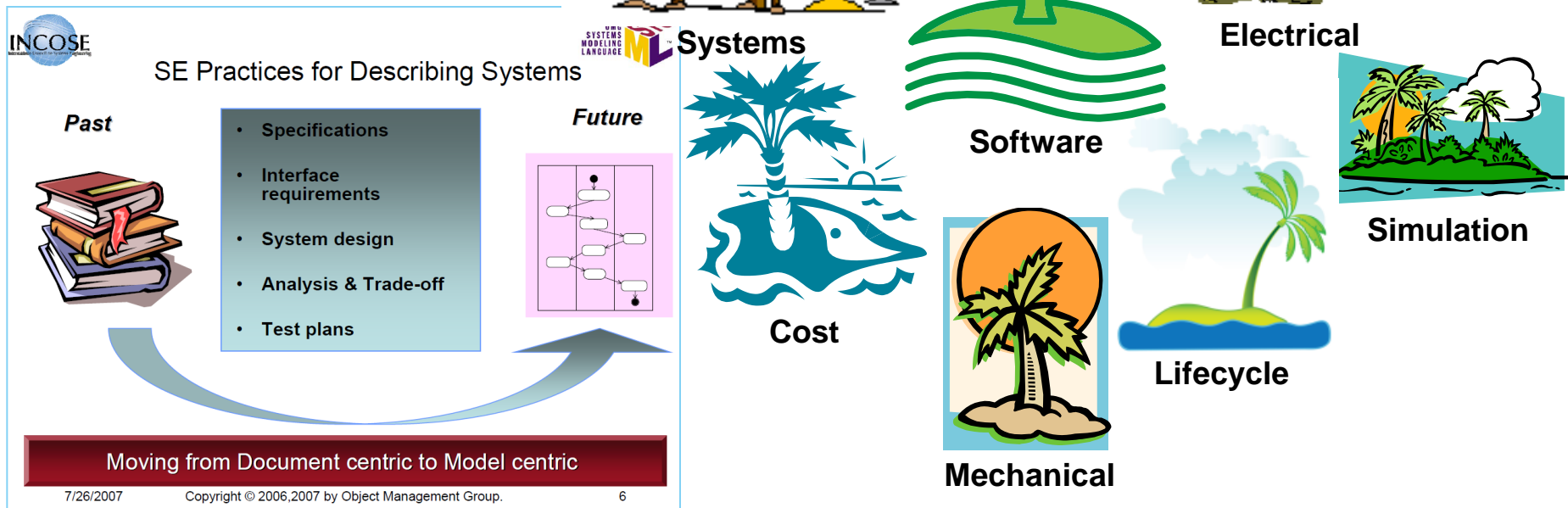


- Robust models that drive the system engineering process
- Traceability and linking to support change impact analyses, system evolution, etc.
- Metrics and assessments

PAYBACK

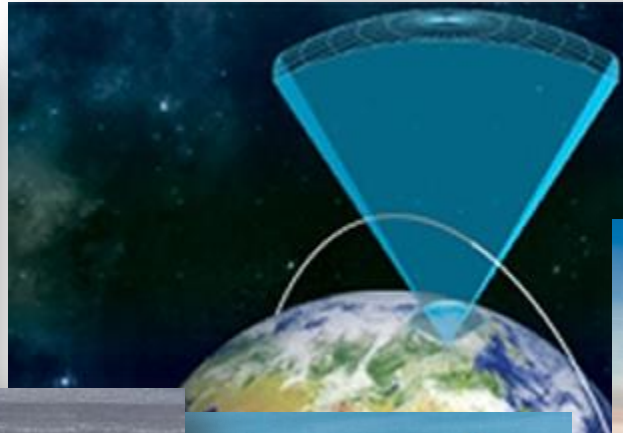
Challenges – Integrating Islands of Models

- Different Integration Standards (if any)
- Correlating Information Assets (What goes with What)
- Naming Conventions and Units of Measure
- Accessibility



Raytheon: Who We Are

- Raytheon Business Focus:
 - Defense
 - Aerospace
- More than 72,000 employees worldwide
- More than 40,000 engineers
- **2012 revenues of \$26.5B**



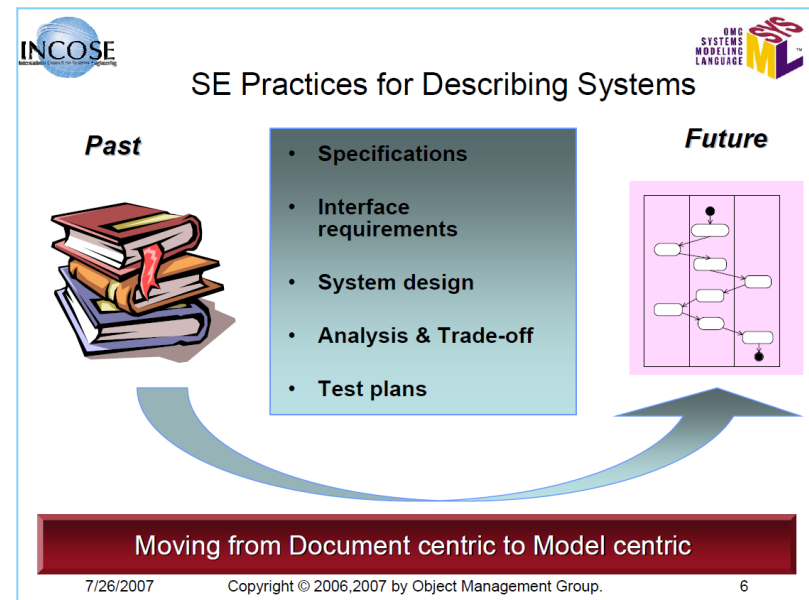
Raytheon

Getting over the MBE Adoption Mountain

- Address two aspects of this challenge:
 - 1. Leveraging automation and data import to accelerate adoption***
 - 2. Leveraging OSLC linking to provide robust multi-disciplinary linking to achieve measurable benefits of MBE quickly**

Case Example

- We wanted to apply MBE on a legacy program for which we had over a hundred B5 specifications, each hundreds of pages long, with thousands of interfaces identified
- Migrating all that information from documents to a Rhapsody model by hand would be costly, time consuming, and error prone.
- It would delay “getting over the MBE Adoption mountain”
- Our Goal:
Extract as much data from these specs as possible and use it to automation generation of a model

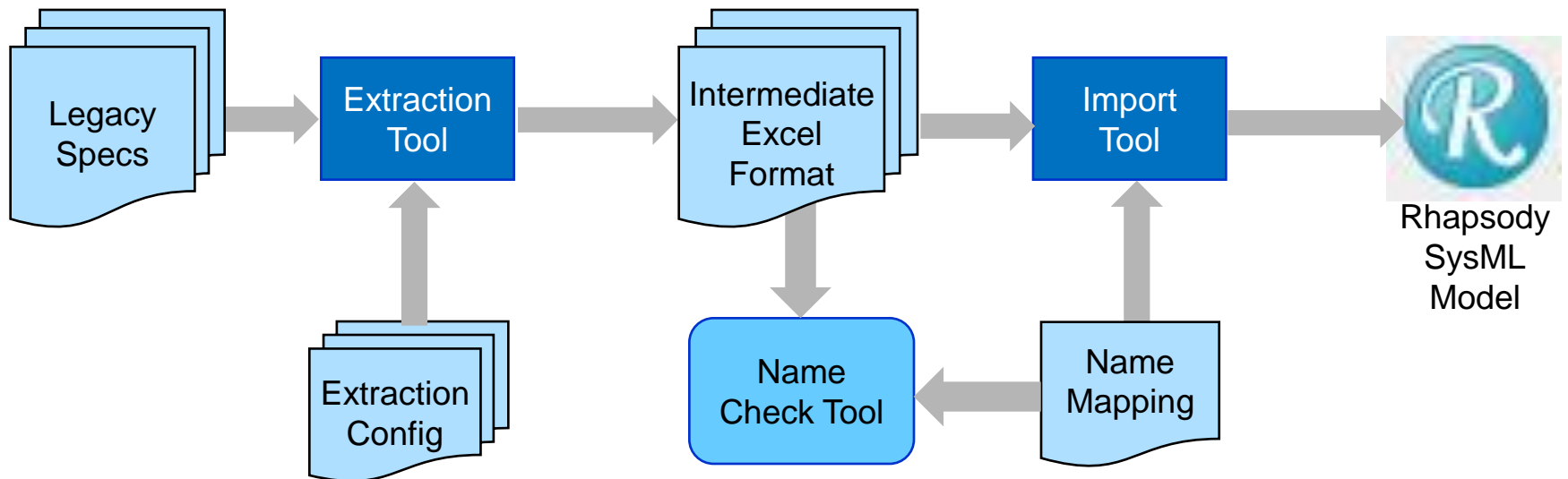


Focus first on the Low-Hanging Fruit

- Our B5 specifications included interface tables, both for internal (component-level) and external (element-level) interfaces
- From one of these simple tables it was possible to extract:
 - Sender and Receiver element and component
 - Message identifiers
 - Message names
 - Message descriptions
 - Several key interface parameters (e.g., rates, data classification)
- We realized that we could also generate:
 - Port names
 - Event reception names
 - Cross references back to the legacy specifications (could be OSLC references to DOORS)
- And that we could later add:
 - Data types (extracted from software artifacts)

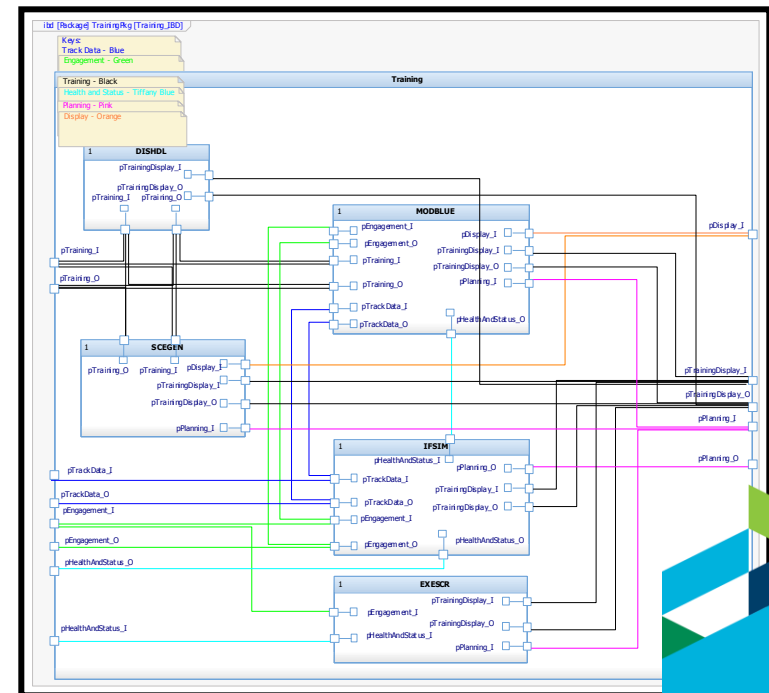
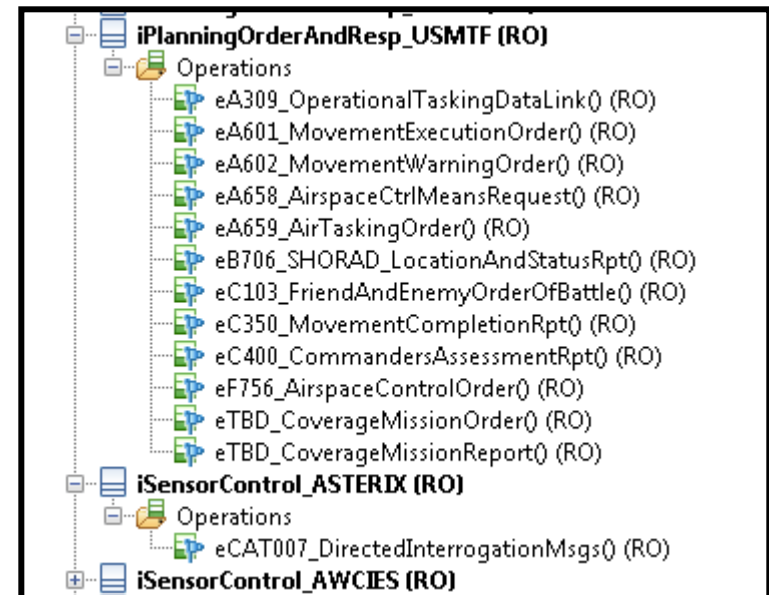
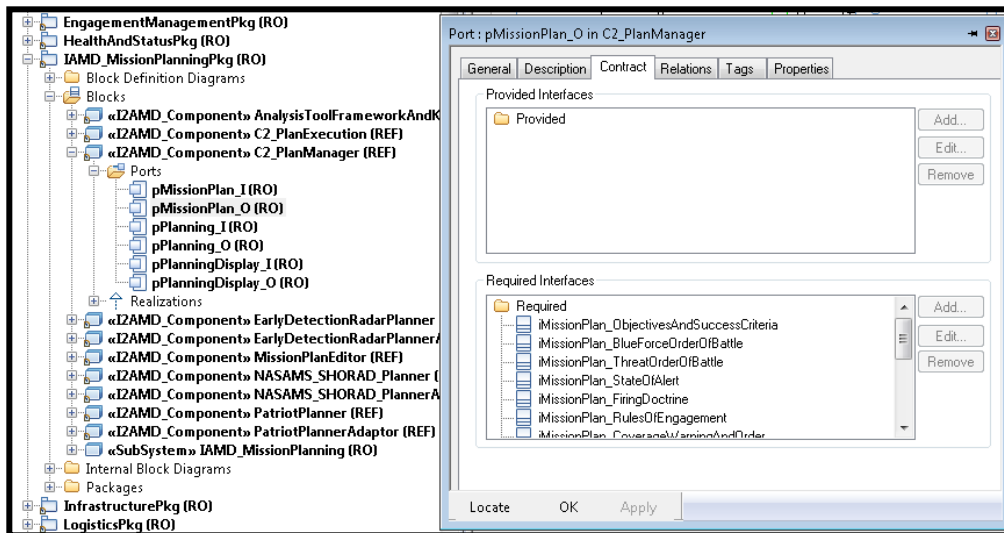
What did we develop?

- Process and supporting automation to support transition from legacy Document-Based Systems Engineering to SysML Model-Based Engineering
- Proof of Concept used on a large legacy program:
 - Over 100 legacy B5 Specifications and Interface Description Documents processed to extract interface and structure data
 - Process generated thousands of consistent SysML artifacts in the Rational Rhapsody tool



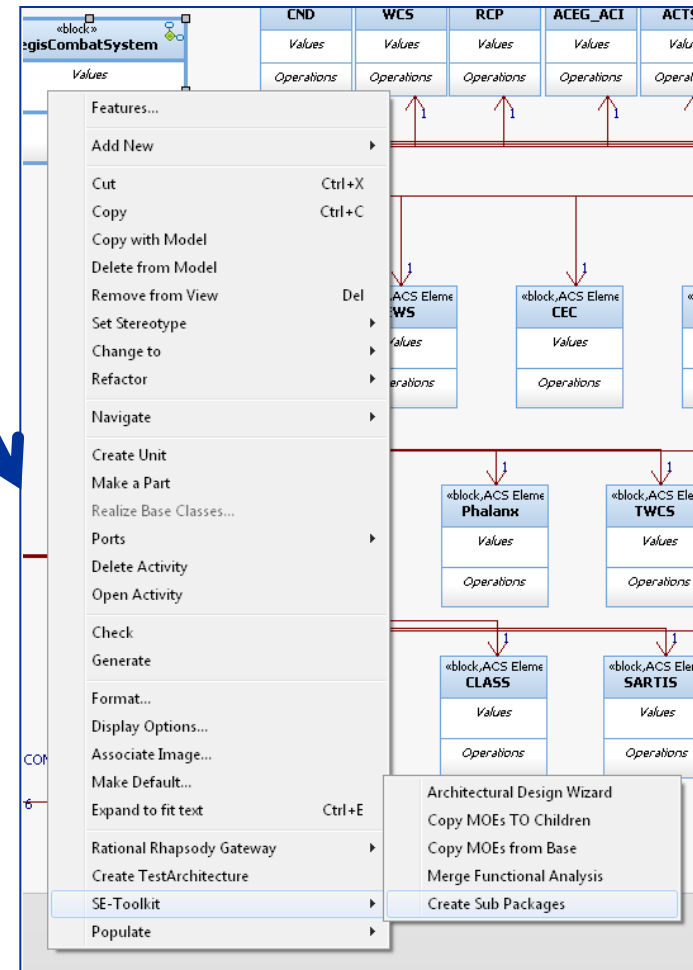
Generated SysML

- Interfaces and Operations on Interfaces
 - Inter-element and component-to-component
- Could have created blocks (but didn't)
- Events associated with interfaces
- Ports on Elements and Components (with Required and Provided Interfaces)
- Receptions on Elements and Components
- Connections between elements and components
- Delegation ports and connections from elements to components
- Relationships among all the above



Further Simplify using Rhapsody Plug-ins

- Make the automation ever easier
- Rhapsody Plug-ins are automation accessed through Rhapsody menus
 - Developed using Rhapsody API
 - Rhapsody provided plug-ins (e.g., SE Toolkit)
 - User developed plug-ins
- Creating a product plug-in includes:
 - Writing the Java application
 - Creating a .hep file containing requirements for loading the plug-in
 - Attaching the .hep file to a profile

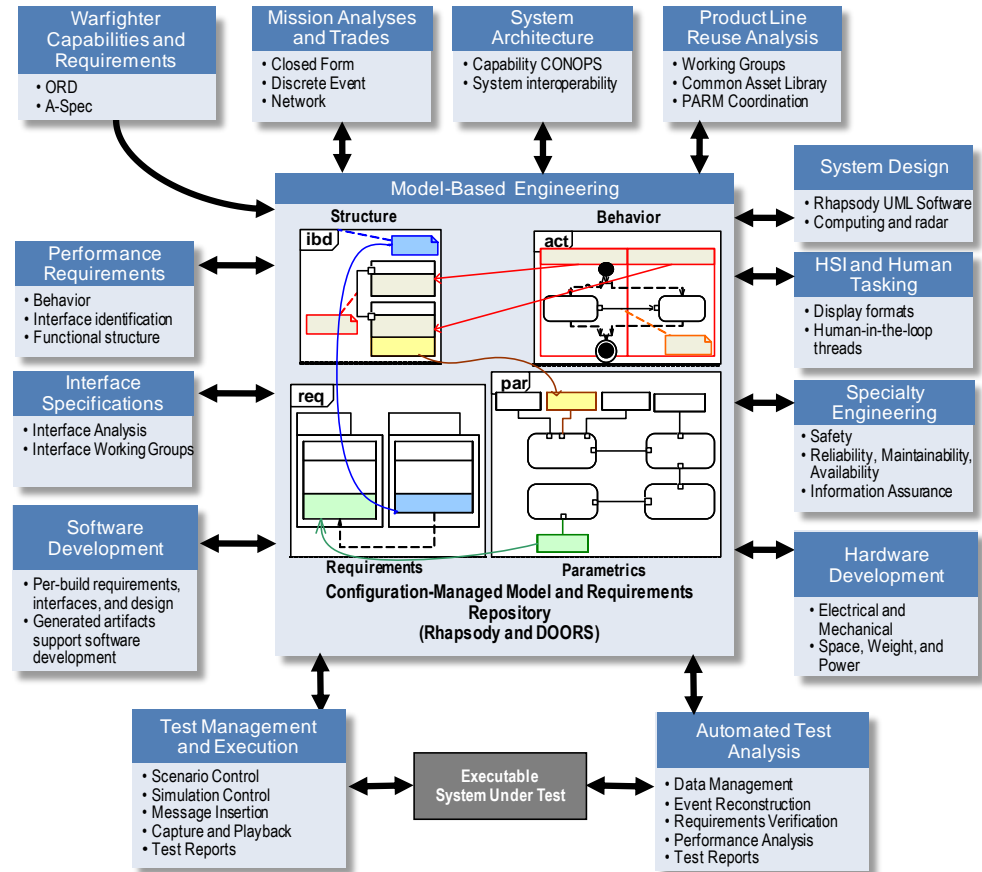


Getting over the MBE Adoption Mountain

- Address two aspects of this challenge:
 1. Leveraging automation and data import to accelerate adoption
 - 2. *Leveraging OSLC linking to provide robust multi-disciplinary linking to achieve measurable benefits of MBE quickly***

MBE Demands Multi-Disciplinary Linking

- MBE ~ Model Based Enterprise
- MBE is not one model but rather a collection of multi-disciplinary models
- Many relationships are missing in today's MBE approaches
- Establishing and linking relationships is the key to ensure design consistency
- Changes made from one perspective need to be reflected in others
- Complete / Interconnect Models = Complete / Consistent System Design



Model Based Engineering

Just Some of the Challenges



MBE Definition

Brian Wells: "The model is the design"

- **Model-Based Engineering (MBE):** An approach to engineering that uses models as an **integral part of the technical baseline** that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle
- **Model:** A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. (DoD 5000.59 -M 1998)
- **Preferred MBE Practices**
 - Models are maintained throughout the system lifecycle
 - Models are integrated with the system development lifecycle
 - The model is used to verify and validate the system requirements and design
 - Models are used to support system analysis and simulation throughout the lifecycle
- **Core to MBE is the integration of descriptive models and the computational models**

NDIA Systems Engineering Division, M&S Committee, MBE Subcommittee Final Report, Feb 2011

Challenge
Lifecycle Integration

Challenge
Stove-Piped Models



Potential MBE Costs and Risks

- **Initiating an MBE approach will require investment in tools, training, and infrastructure**
 - MBE must be institutionalized to be cost effective
 - The initial investment may be prohibitive if only used on one project
- **MBE approaches and tools will not replace strong, rigorous, and disciplined enterprise processes**
 - They must be integrated with the processes
- **Training is necessary, but not sufficient**
- **Must address stove-piped responsibilities**
 - Model artifacts will cross organizational / discipline boundaries
 - Requires a strong interdisciplinary team to support concurrent engineering processes and practices

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Challenge
Interdisciplinary Teams

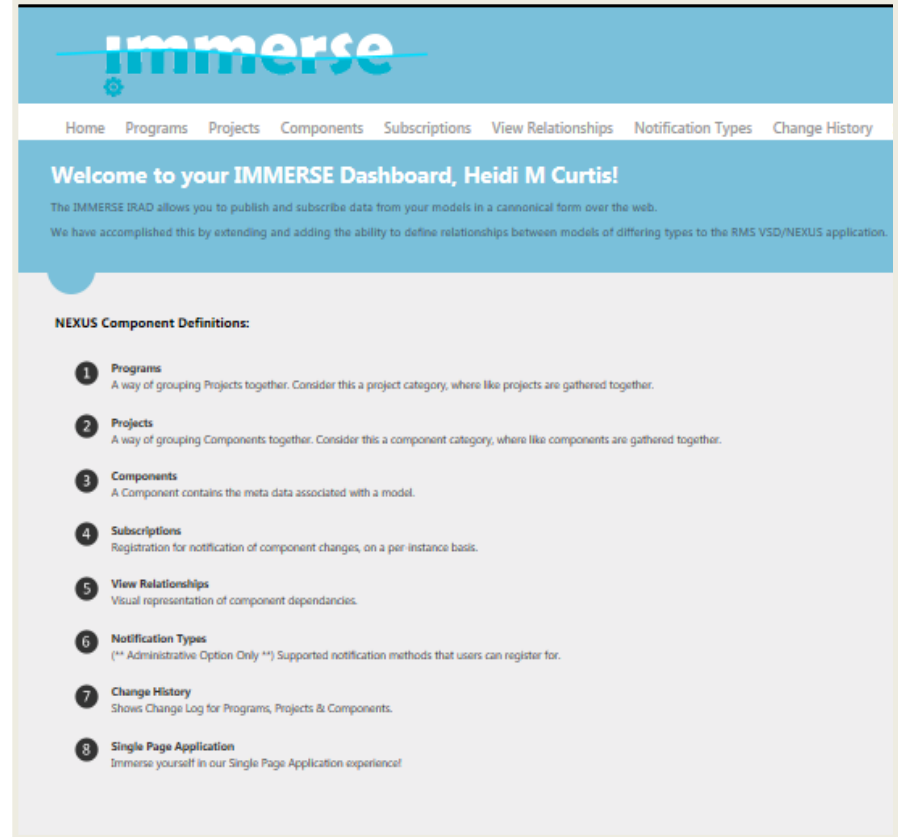


MBE Goals

- **The Models are the Design**
 - From Concept to Mission Scenarios to Architecture to Systems Design to Software/Hardware Design & Development to Verification & Validation and finally to Sustainment
....all based on linked Models across engineering disciplines, with end to end semantic consistency
- **Generate Data Once**
 - ...and transform and link as needed
- **Compose Future Systems**
 - Model based composition of components, subsystems, assemblies, test artifacts, etc....all linked, query able and managed under configuration control
 - Emphasis on model libraries and patterns for re-use across Product Line Engineering environments

Our Approach - Integrated Models & Methodologies

- Linked Data Architecture
- Tool Agnostic
- Leverage integration standards
 - Open Service Lifecycle Collaboration (OSLC)
 - Resource Descriptor Framework (RDF)
 - Modelica
 - Service Oriented Architecture (SOA)
 - Functional Mockup Interface (FMI)
 - Base Object Model (BOM)
 - Standard for Exchange of Product Data (STEP) / AP233
- MBE Data Model
 - What we want to link
 - Attributes of what we link



The screenshot displays the IMMERSE dashboard interface. At the top, the 'immerse' logo is visible in a blue header. Below the logo is a navigation menu with links for Home, Programs, Projects, Components, Subscriptions, View Relationships, Notification Types, and Change History. A blue banner below the menu reads 'Welcome to your IMMERSE Dashboard, Heidi M Curtis!' and includes a brief introduction to the IMMERSE IRAD and a note about extending the RMS VSD/NEXUS application. The main content area is titled 'NEXUS Component Definitions:' and lists eight items:

- 1 Programs**
A way of grouping Projects together. Consider this a project category, where like projects are gathered together.
- 2 Projects**
A way of grouping Components together. Consider this a component category, where like components are gathered together.
- 3 Components**
A Component contains the meta data associated with a model.
- 4 Subscriptions**
Registration for notification of component changes, on a per instance basis.
- 5 View Relationships**
Visual representation of component dependencies.
- 6 Notification Types**
(** Administrative Option Only **) Supported notification methods that users can register for.
- 7 Change History**
Shows Change Log for Programs, Projects & Components.
- 8 Single Page Application**
Immerse yourself in our Single Page Application experience!

Lessons Learned – Model Linking

- Our engineers want to work in their own comfortable modeling environments, so our team needed to provide a (very) user friendly approach to enable linking of cross-domain models
- We could not find a “reusable” data model that would adequately represent our model based enterprise
- Use of RDF as common denominator for model linking
 - Also enables use of many open source semantic tools
- Building plumbing is hard and not very rewarding

Future Directions – Model Linking

- Work with our tool vendors and standards organization to promote multi-discipline model linking
- Continue to experiment through our IMMERSE environment as a means to influence development of commercial solutions
- Working Semantics through technology and process
- Reasoning and Visualization

Summary

- Achieving widespread adoption of MBE in an organization is challenging
 - New processes, tools, and approaches to learn
 - Legacy data to leverage
 - Critical need to show return on investment
- Automation provides a way to help “get over the MBE Adoption Mountain”
 - Get started quickly by building a core set of model artifacts from existing documents
 - Focus on automation to support robust multi-disciplinary data linking to ensure ROI benefits can quickly realized
- Raytheon is focused on improving life cycle productivity through use of MBE methods