Industrial Integration of MBSE into PLM for Mission Critical Systems

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Agenda

- Introduction
- Use Cases
- Path to MBSE – PLM solution
- PLE and variability
- Current state and look forward

Introduction

PLM - Product Lifecycle Management

In industry, product lifecycle management (PLM) is the **process of managing the entire lifecycle** of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products. **PLM integrates** people, data, processes and business systems and provides a product **information backbone** for companies and their extended enterprise.

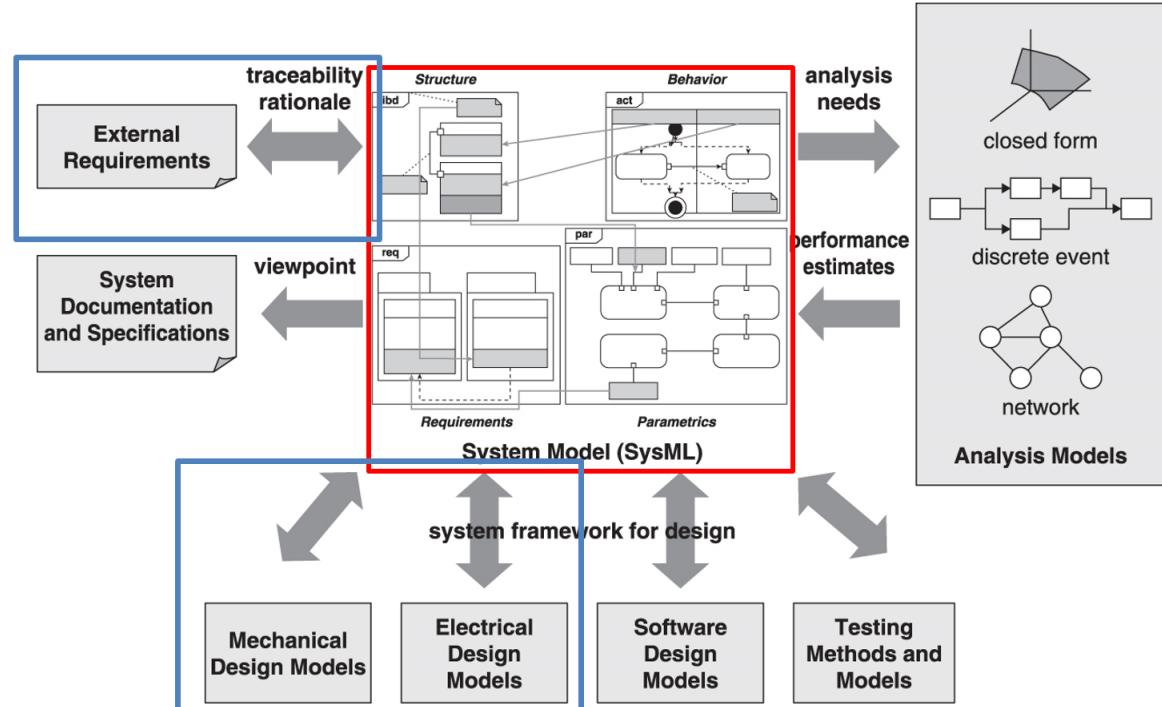•"About PLM" CIMdata;

•"What is PLM?" PLM Technology Guide.
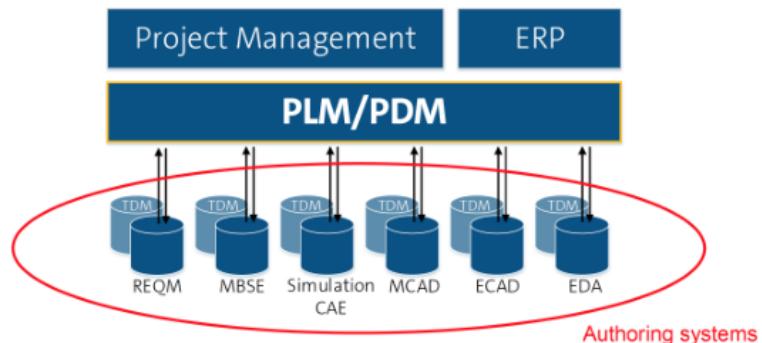
MBSE

Model-based systems engineering (MBSE) is the **formalized application of model** **design, analysis, v**... beginning in the con... throughout developme...

(INCOSE-TP-2004-004-02,


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Mission Critical Systems

Mission-critical system — a system whose failure may result in the failure of some goal-directed activity. An example of a mission-critical system is a navigational system for a spacecraft.

WHAT IS IMPORTANT FOR SUCH SYSTEMS DESIGN?

Formal: Traceability, configuration and change management, access control, safety, etc
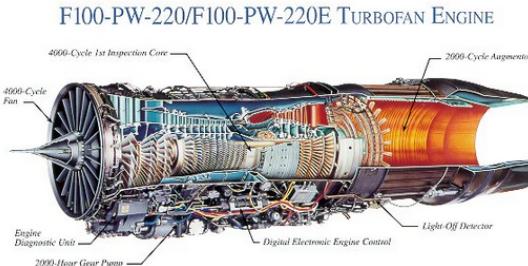
Why MBSE and PLM?

MBSE provides standards, processes, and tools for systems engineering.

PLE provides integrated data management platform.

INTEGRATED TOOLCHAIN – SOLUTION FOR MBSE DATA MANAGEMENT

Use Cases

Sample Use Cases (1)

Integrated MBSE solution for:

- Change management

- Requirements management

- Integrated models: enterprise architecture, requirements, functional architecture, logical architecture, physical architecture

- Systems perspectives: electrical, mechanical

- Integration with requirements, design, embedded systems, analysis tools

- Safety, export control, access control management

- ICDs

- Simulation

- AADL analysis

- Program management

- Variant management

- Workflow management

- Dashboard

- Scalability

source http://hdwpics.com
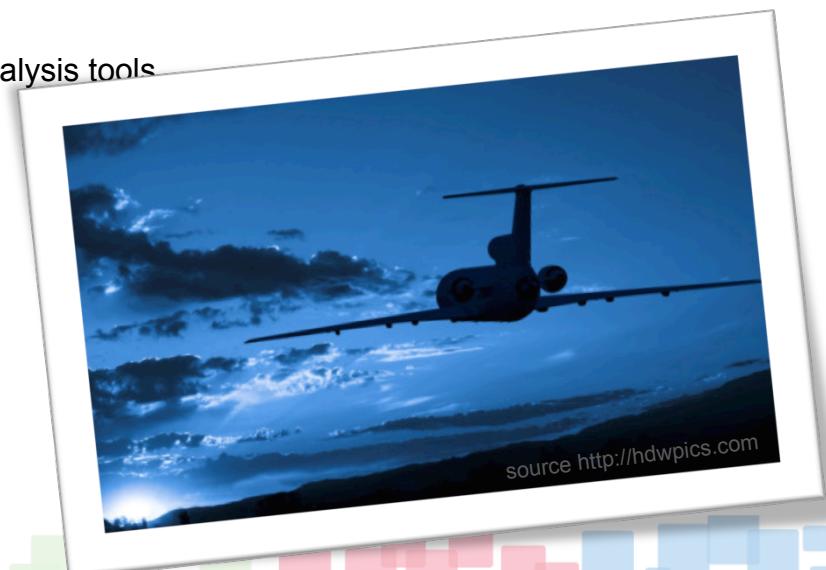
Sample Use Cases (2)

Integrated product line for the engine controls system for an highly variant engine family (to expensive to manage variants with standard approach)

- Existing and new tools integration
- Comply with aerospace regulations, guidelines, standards, e.g. DO-178B
- Traceability, improve awareness, enable analysis
- Change, configuration, variants management
- Integrated testing

source http://hdwpics.com
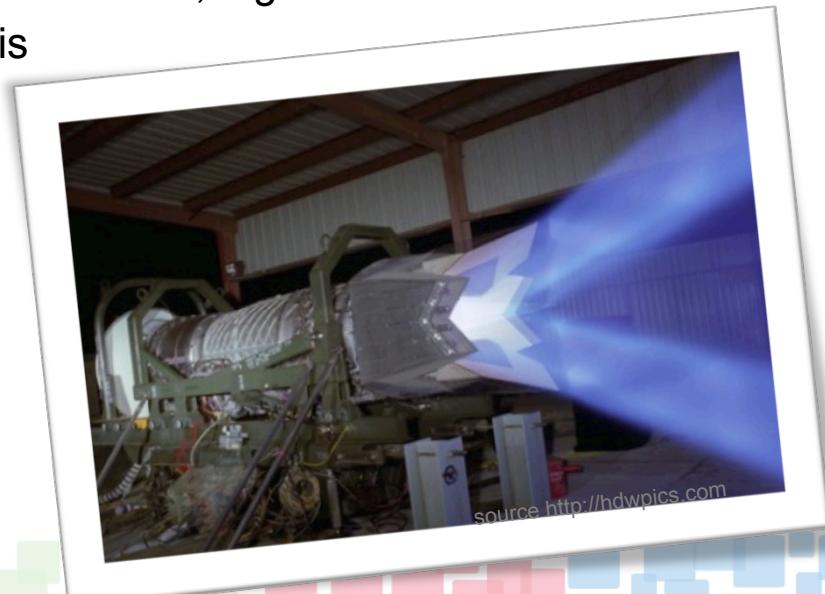
Sample Use Cases (10)

When file checked into teamwork versioning goes into PLM and has a link to MagicDraw

- In PLM, we can get viewables of diagrams
- In PLM, we can mark up and comment diagrams
- In PLM, we can submit workflows on specific diagrams

source NASA

Use Cases in General

- Integrated toolchain

- Possible information exchange:

    – Requirements

    – Functional model

    – Logical model

    – Feature model / variants

    – Physical model (BOM)

    – CAD parameters

    – Testcases

    – Process and workflows

- Traceability

- Single data and configuration management platform

Show Stoppers

- Metamodel:
    - No standard metamodel on PLM side
    - No standard mapping between SysML and PLM

- Data management:
    - No server based integration between SysML authoring tools and PLM
    - Not clear how to change and configuration manage separate repositories

- Vocabulary:
    - Need for vertical domain knowledge
    - Need for common terminology (different understanding about MBSE)
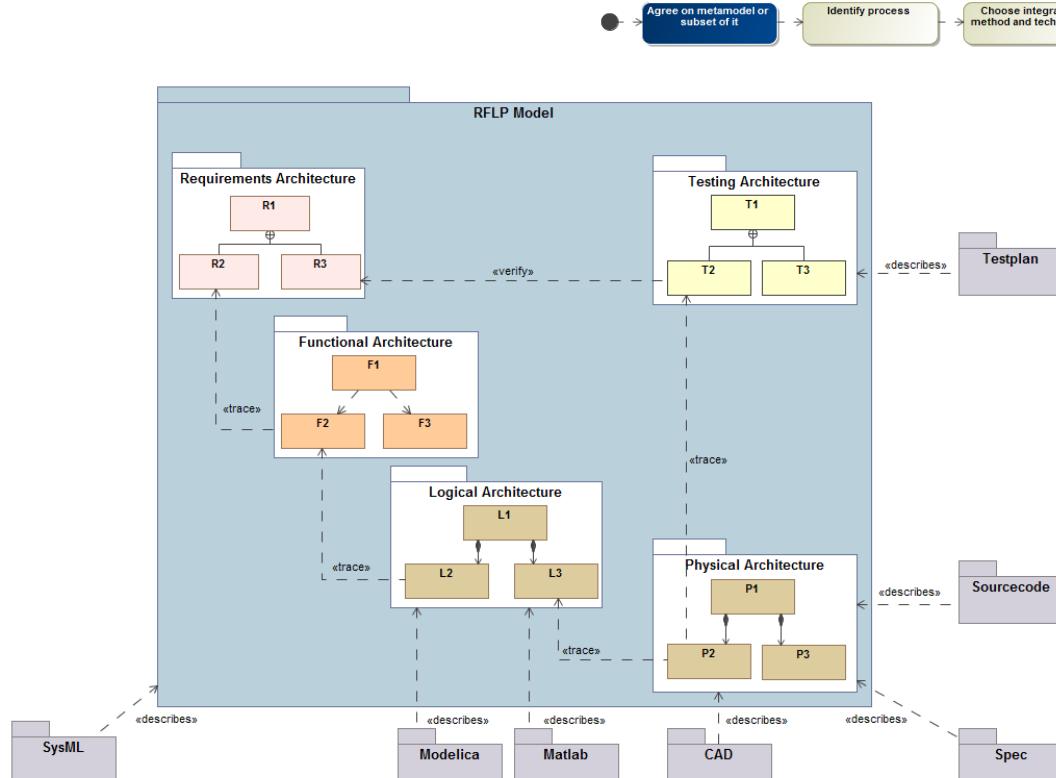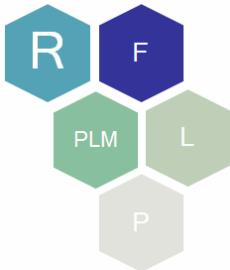
Path to Solution

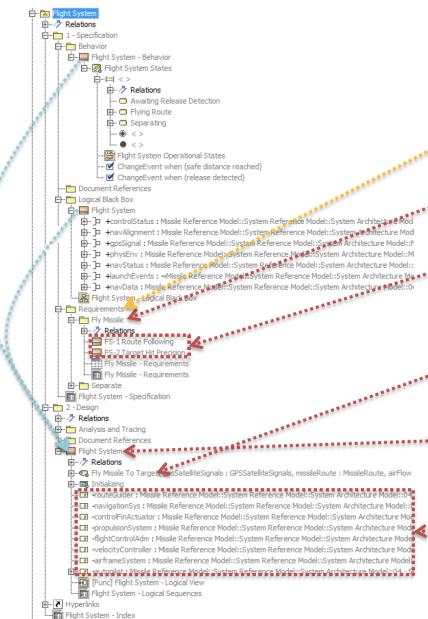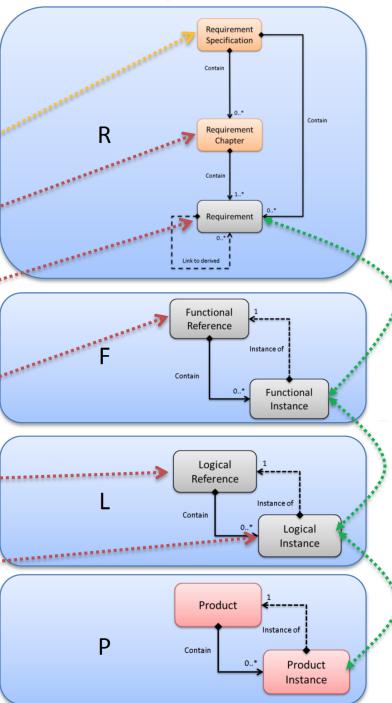# Solution Steps
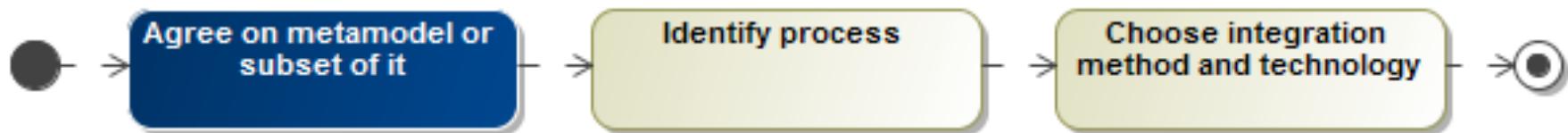
Metamodel

- Custom

- RFLP?

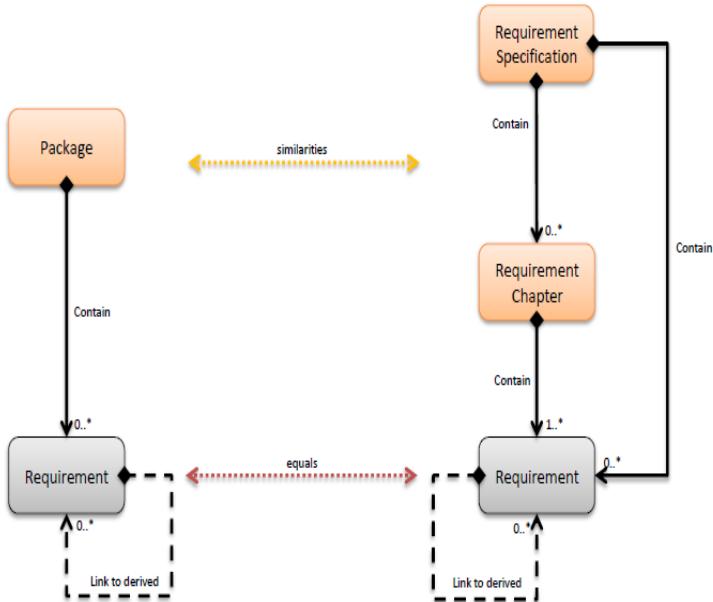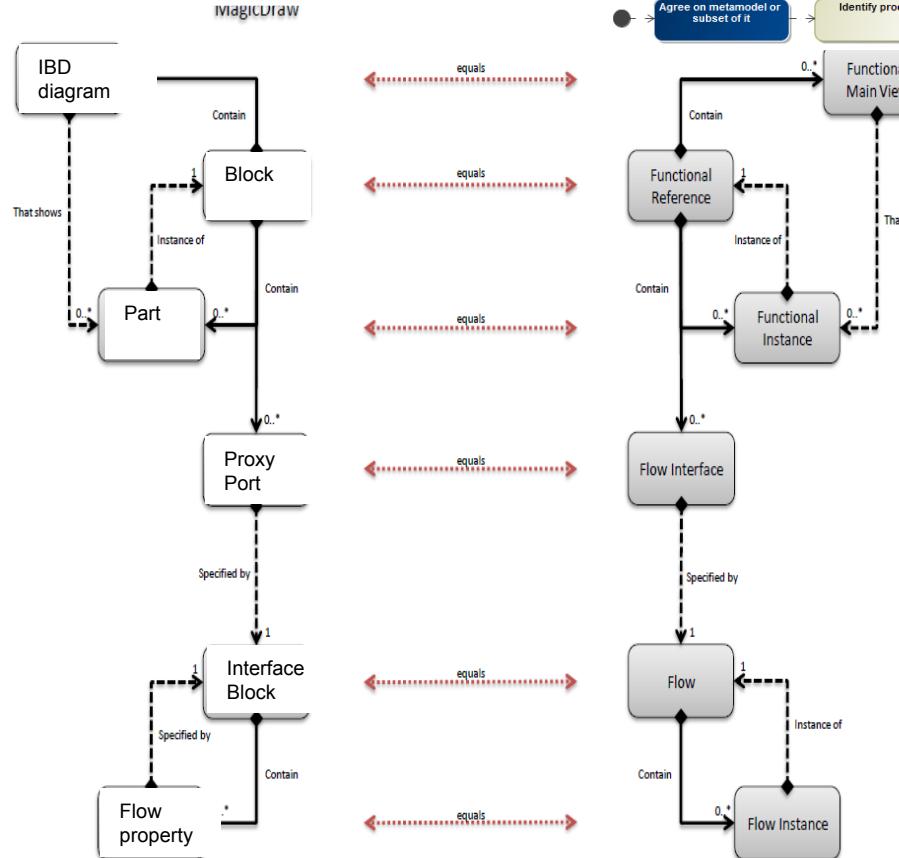# RFLP

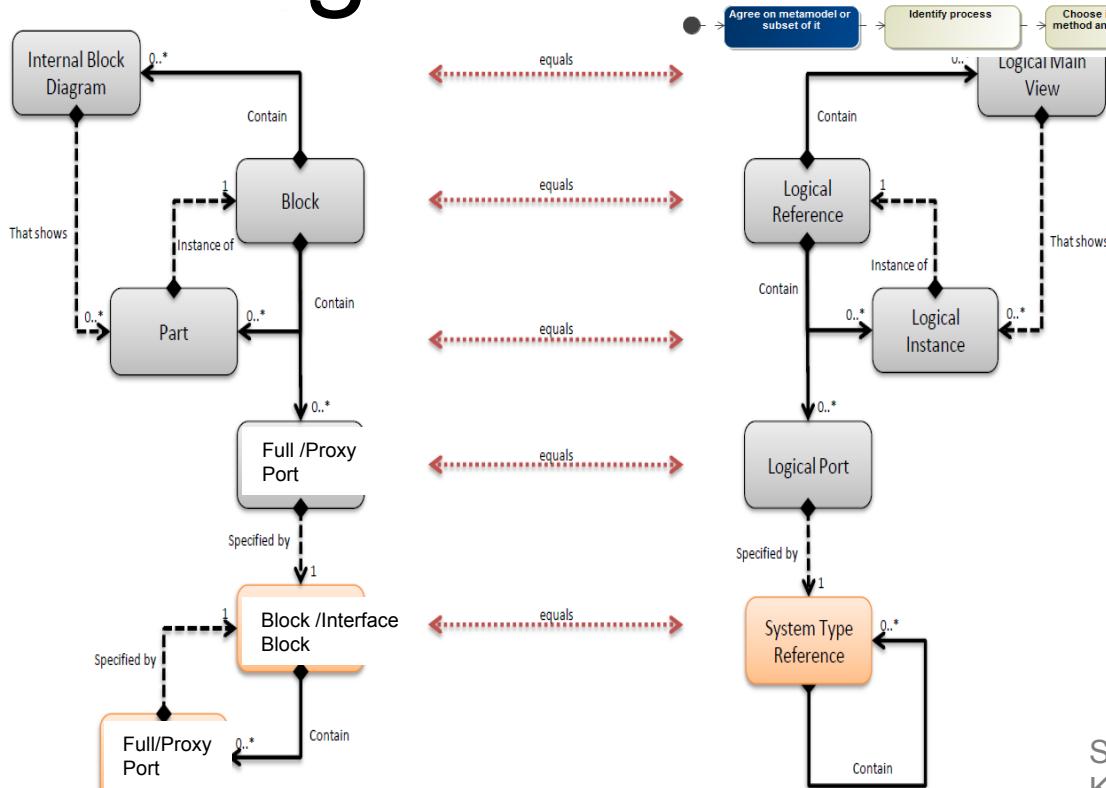Source: Dassault Systems, Kongsberg

Requirements
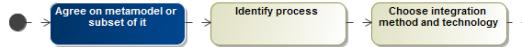
Source: Dassault Systems, Kongsberg

Functional Architecture

Source: Dassault Systems, Kongsberg

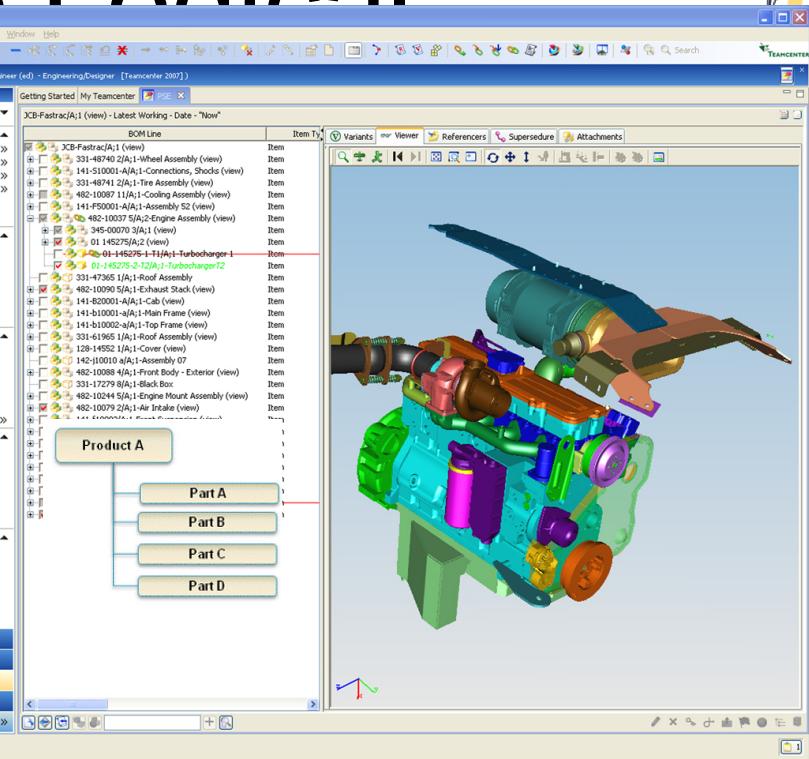# Physical / Logical Architecture

Source: Dassault Systems, Kongsberg

Physical to Logical

Allocation of physical con...
From PLM to SysML

SysML
Block
Product Tree

PL... ...their
as... ...me...

		Pillar			
Layer of Abstraction	Specification		Requirements	Behavior	Structure	Par...
		Concept	Stakeholder Needs	Use Cases	System Context	Meas...
	Problem	Goals & Objectives	Functional Analysis	Logical Subsystems	Effectiveness (MoEs)
	Design	Solution	Component Requirements	Component Behavior	Component Assembly	Component Parameters
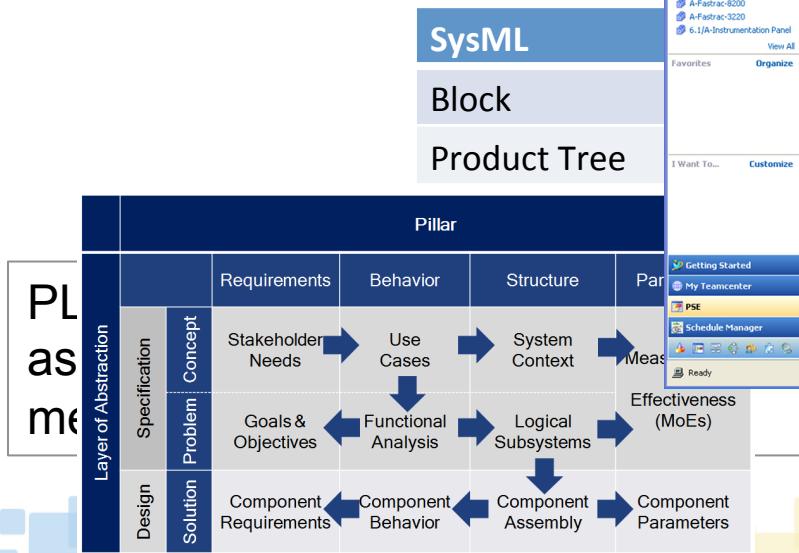
Process

- Choose data interchange method:

  - Import, Synchronization, Trace

  - Synchronization is on demand or automated

- Choose data interchange direction:

  - One way or bidirectional

- More:

  - Define change, traceability, configuration, access control, export control management strategies, etc.
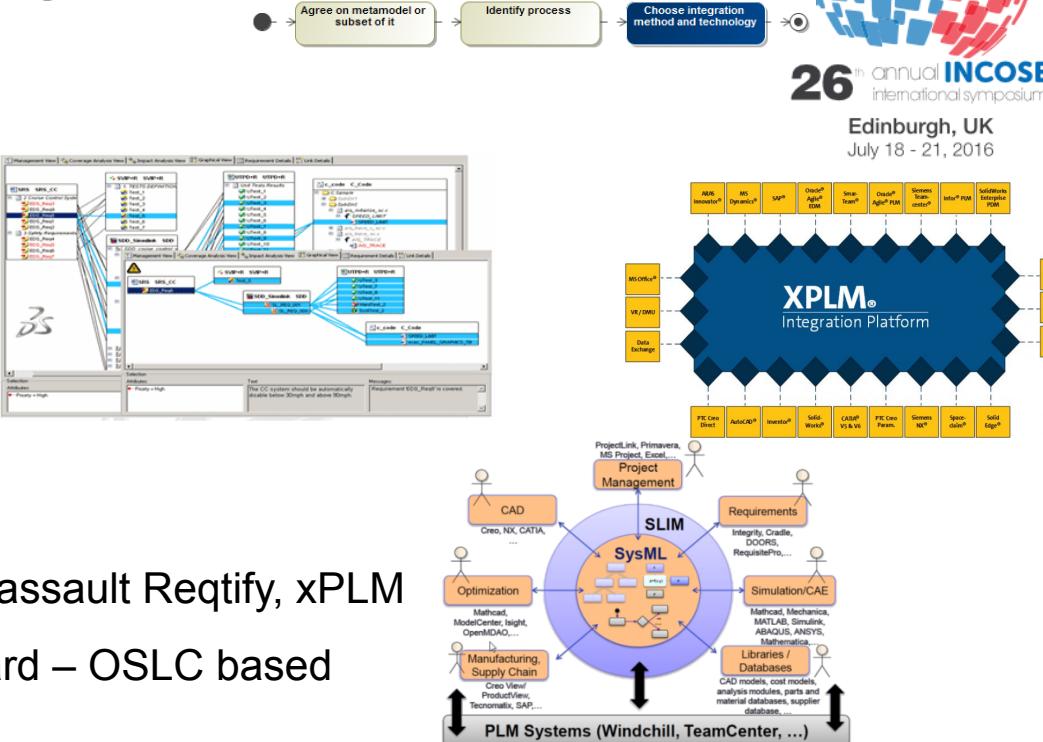
Interchange Method

- Interchange maturity level:

  - File

  - Client software

  - Server based

- Solution:

  - Customer specific

  - 3rd party: Intercax Syndeia, Dassault Reqtify, xPLM

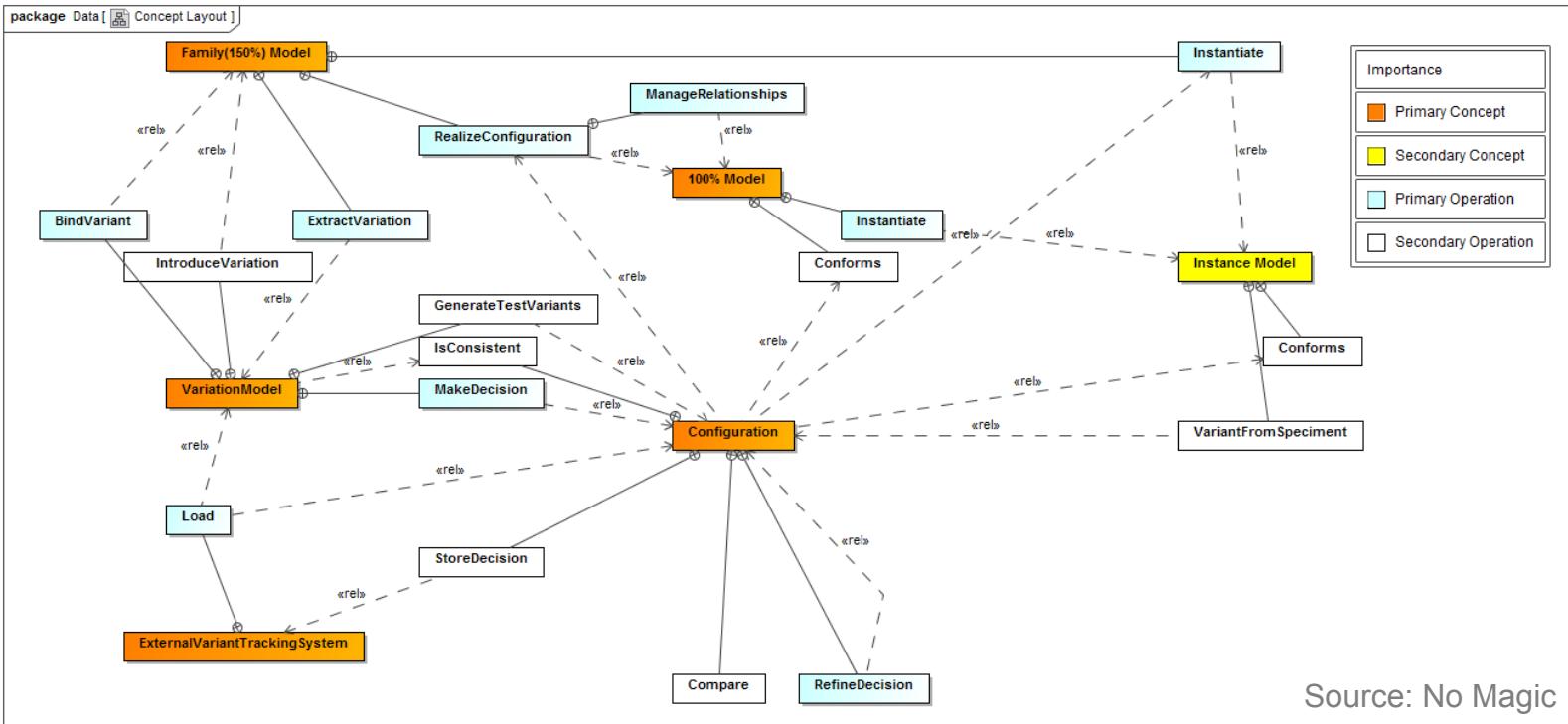 - Server based: direct or standard – OSLC based

PLE and Variability

...ne Engineering

...ucts with variations in features and

...eering of a product line using a shared
... d set of features, and an efficient

- taking advantage of the con...
- efficiently and systematically...

Ford Focus

Ford Explorer

GLOSSARY

Variability Engineering – Big Picture

Feature-based Product Line Engineering

Feature Catalog

Bill-of-Features™

Gears Product Configurator

Shared PLE Asset Supersets

Product A Asset Subsets

Product B Asset Subsets

...

Product N Asset Subsets
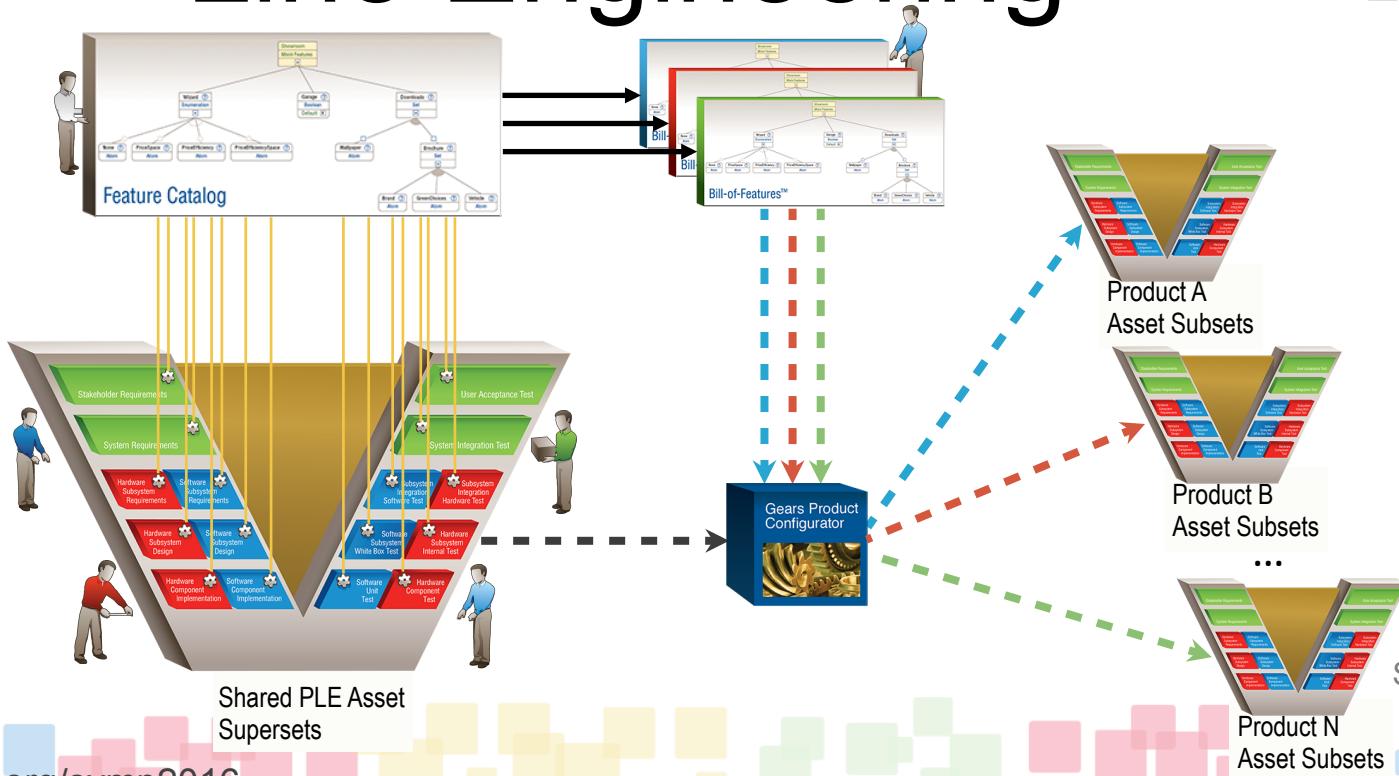
Source: BigLever

High Level Questions

- How to deal with behavior variation?

- How to have 150 % project not barking standard rules? How to have reasonable variant model?

- How to merge changes to new variant?

Implementation Questions

- Transformation method: in place, new project

- Variation point detector: Stereotypes and tags

- Variation effects support: simple cut, control of property type, arbitrary relationship retargeting, control of property default value, control of property multiplicity, control of arbitrary metaproperty of any element type, variant text expansion (as in requirement text), new through Open API

Solutions

- Model is more complex system when document or requirements

- We need dedicated stable open API for external variations management tool

CLOSE PARTNERSHIP BETWEEN MBSE AND PLE

Leads to

WORKING SOLUTION

Current MBSE – PLM Stage and Look Forward

Current MBSE - PLM Stage

- Standardization – PLM 4 MBSE working group

- Logical solution – RFLP metamodel or subset of SysML

- Architectural solution – server based, both ways changes synchronization, separate data repositories.

- Implementations – next slide

MOVING FORWARD! TO

PLATFORM SUPPORTING SERVER BASED DATA SYNCHRONIZATION

BigLever Software Integration Solution for No Magic®

BigLever's industry-standard Gears Product Line Engineering (PLE) Lifecycle Framework™ enables the integration of tools, assets and processes across the entire systems and software development lifecycle – from requirements to design, implementation, testing, maintenance and evolution.

BigLever Software™ provides enhanced integration solutions that utilize Gears concepts and constructs to extend third party tools and ensure consistent PLE capabilities directly from the framework. BigLever's Bridge solutions make third party tools "product line aware" by incorporating standardized variation point mechanisms and enabling the execution of PLE operations – such as product

THE PLE ECOSYSTEM AND BIGLEVER BRIDGE SOLUTIONS

The Product Line Engineering (PLE) Ecosystem is an open community of world-class tool providers – including developers of commercial, open source, customized, integrated or proprietary Application Lifecycle Management (ALM) and Product Lifecycle Management (PLM) tools – established for the benefit of engineering organizations seeking consistent, compatible, fully unified PLE solutions.

Source: BigLever

Webinar: http://www.nomagic.com/mbse/events/completed-webinars/item/mbse-ple-webinar-product-line-engineering-meets-mbse-%E2%80%94-the-best-of-both-worlds.html
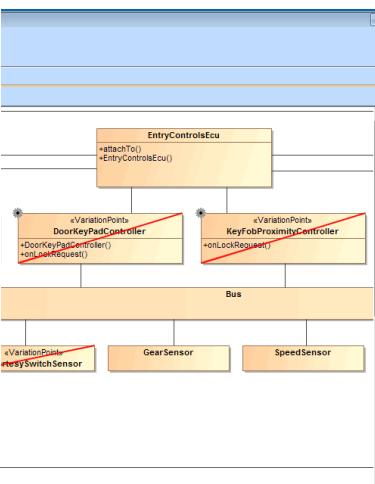
Siemens PLM

- A
- P
- P

Reuse Integration Framework

Synchronize

Drag and drop

Select association/
export mode

Add data
source

Dassault Systems PLM

Multiple
mappi
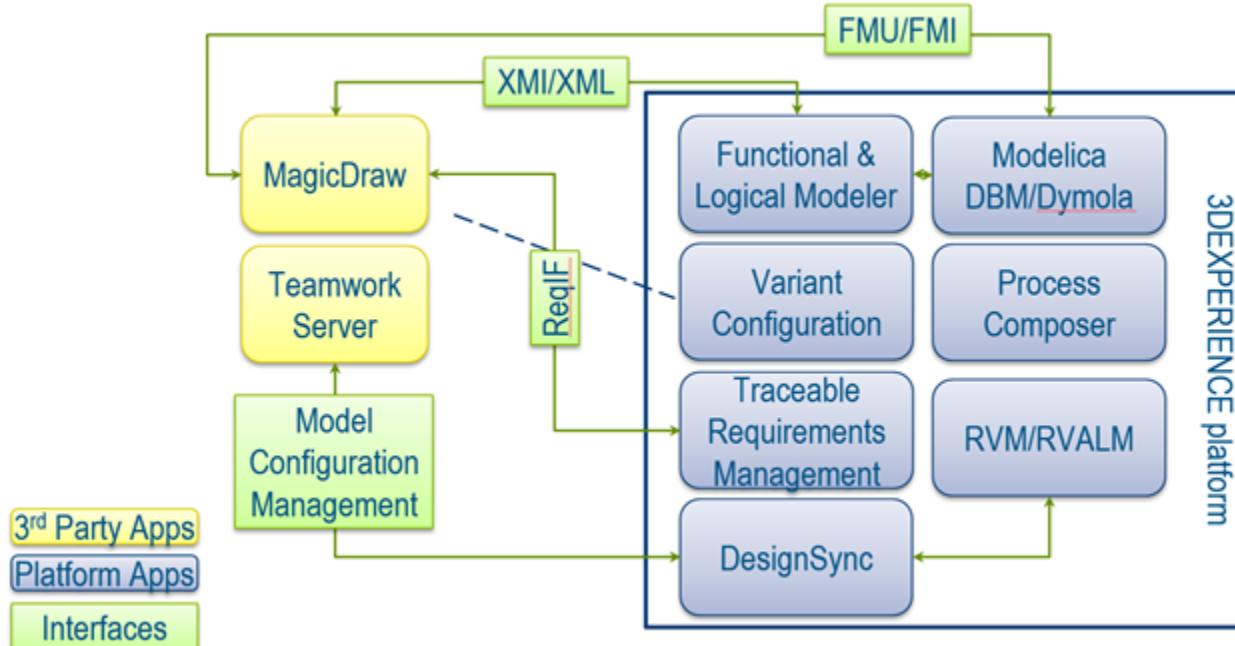
Future Interfaces

Configuration Management
Configuration Manage Assets on the Platform or Work in Process: Models, Scripts, Source.

Architecture Exchange
MagicDraw Architecture Exchange with Platform Architecture

Simulation Lifecycle Management
Manage Models, Simulation, & Configurations in the context of Validation Assets or Verification Assets and their Impact Analysis Supports All File-Based Tools in addition to Native Object-Oriented.
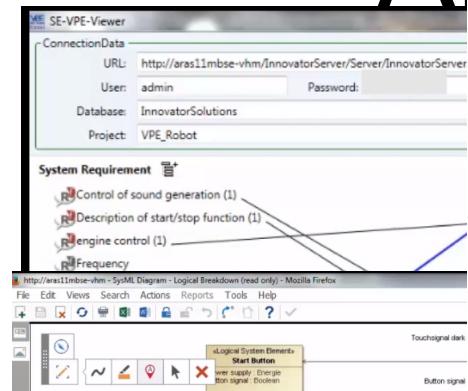
Co-Simulation
Common Simulation & model Interface using FMU. Interfaces with 80 Third-Party Tools.

CM

Exchange

SLM

Simulation

No Magic Interfaces

Trace

Review

Optimization

Trace Related Elements
Relate Requirements to Model Elements
Relate Requirements to Code
Relate Requirements to Validation Cases
Relater Requirements to Verification Cases
Interfaces with 60+ Third-Party Tools

Model Review
Review Models in the Context of Systems and Requirements

Optimization
Connect up Loosely Coupled Simulations to Explore Optimums of a Solution Space.
Interfaces to over 40+ Third-Party Tools

Source: Dassault Systems

www.incose.org/symp2016

Cameo Systems Modeler (MagicDraw) Integration for ARAS Innovator (*Preannouncement*)

The integration of Model-Based Systems Engineering (MBSE) and Product Lifecycle Management (PLM) is one of the key technologies for enabling a modern engineering approach. With the **Cameo Systems Modeler (MagicDraw) integration for ARAS Innovator** XPLM is developing one of the first solutions in that area.

MBSE/PLM-Integration Concept

System Engineers using Cameo Systems Modeler (MagicDraw) need access to information usually

Parts of the Integration

The integration is based on a Cameo Systems Modeler Plugin so that the modeler does not need to leave his native environment. On the ARAS side the data model has been enhanced by requirements, functions and logical system elements. All elements can be synchronized bidirectional.
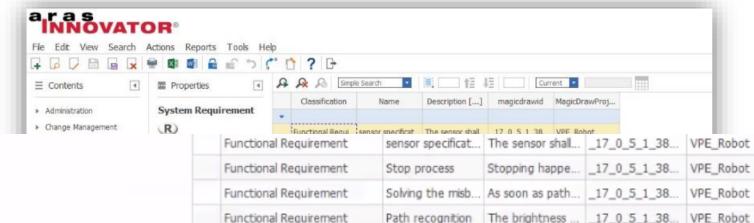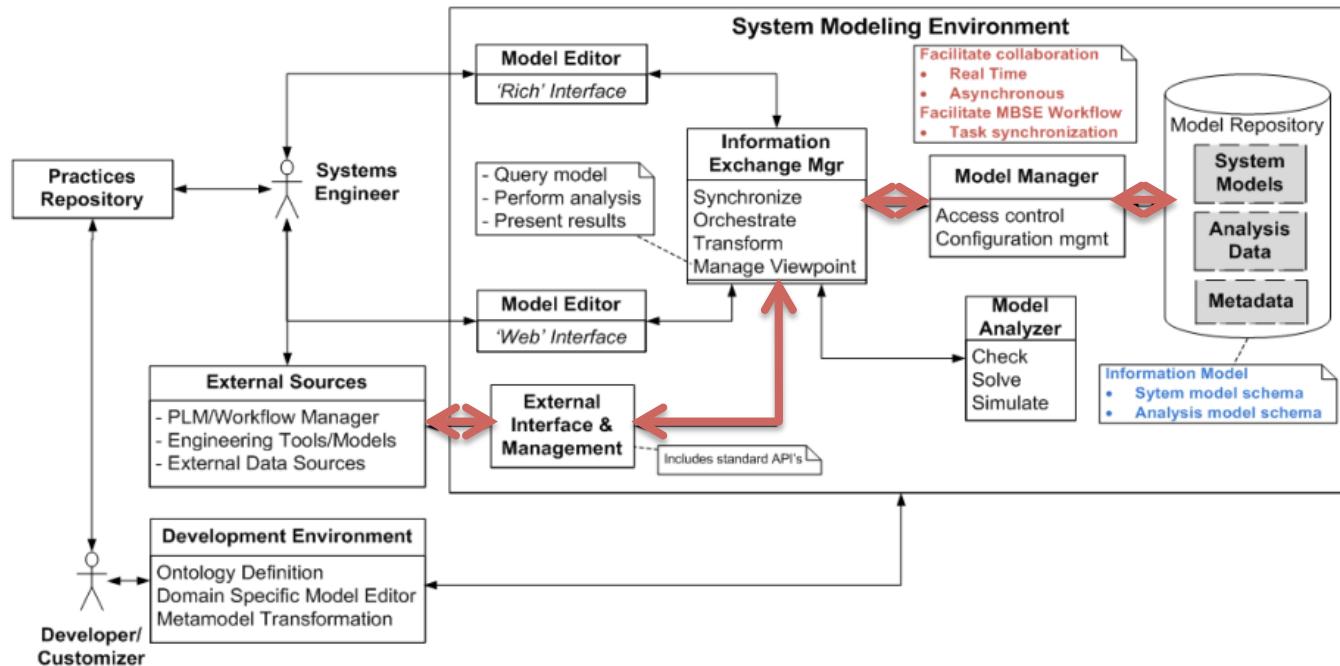
Systems Modeling Environment Conceptual Architecture

The Recipe for Success

think **BIG**

start SMALL

and EVOLVE

Questions?

Thank You!

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