

SAVI System Behavior Modeling & Model Integration

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3 February 2016

Notes:

1. This presentation is based largely on a public presentation at the 2015 Global Product Data Interoperability Summit (GPDIS) by Dr. David Redman. Supplemental material approved for public release by the SAVI Project Management Committee (PMC) on 28 January 2016.
2. Except where other sources are identified, all images and graphics in this presentation are generated by SAVI member organizations and are used with the permission of the SAVI PMC.

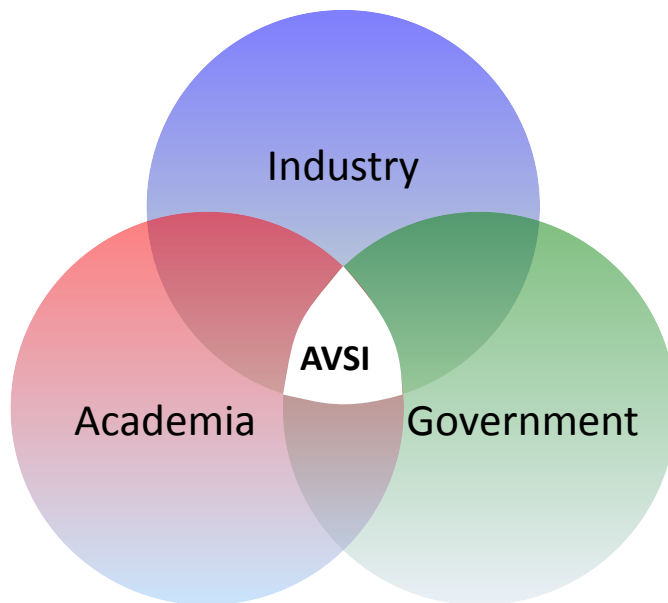
What's covered in this talk

- High-level overview of AVSI and SAVI
- What we mean by “behavior model”
- Behavior model integration
- Introduction to “consistency”
- Where SAVI behavior analysis is heading this year

AVSI overview

MISSION

AVSI addresses issues that impact the aerospace community through international cooperative research and collaboration conducted by industry, government and academia.



- *Contribute to **standards** and **policies***
- *Establish the **environment** that **enables collaboration** and **sharing of costs***
- *Create an **aerospace industry voice***

SAVI overview

Full Members

Airbus
Boeing
DoD
Embraer
GE Aviation
Honeywell
Rockwell Collins
United Technologies

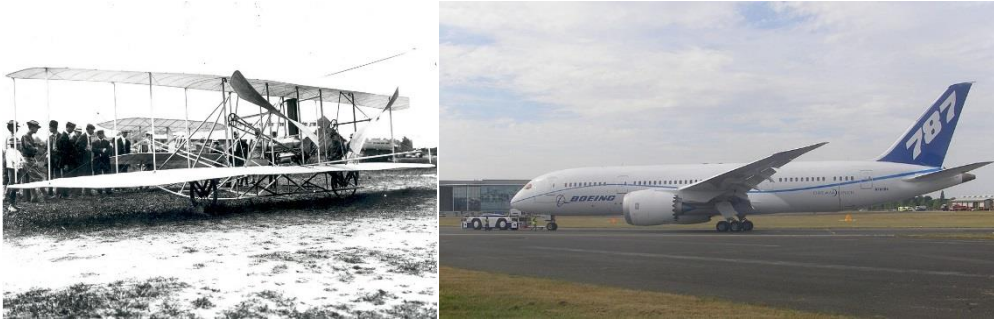
Liaison Members

- FAA
- NASA
- SEI

Tool Vendor Partners

- Adventium Labs
- Esterel Technologies
- Eurostep Limited

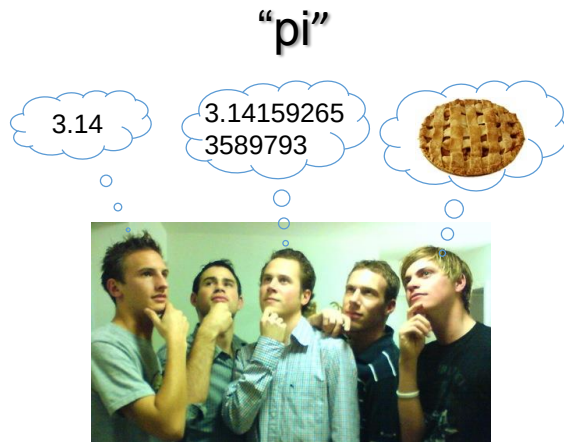
System development challenges



Increasing System Complexity

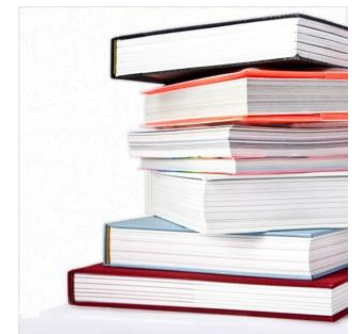


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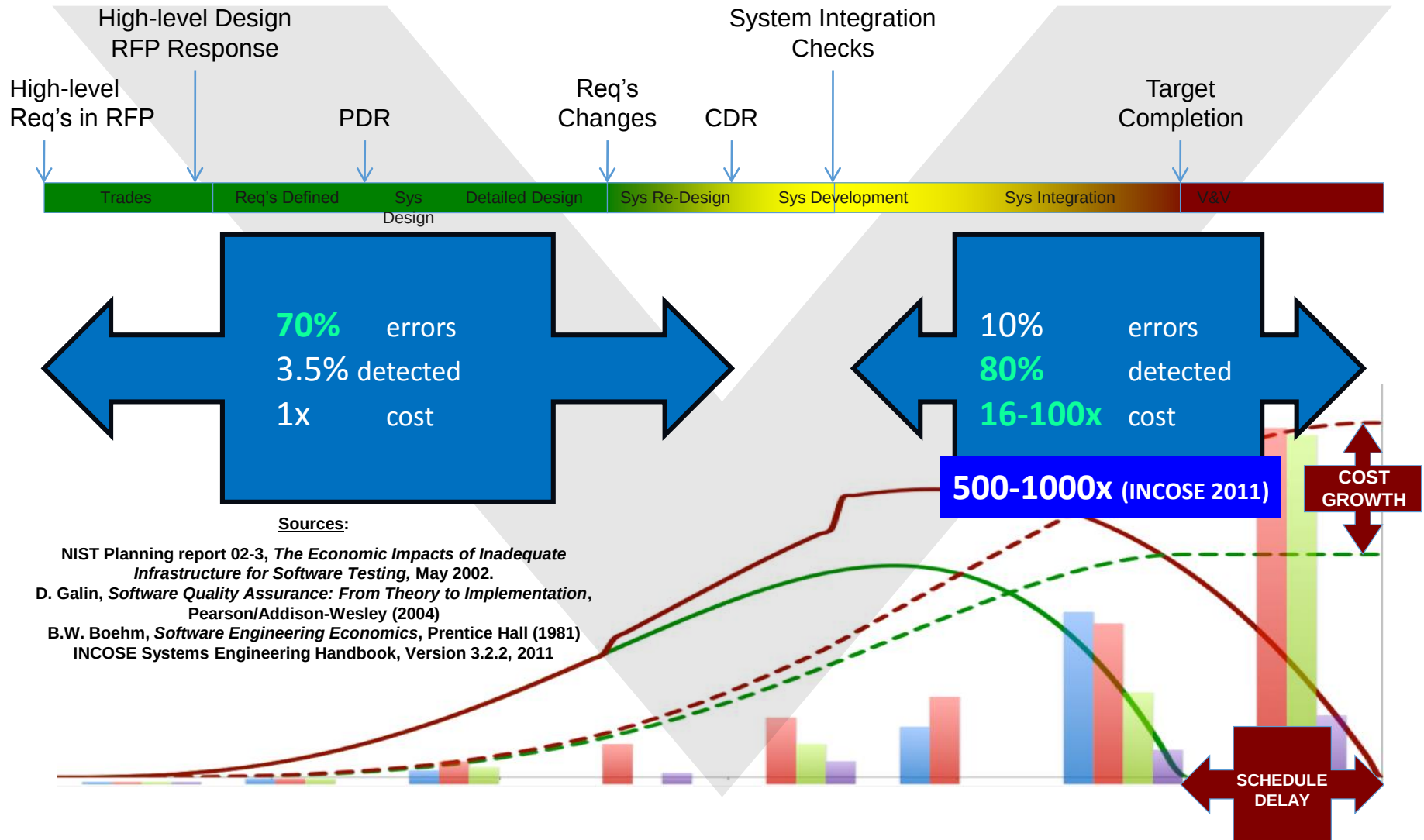
Mismatched Assumptions

Siloed Organizations



Written Requirements

Impact of challenges



SAVI Description

The *System Architecture Virtual Integration* (SAVI) Program is a collaboration between aerospace system development stakeholders whose goal is to lower development costs of complex aerospace systems by enabling model-driven virtual integration of complex systems across multiple development environments. The resulting SAVI Virtual Integration will eliminate errors and reduce both development cost and time to market.

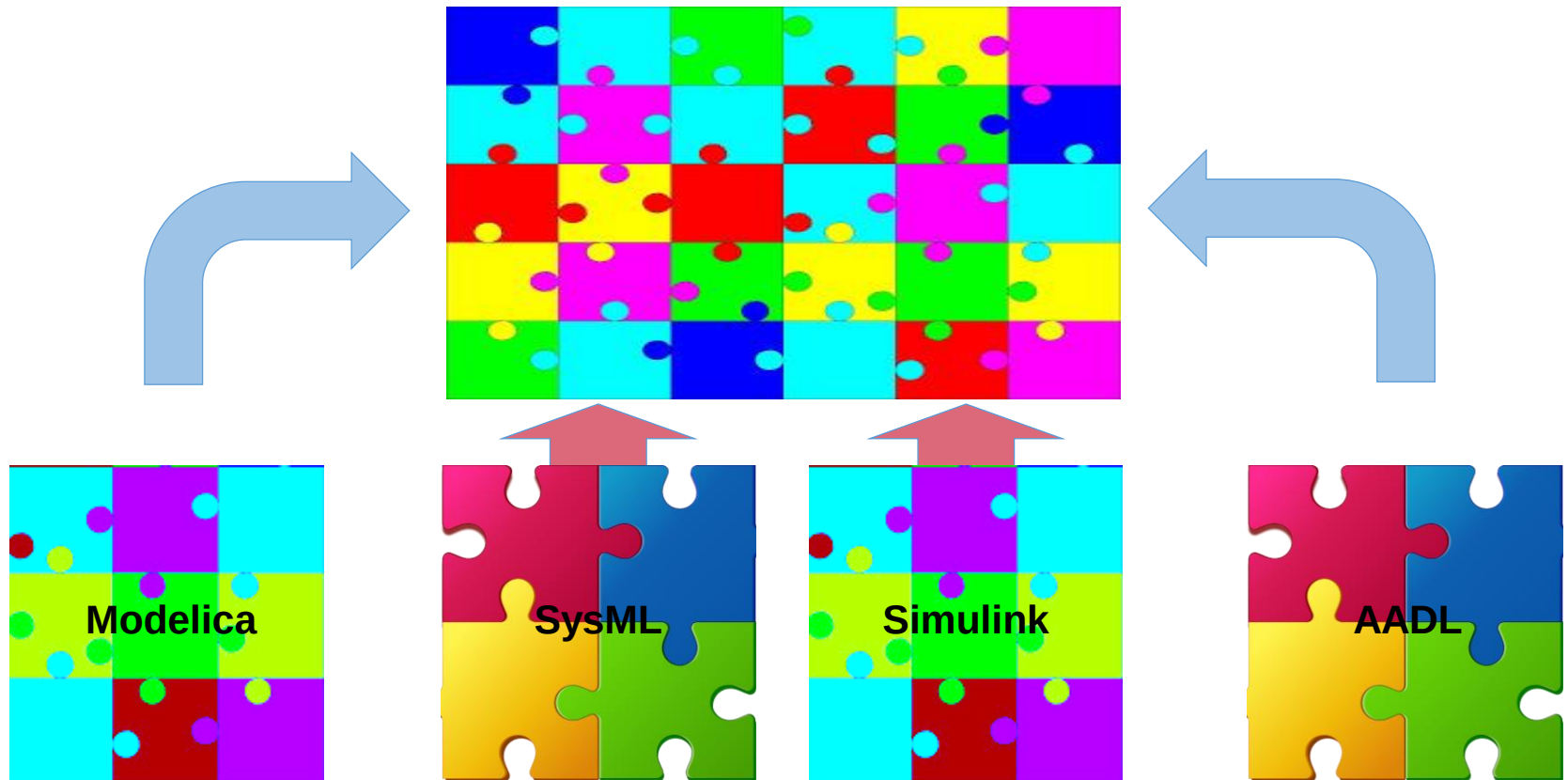
- Addresses challenges by...
 - System complexity: Model system/subsystems in environment of choice
 - Distributed development: Use international standards for data interoperability and transformations
 - Mixed assumptions: Capture as liens against development, include in consistency analysis, and require dispatching as part of refinement
 - Siloed organization: Register and track model dependencies (data and metadata)
 - Written requirements: Facilitate MBSE practices: i.e., model-based requirements, embedded traceability, executable specifications

Behavior Models

- Use some of the same information as static models, such as:
 - Weights and other inertial properties
 - Locations with respect to coordinate reference frames
 - Dimensions
 - Hinge axes and orientations
- Represent dynamic and/or functional properties
 - At the “component” level
 - At the system/subsystem/item level when composed with other models that provide other behaviors/functions
 - Here an integrated model set produces a realization of emergent behavioral properties of the system.

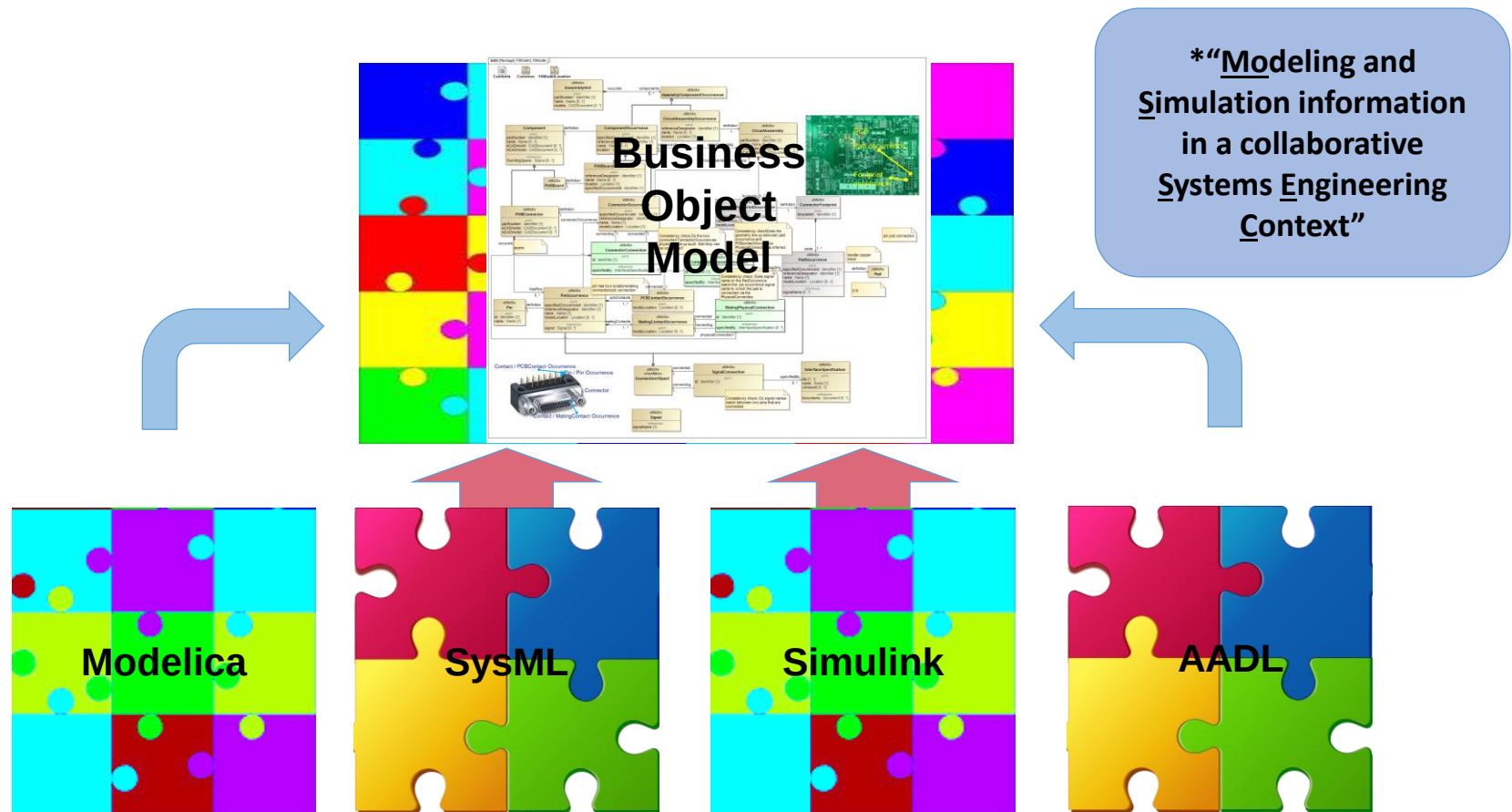
Integration challenge

- Question: How do we compose a system representation from a set of disparate models.

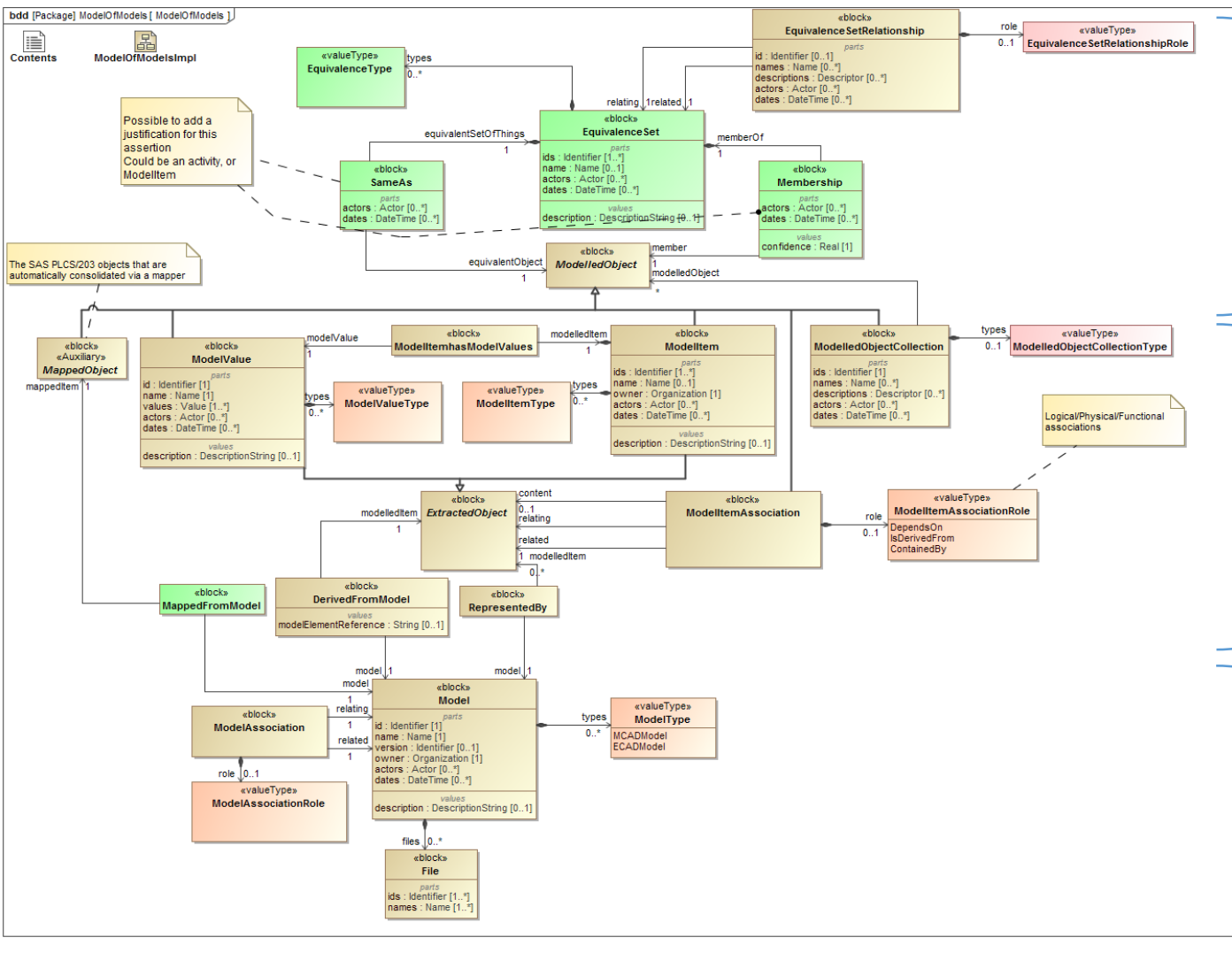


Integration approach

- Answer (prospective): Use a standardized data model to develop a target jigsaw (MoSSEC* methodology)



“Model of Models”



Information about
equivalence between
things found in the
models

Information about things
found in the models

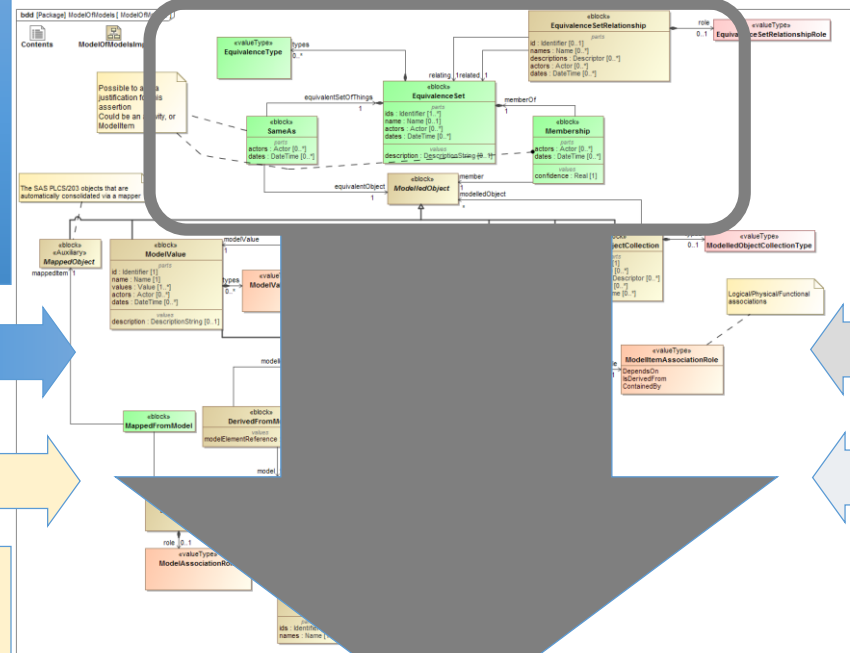
Information about each
model

Model relationships

- Equivalences mapped into collaborative environment

A system specification
using SysML

A system model
using AADL



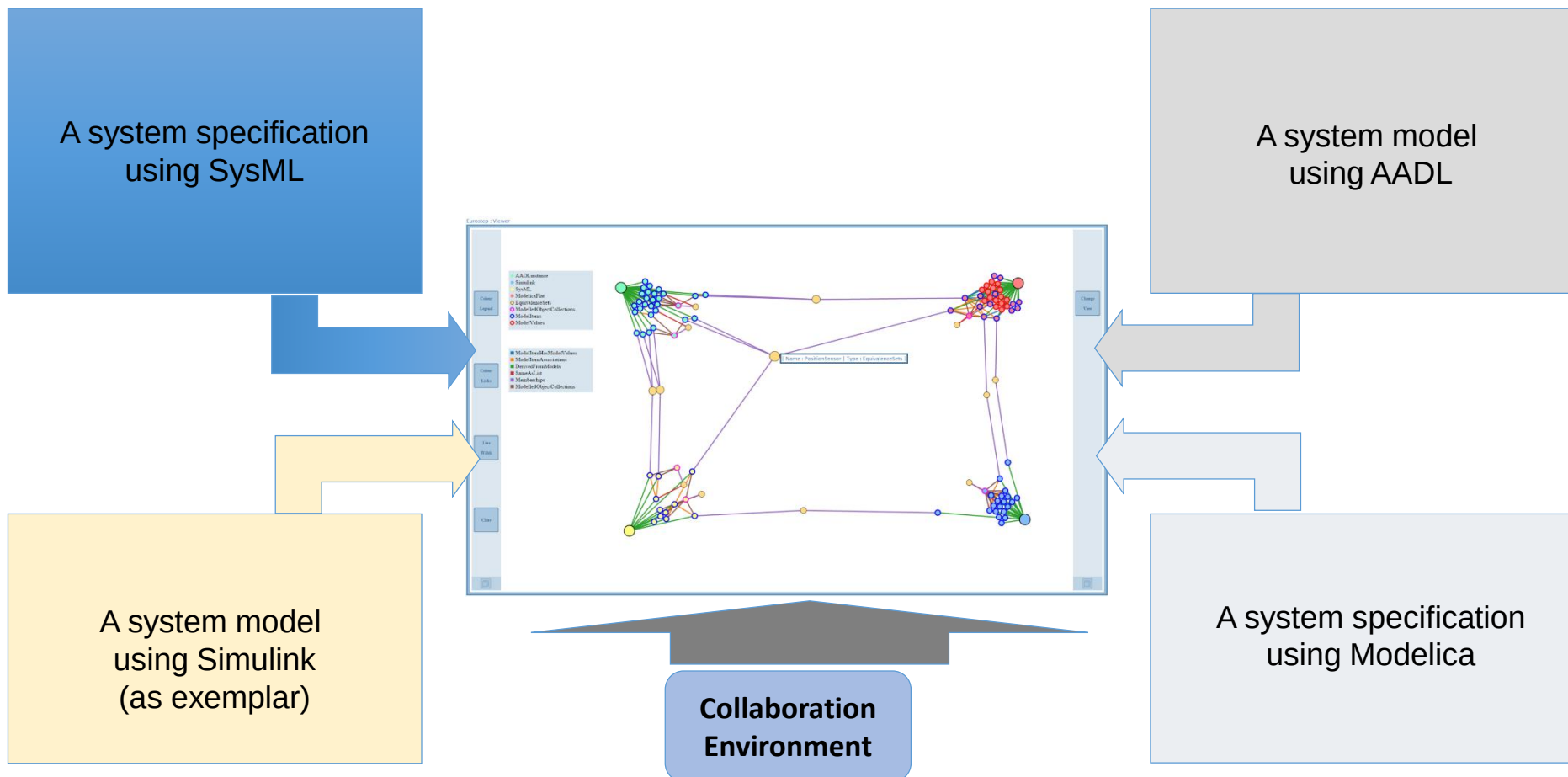
A system model
using Simulink
(as exemplar)

Collaboration
Environment

A system specification
using Modelica

Visualization of relationships

- Visualize model contents, relationships, equivalences



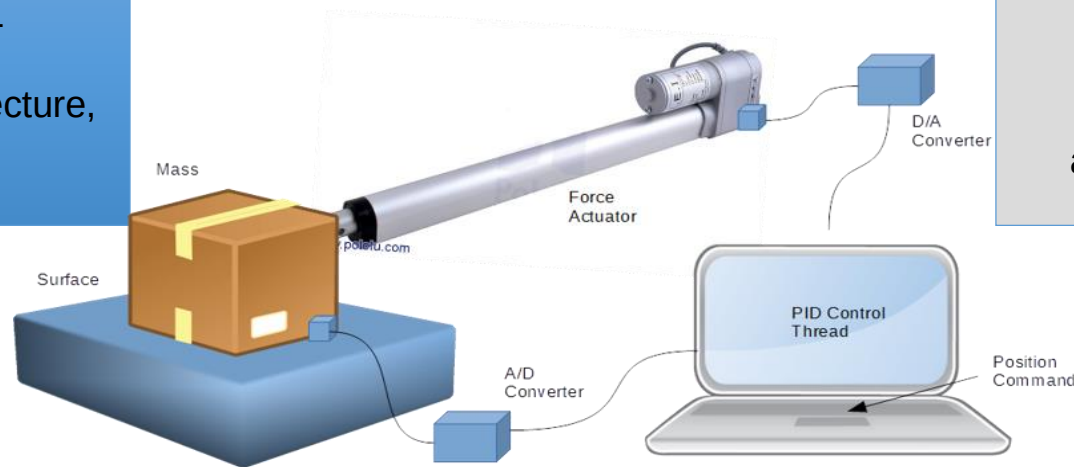
Example System

A system specification
using SysML

(emphasis: architecture,
packaging)

A system model
using AADL

(emphasis: computer
architecture, data flow)



A system model
using Simulink
(as exemplar)

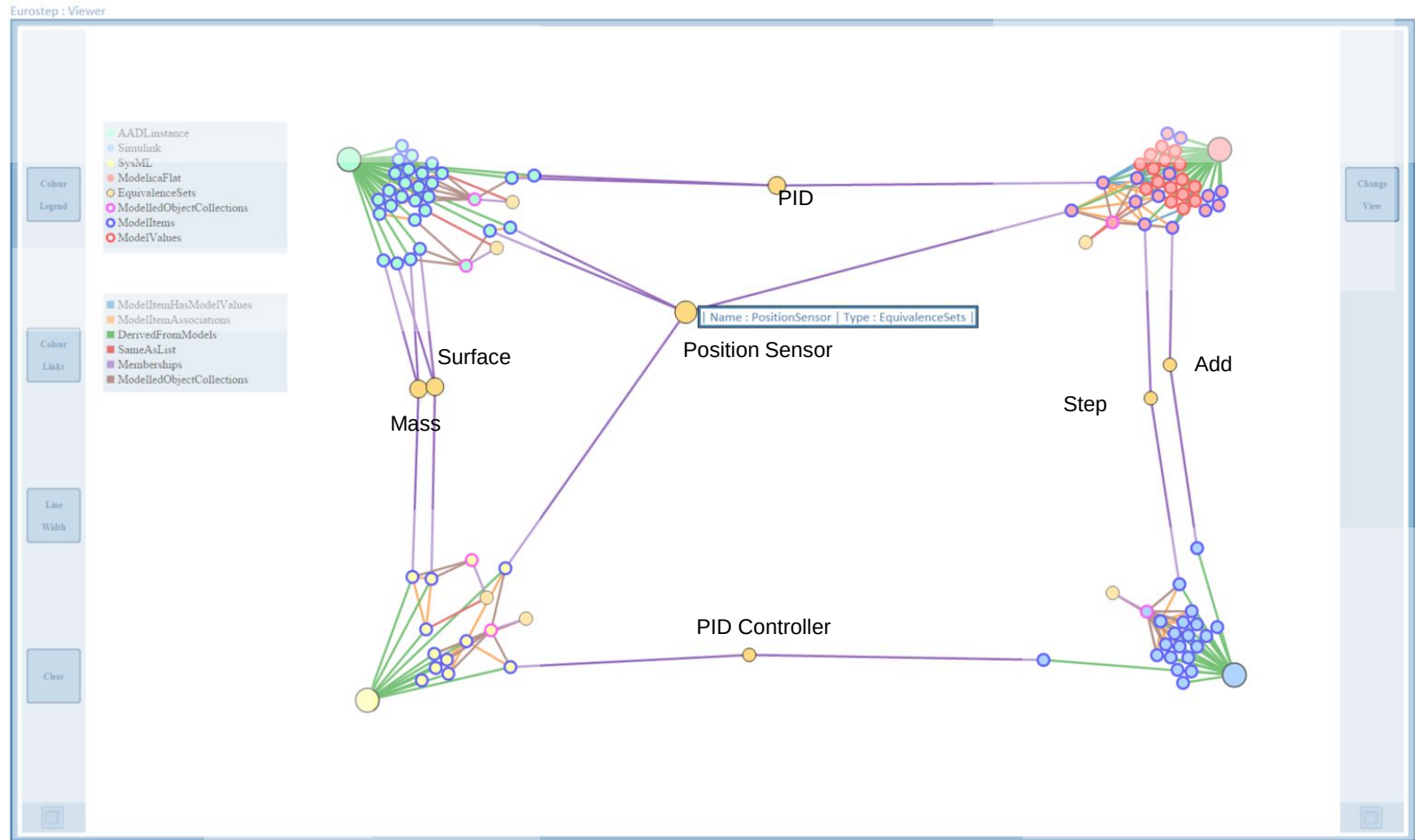
(emphasis: control system,
simulation)

A system specification
using Modelica

(emphasis: physical
interactions)

The Sliding Mass Example System

Visualization of Example System



Model Consistency

- Closely tied to use of “equivalence” but extends to behavioral attributes as well
- Context-dependent
 - Design lifecycle phase
 - Early: POC/Feasibility/trades
 - Late: High-fidelity validation
 - Analytical efficiency
 - Reasonable assumptions and approximations
 - Environment
 - Altitude, vibration, motion
- Example: vehicle model
 - Behavior
 - Acceleration, speed, range
 - Properties
 - Passengers/ seating
 - Number of wheels
 - Color
- Consistency cannot be evaluated outside of context of intended purpose of system model



FY2016 SAVI Behavior Analysis

- Extend/refine AIR-6110 type Wheel Brake System model set and mapping to Share-A-space®
 - As an example collaborative environment
- Explore methods for mapping from annotated system model down to low-level models
- Refine capture, visualization, and vetting of known equivalences and candidate equivalences
- Extend coverage of SAVI Virtual Integration Process (VIP) to address greater coverage of MBSE
 - Requirements capture and trace
 - Focus on ARP-4761 safety analysis classes



Conclusion

- SAVI collaboration is making headway
 - Developed preliminary approach that addresses virtual integration challenges
 - SAVI addresses semantic challenge of interfacing disparate modeling languages
 - SAVI has prototype strategy to capture, inspect, and track intra-model dependencies
 - SAVI has a framework for evaluating model consistency
 - Consistency depends on level of abstraction driven by system model purpose
 - Near term focus: refined VIP, extension to multi-tiered acquirer/supplier, extension to additional safety analysis types
- Questions?

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