Managing the Testing and Workflow with MBD Systems

Jace L. Allen
dSPACE, Inc.

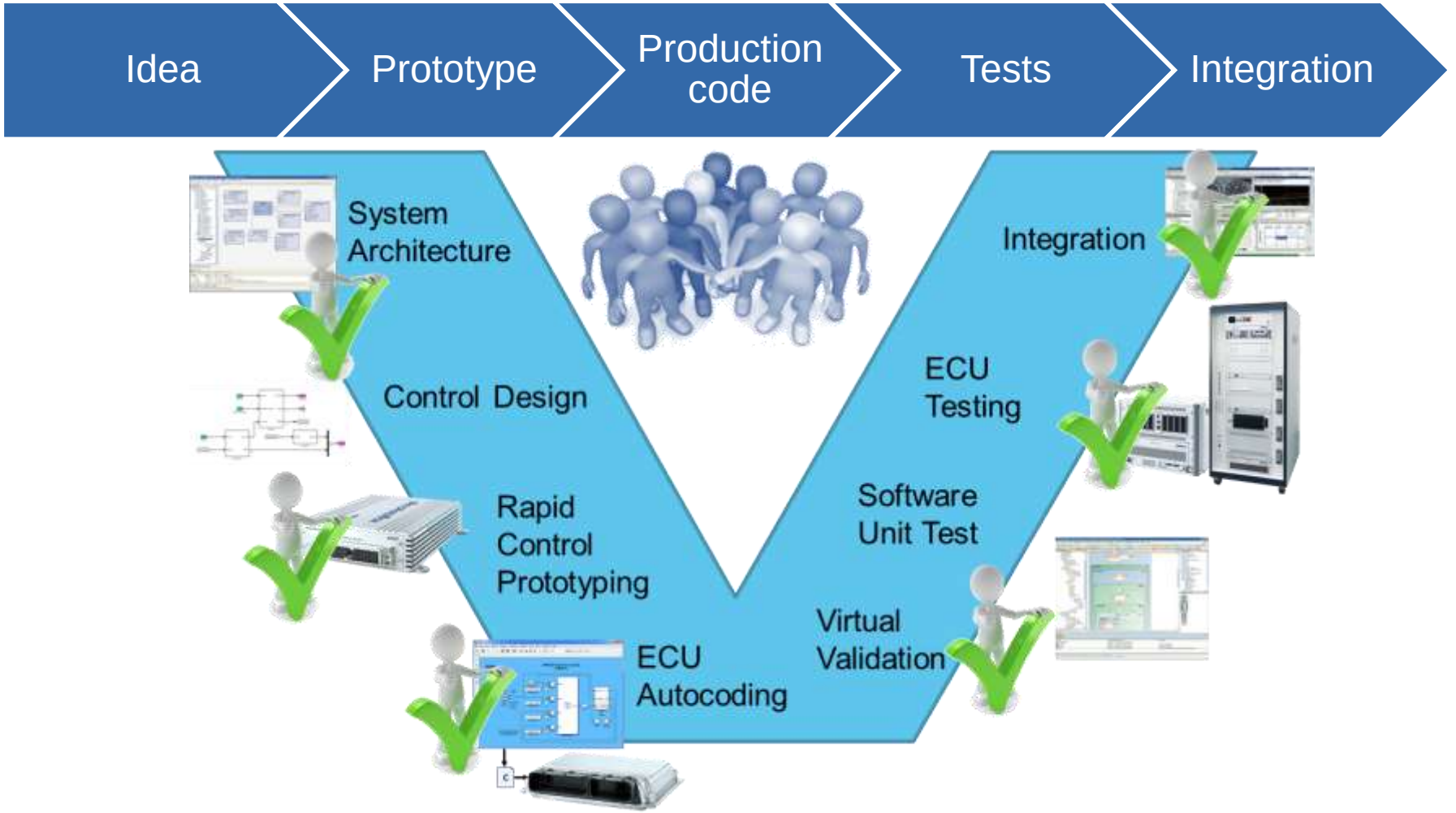
Background

- Jace L. Allen
  - Business Development Manager – Simulation, Test , & EEDM
  - dSPACE, Inc. – Wixom Michigan
  - Managed Test System Engineering for 10+ years
  - HIL/Simulation Systems Specialist – Controls/Electronics – 20+ years
  - Data Management Background
  - Cross-Industry Experience – Aerospace, Automotive, …
  - Presented numerous papers – SAE, AIAA, etc.

Agenda

1. Model-Based Development (MBD) and Embedded processes
2. Introduction to SYNECT and ALM/PLM Integration
3. Variant Management and Workflow Management
4. Model Management and MBSE/MBD Synchronization
5. Application Examples

dSPACE – From Idea to Integration in MBD Systems



dSPACE – 30 years of service

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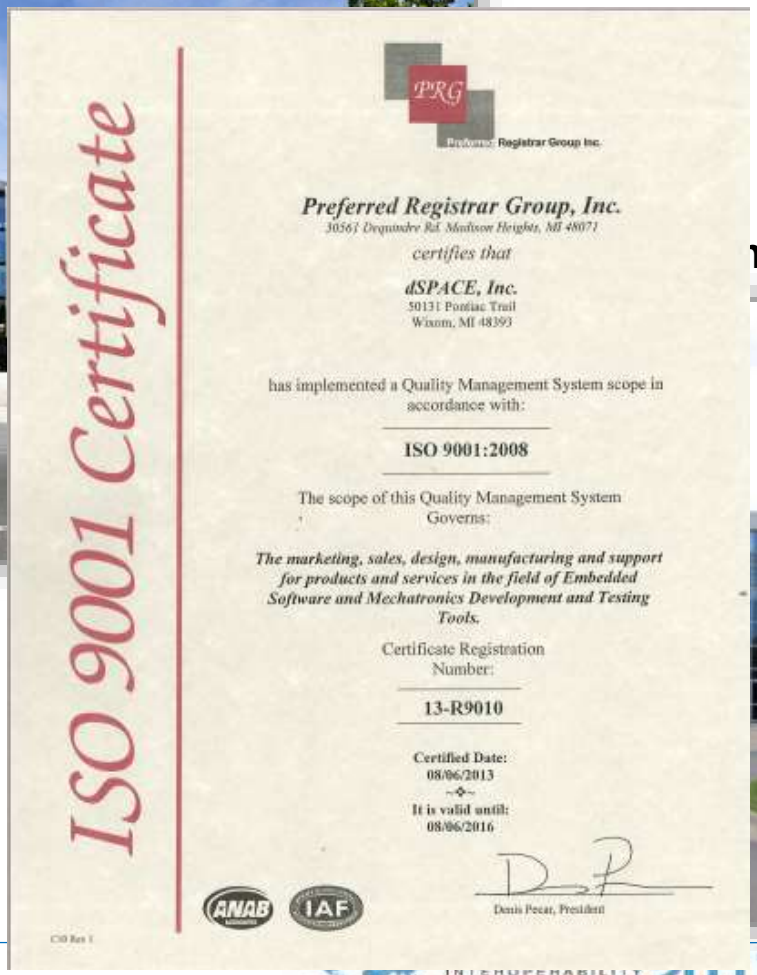
dSPACE Headquarters –



ISO 9001 Certificate

PRG
Preferred Registrar Group Inc.

Preferred Registrar Group, Inc.
30561 Dequindre Rd. Madison Heights, MI 48071
certifies that

dSPACE, Inc.
50131 Pontiac Trail
Wixom, MI 48393

has implemented a Quality Management System scope in accordance with:

ISO 9001:2008

The scope of this Quality Management System Governs:

The marketing, sales, design, manufacturing and support for products and services in the field of Embedded Software and Mechatronics Development and Testing Tools.

Certificate Registration Number:

13-R9010

Certified Date:
08/06/2013
It is valid until:
08/06/2016

ANAB IAF

Denis Pecar, President

nc – Wixom, Michigan, USA

Improving V&V Process Efficiency

- Tool Ecology
- Validation and Verification
- MBD Data and Test Management
- Automation of Test and Process

- **Simulations derived directly from models enable us to validate operations concepts and validate scenarios early in the project lifecycle, reducing the cost of later remediation**
  - Validate the model itself
  - Validate the design
- **V&V products developed as views developed from an integrated model**
  - provide greater inheritance from plans, to testbed procedures, through integration procedures, to operational procedures than existing products
  - are more intuitive to modify and execute than text based procedures
  - The procedure can become the script for configuring and running the unit under test
- **All of the above save time and money during the development cycle and reduce defects**

Simulate More

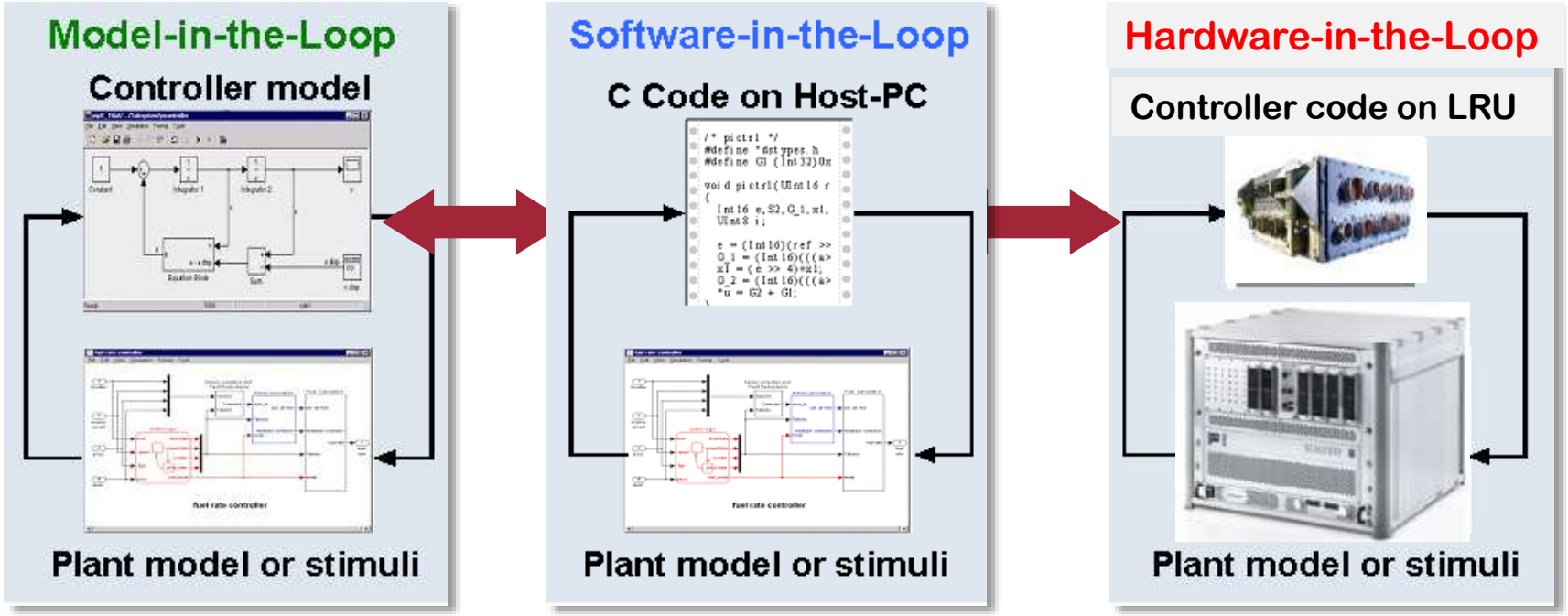
Early Validation

Continuous Build and Test

Reuse Strategies

Streamline Data flow between Tools

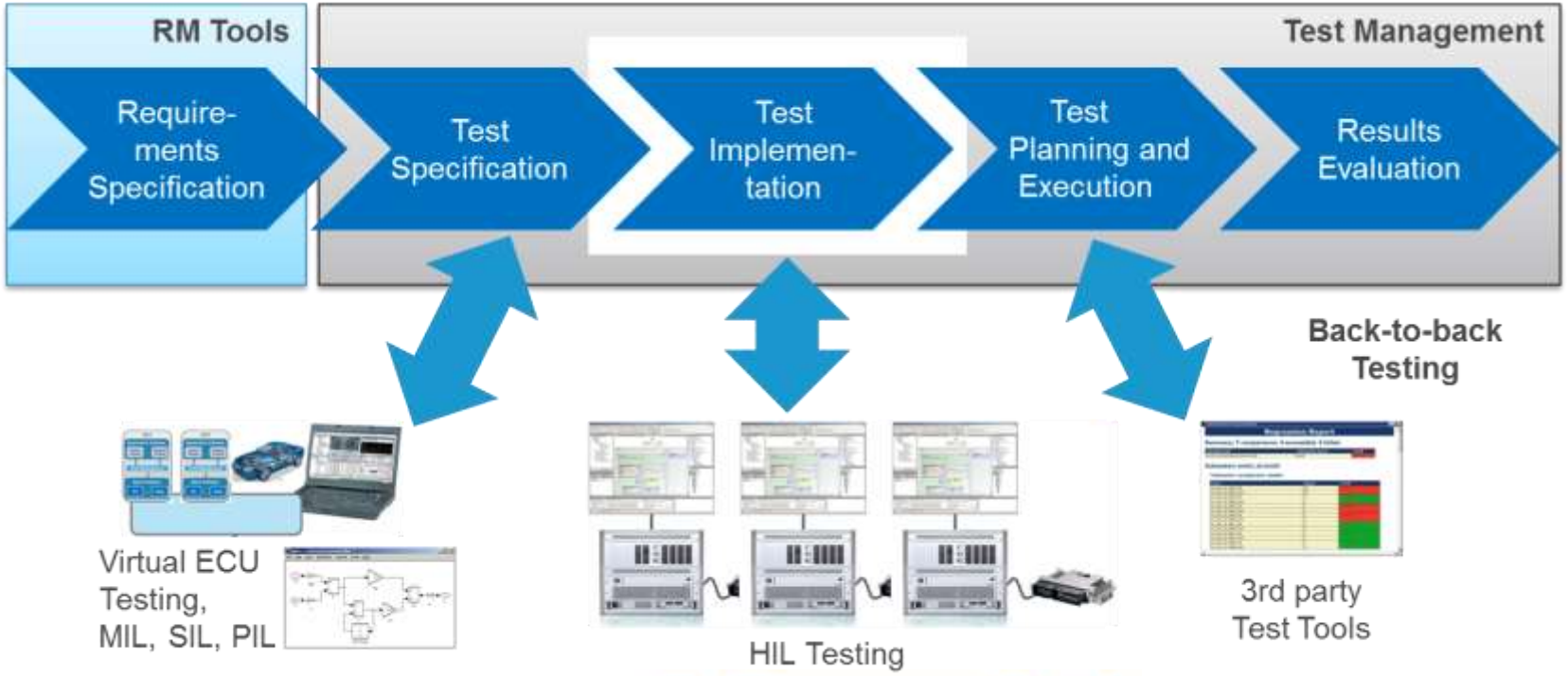
Back-to-Back Testing using MIL/SIL/HIL



- MIL, SIL, HIL simulation are the „backbone“ for model-based testing
- Prerequisite and basis for testing during function development and software implementation
- Need to re-use Models and Test Assets throughout the total V-cycle

MBD Process: Improve Efficiency and Workflow

- Navigate Large Amounts of Data – Store/Find Data used by all MBD tools
- Handle an exploding number of Variant combinations
- Get full traceability for an MBD safety-related process (DO-178C, etc)
- Improve the re-use of models, tests, and data across different MBD phases
- Remove ineffective data transfer and manual processes



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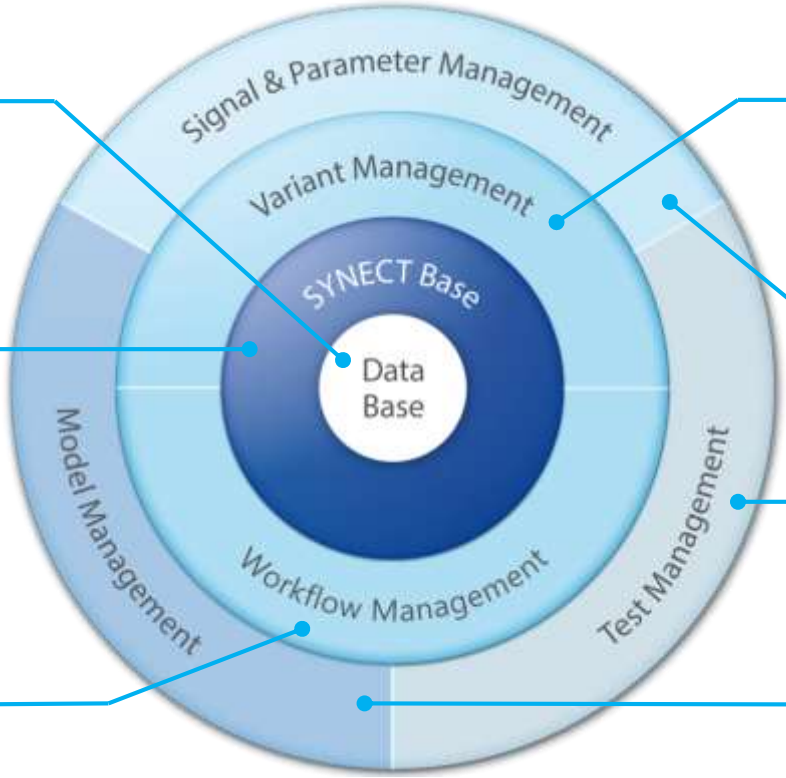
SYNECT – Infrastructure and Modules

SQL Server, ORACLE

Data base access, user & rights management, version control, …

Define and manage complex workflows including variants



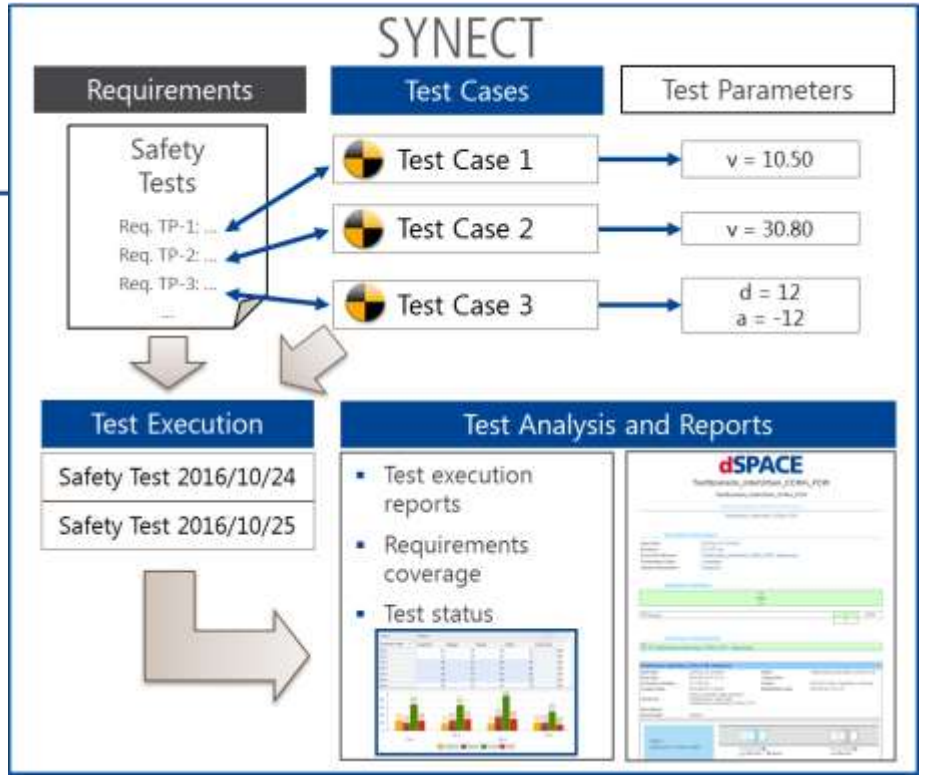
Define and manage variants and their impact on data

Manage signals, parameters and parameter sets

Manage test cases, execution plans and test results

Manage models, submodels and interfaces

Connection to Requirements Management Systems



- Broad support of RM tools
- Support of Open Standards
- Support DO-178C Compliance

Establish traceability across tool boundaries

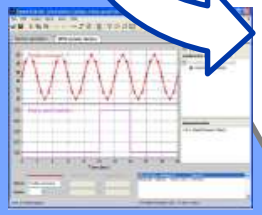
Traceability of work products

SW Architecture

Models

RCP

Signals / Parameters



Requirements

Iterations

Tests

LRU Autocoding

Trim/Tuning

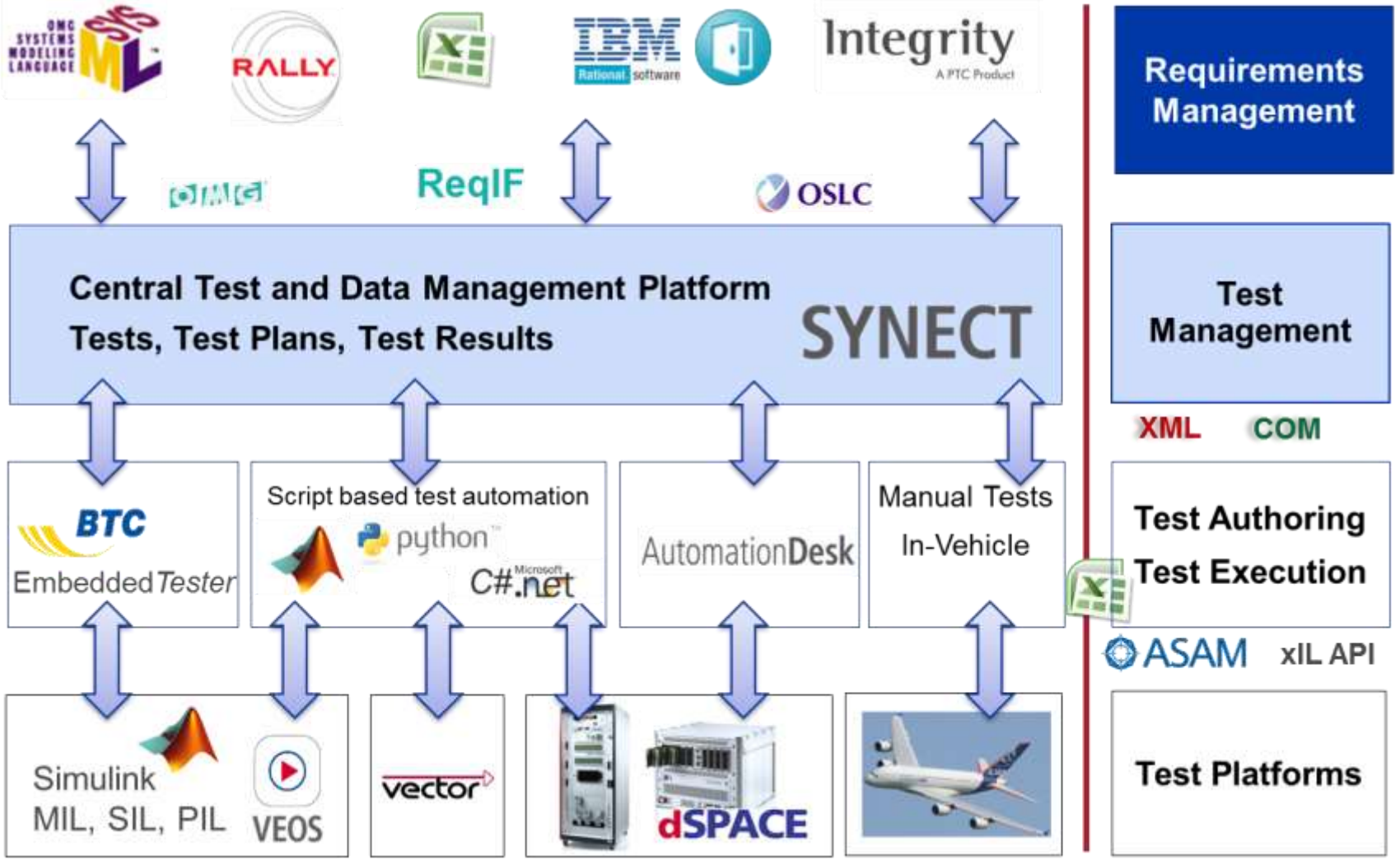
Variants

HIL Testing

Central Data Management

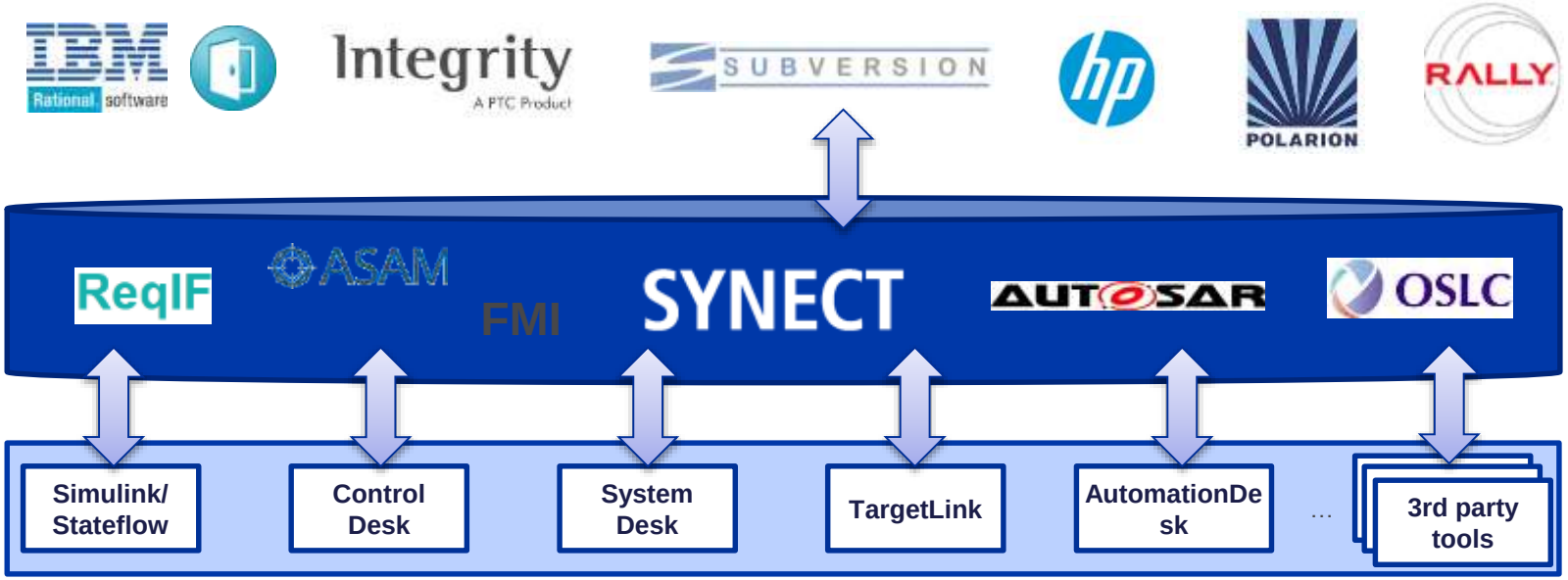
- Integrated Toolchain
- Multi-User Support
- Integrated Version Management
- Integration of 3rd-Party Tools
- SCM Integration

MBD V&V Tool Chain – SYNECT Test Management



SYNECT – Glue between ALM/PLM and MBD Systems

- Integrate with your ALM tools, e.g. for requirements and file management
- And use your standard engineering tools: *link your tool chain with SYNECT*
- Embrace standards: *be flexible and open to new tools and workflows*
- ***Provide an open COTS system for Tool and Process Integration***



Bridging the Gap Between MBD and ALM/PLM

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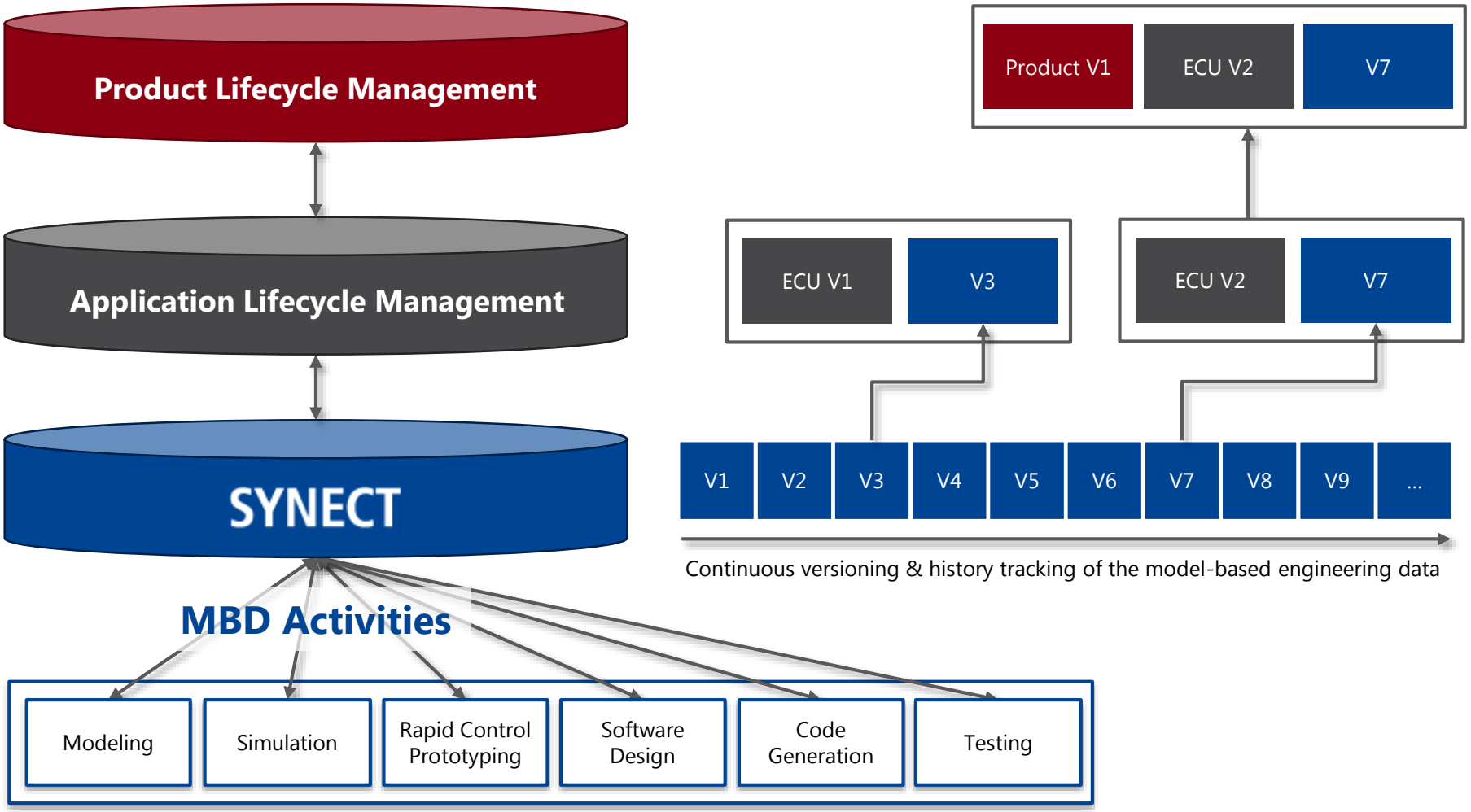

Best in Class for MBD Data Management

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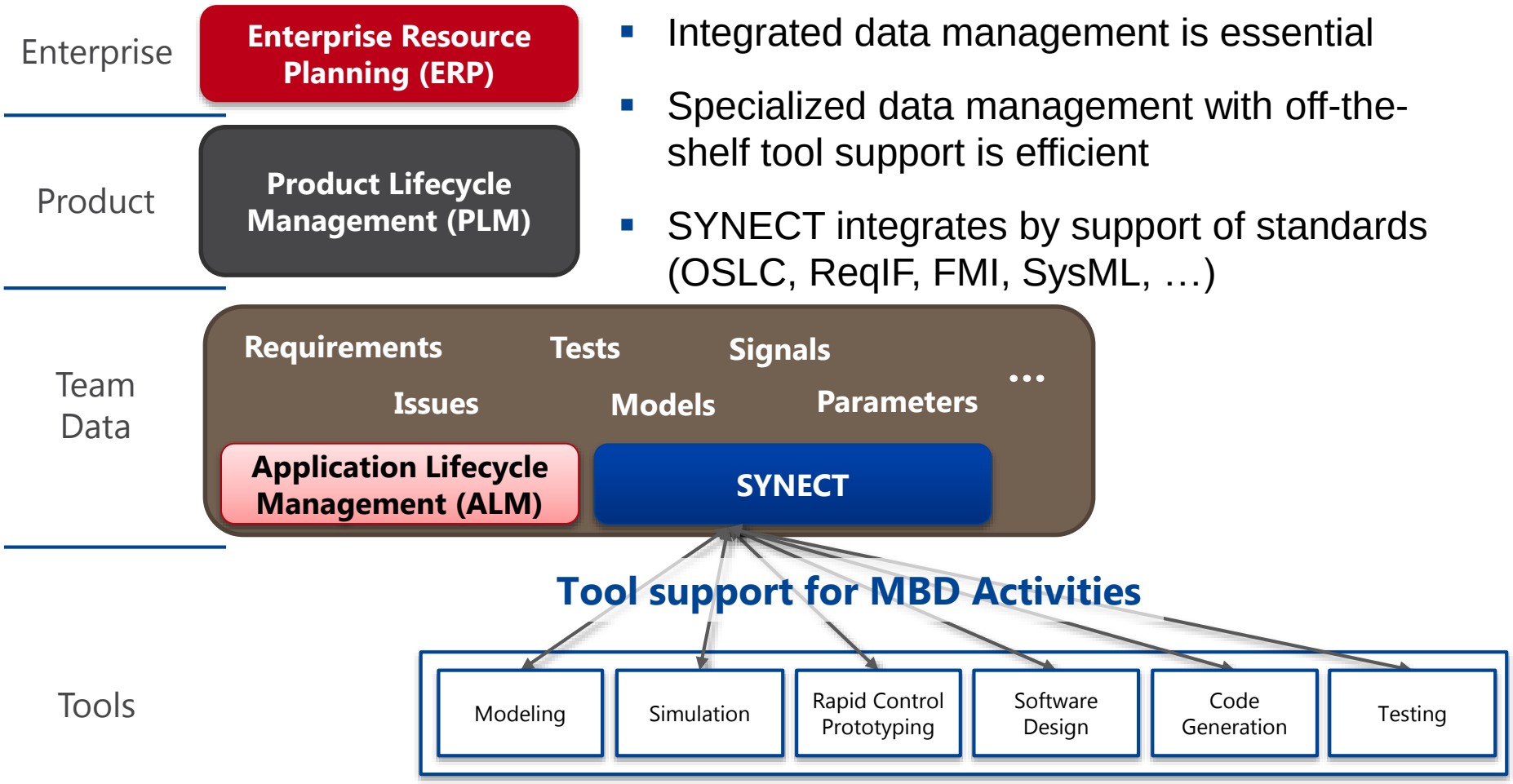

- Integrated data management is essential
- Specialized data management with off-the-shelf tool support is efficient
- SYNECT integrates by support of standards (OSLC, ReqIF, FMI, SysML, …)

Integration of ALM Tools

Cooperation with ALM tool provider and integrations with ALM tools

- Product level
- Customer projects

PLM/ALM Integration Connections

- Requirements Management
- File and Configuration Management
- Change Management, Issue and Bug Tracking
- Workflow Management

Support of ALM standards and integration activities

- Support for **OSLC** as a standard for lifecycle integration
- dSPACE is active member of **ReqIF – Implementor Forum**

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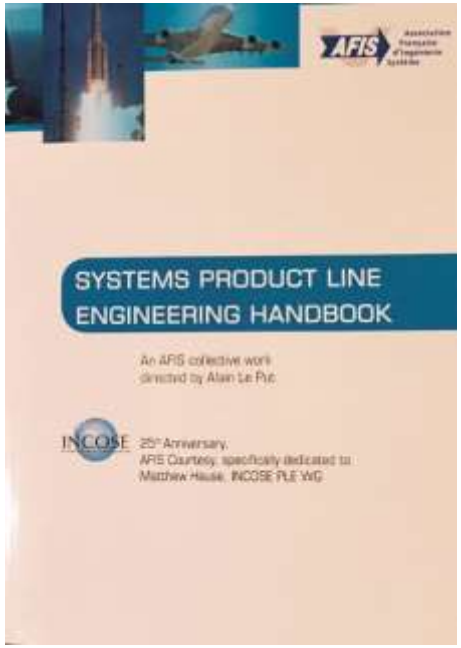
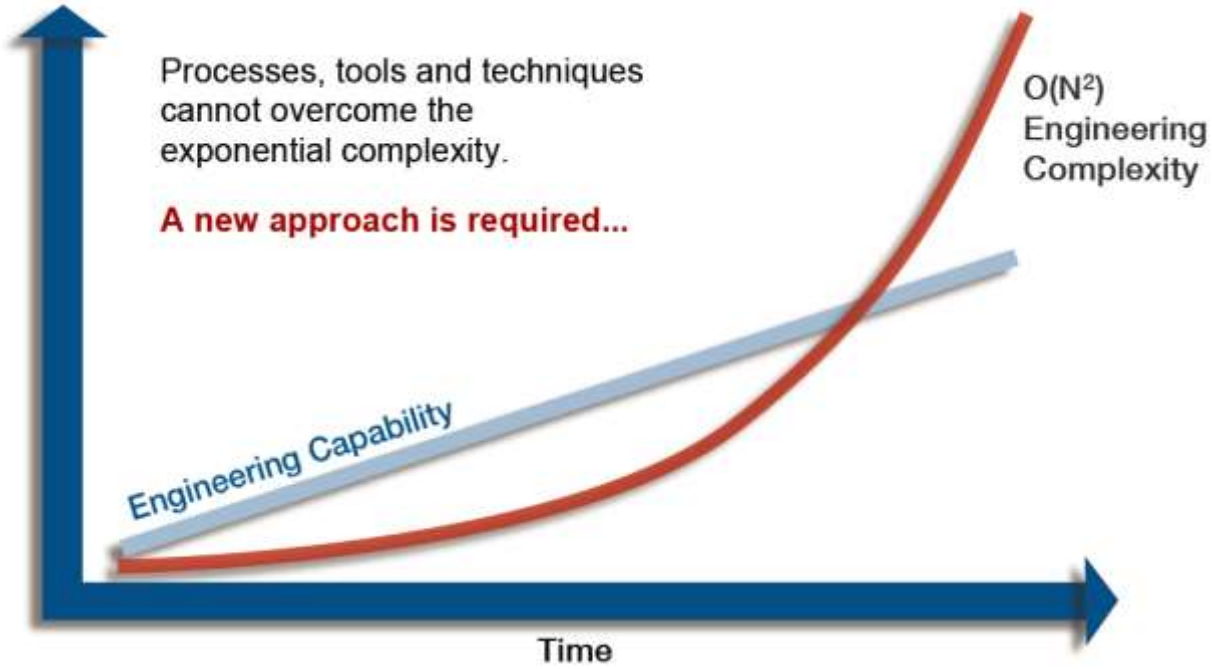
Challenge: Product Line Explosion!!!

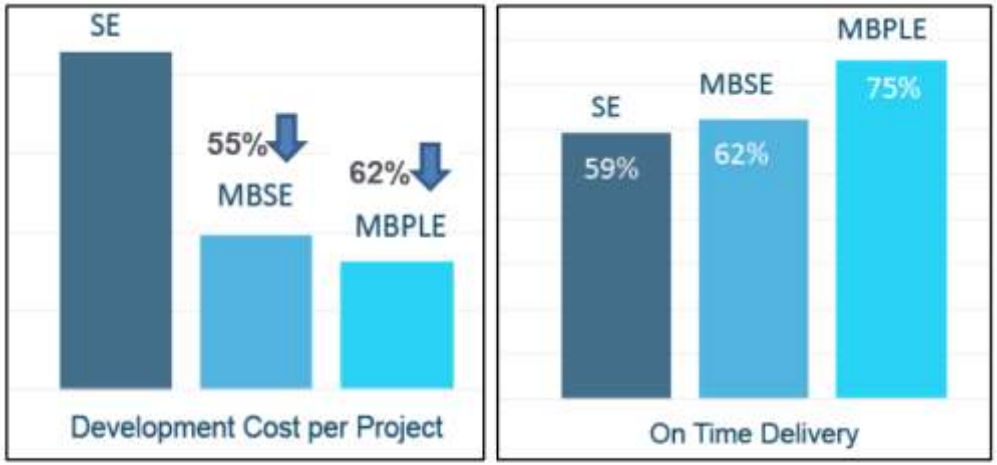
- Increasing number of product families and products in families
- Understanding product similarity and variations
- Orthogonal Variant Modeling (OVM) – SAE standard
- Systems Product Line Engineering – INCOSE and AFIS





Workflow Management and Variant Handling

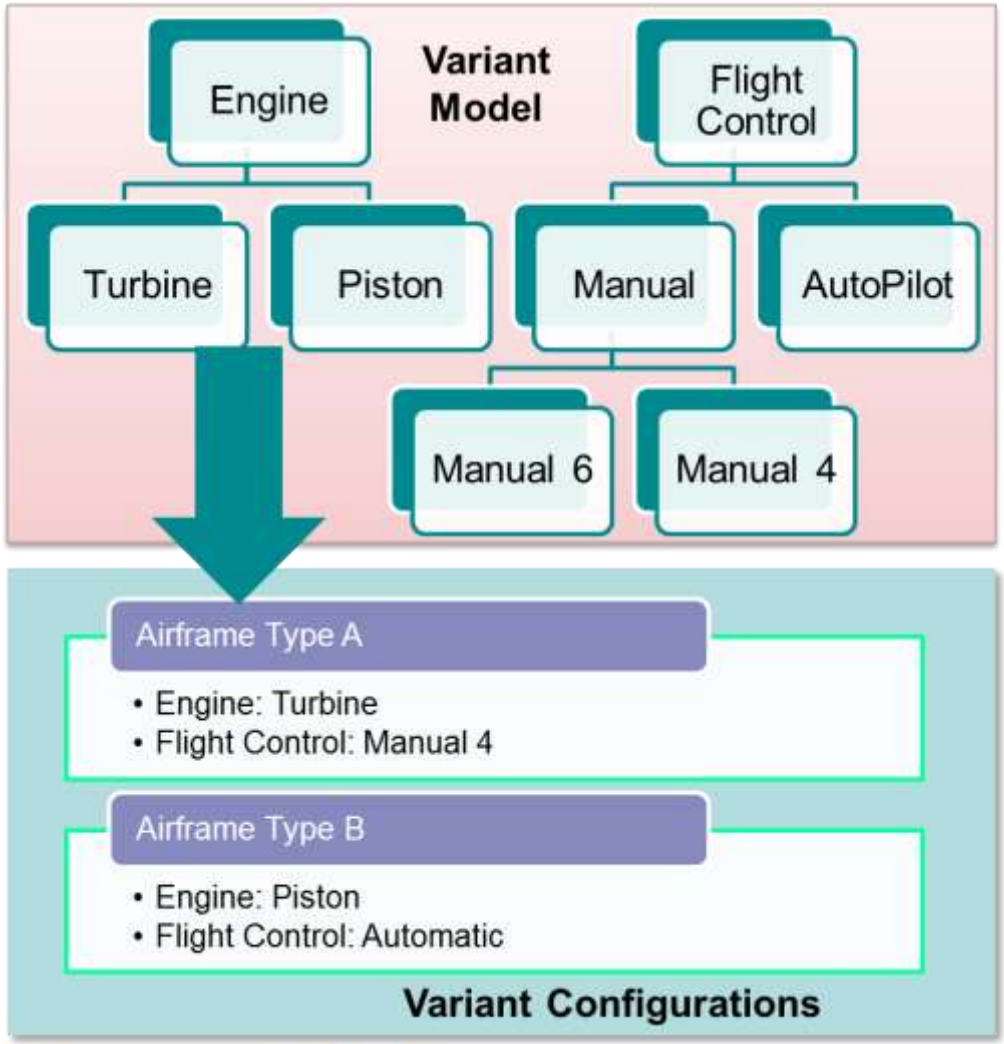
- Managing the flow of data in a testing process
- Integration of all tools involved in the MBD V&V process
- High flexibility - adapt to customer specific workflows
- Manage complexity due to variations – Variant Handling
- Simplify use of MBD systems - Handle Models and Variables



SE (Non-Modelled Systems Engineering)
MBSE (Model Based Systems Engineering)
MB-PLE (Model Based Product Line Engineering)
(EMF 2013 Independent Survey Results from 667 Systems engineering respondents)

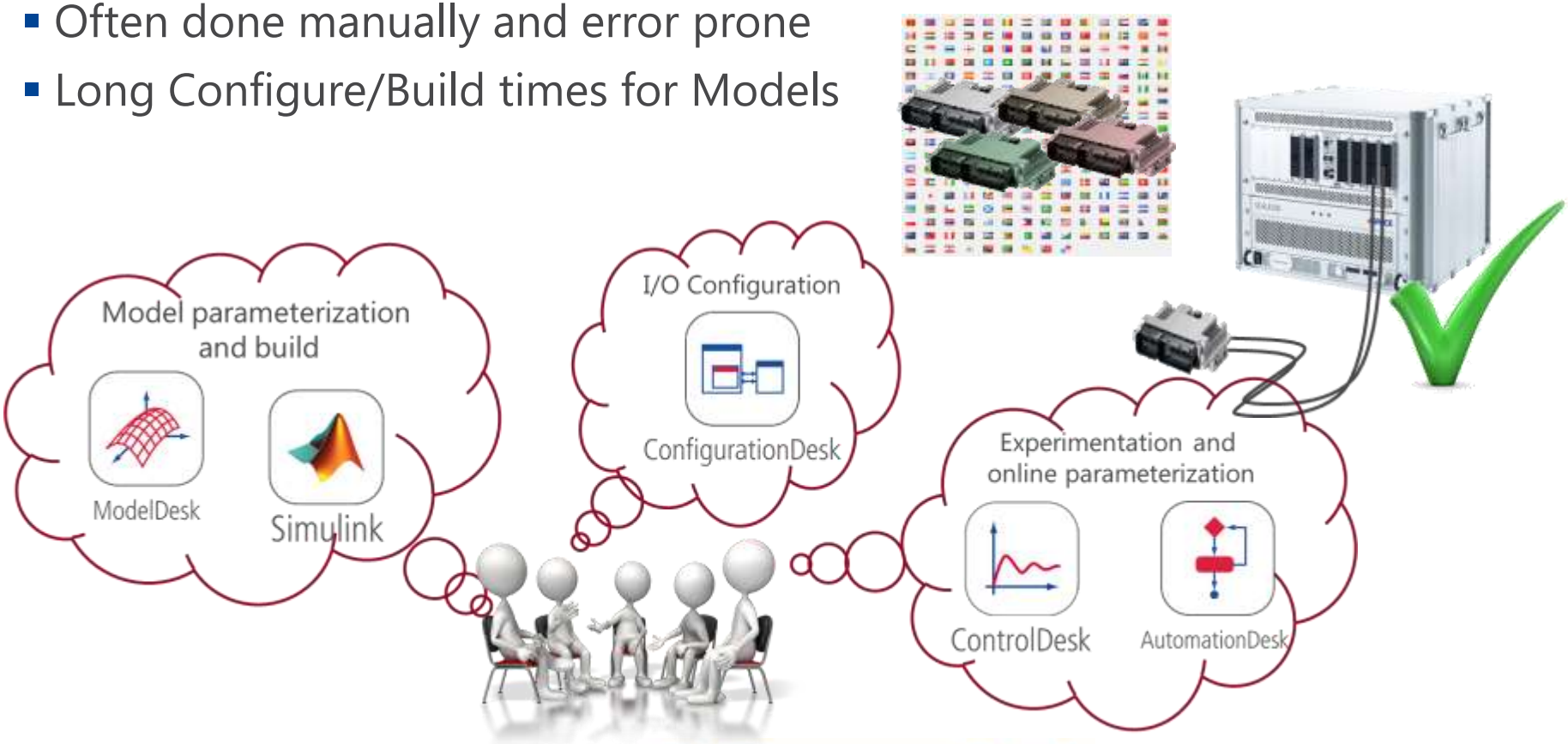
Model-Based Variant Management

- Define and manage your variant model: a variant tree knowledgebase
- Define and Manage Variant Configurations: Abstract mapping at Model Tree nodes
- Define dependencies to your data, e.g. to parameters, tests, models: perform variant specific tests, work with variant specific data
- Manage impact of variants on your data: work efficiently and always with correct data



Improving Downtime in Processes

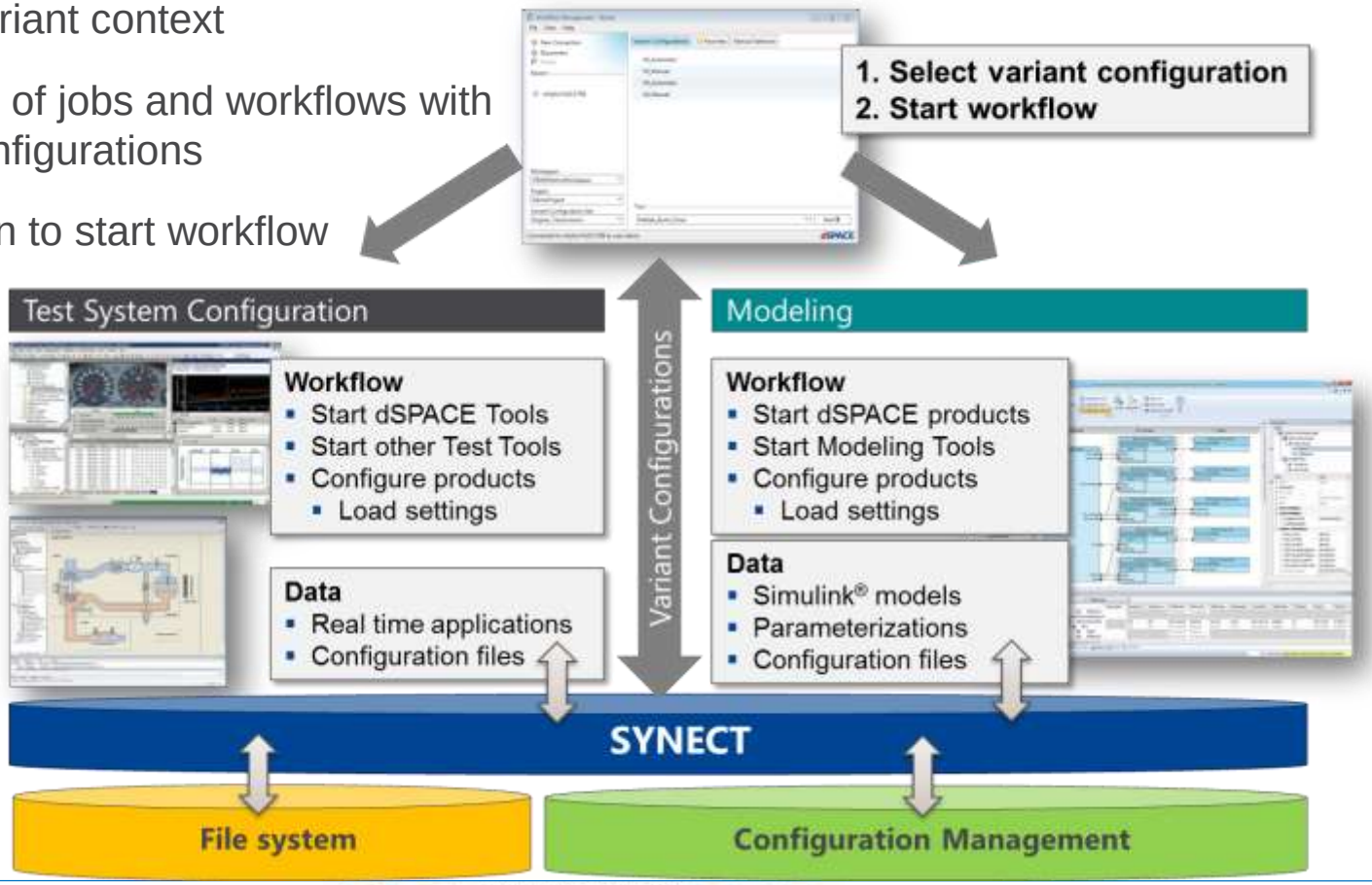
- Need to test multiple software versions and variants
- Time-consuming HIL preparation and configuration
- Often done manually and error prone
- Long Configure/Build times for Models



SYNECT Workflow Management

- Automate process steps with SYNECT workflows
- Central management of workflows and workflow parameters in a variant context
- Scheduled running of jobs and workflows with multiple variant configurations
- One-button solution to start workflow

Handle complex workflows including variants



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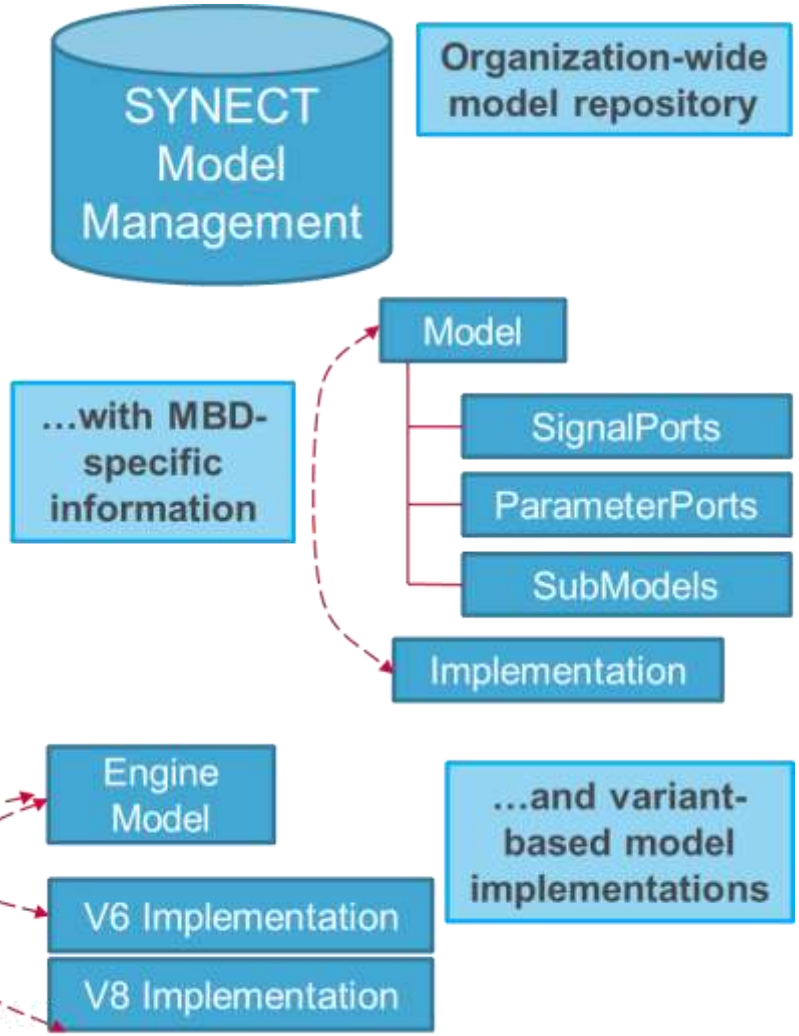
Model Management

Manage models and their compositions

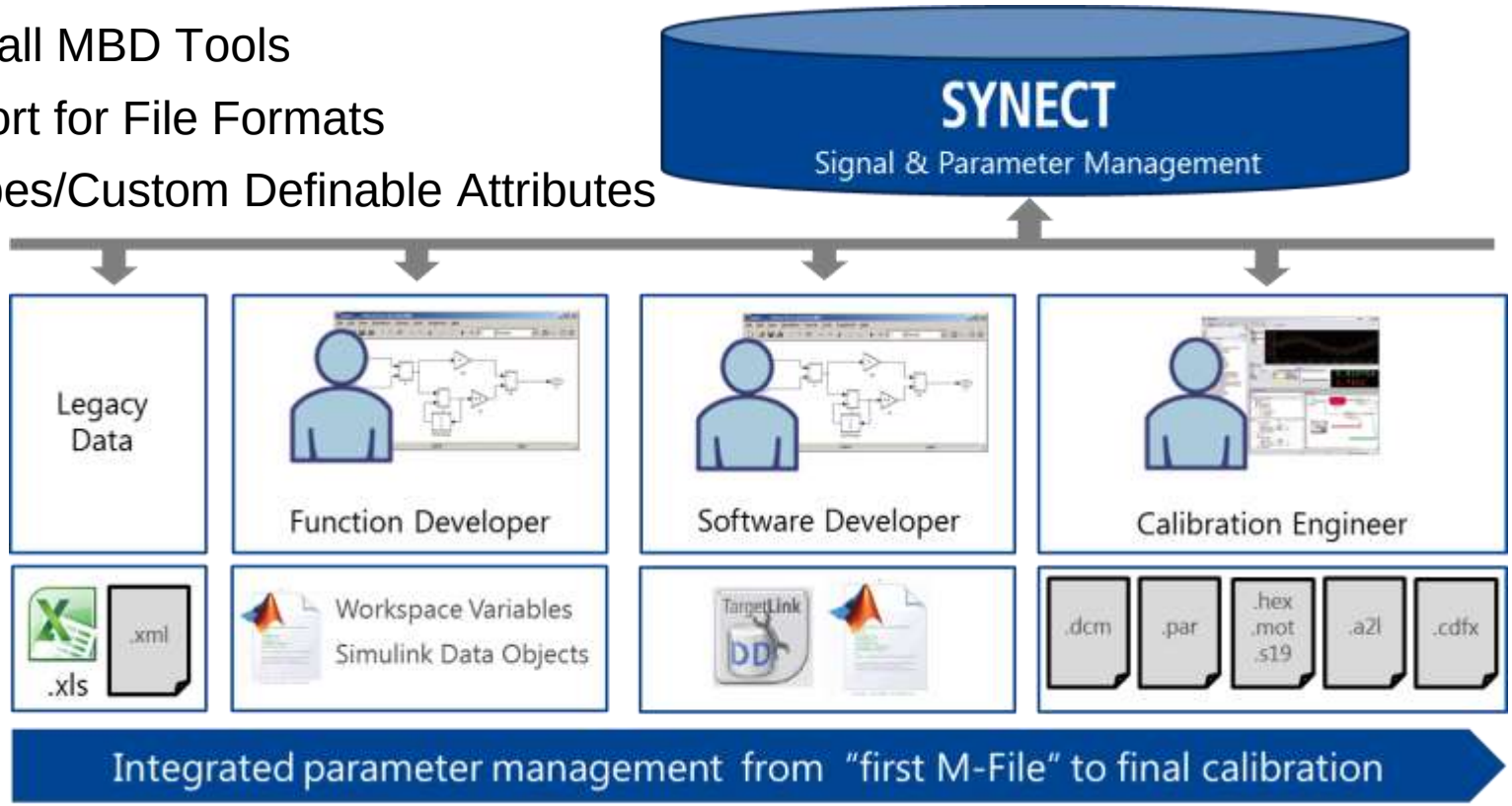
- For architecture, plant models and controller model development
- Interface to modeling tools like Simulink® and FMI authoring tools (e.g. AmeSIM, DYMOLA..)
- Model Interfaces, Parameters, Submodels
- Integrated support for variants
- Signal & Parameter Management
- Configuration management Integration
- Multi-User Collaboration, Rights Management
- Version Control



Signal & Parameter Management

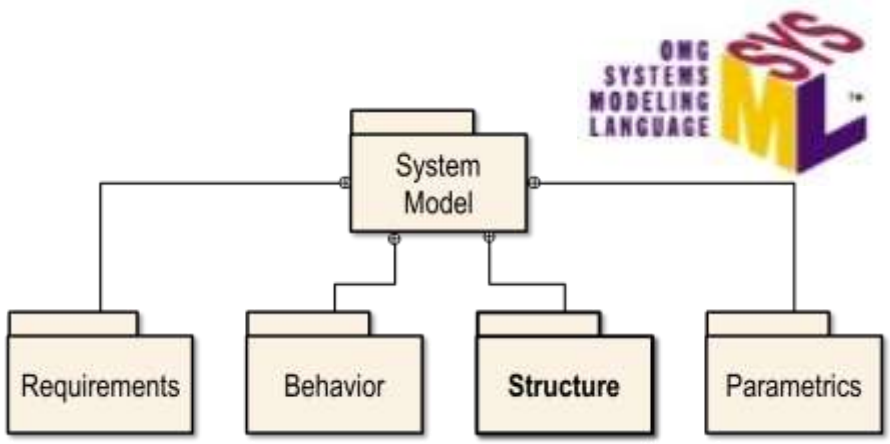
- Manage signals, parameters, and parameter sets
- More Granular Scope of Information than Files
- Integrated variant management
- Interface to all MBD Tools
- Open Support for File Formats
- All Data Types/Custom Definable Attributes

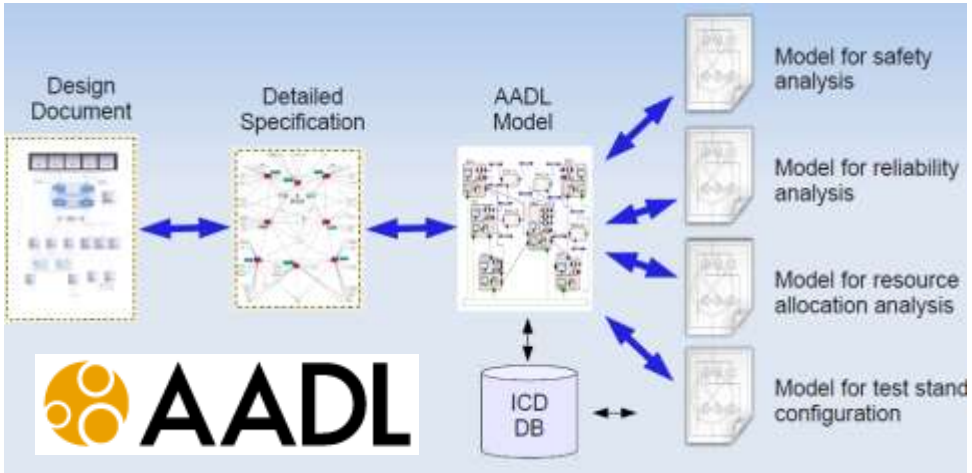
Global Data Dictionary



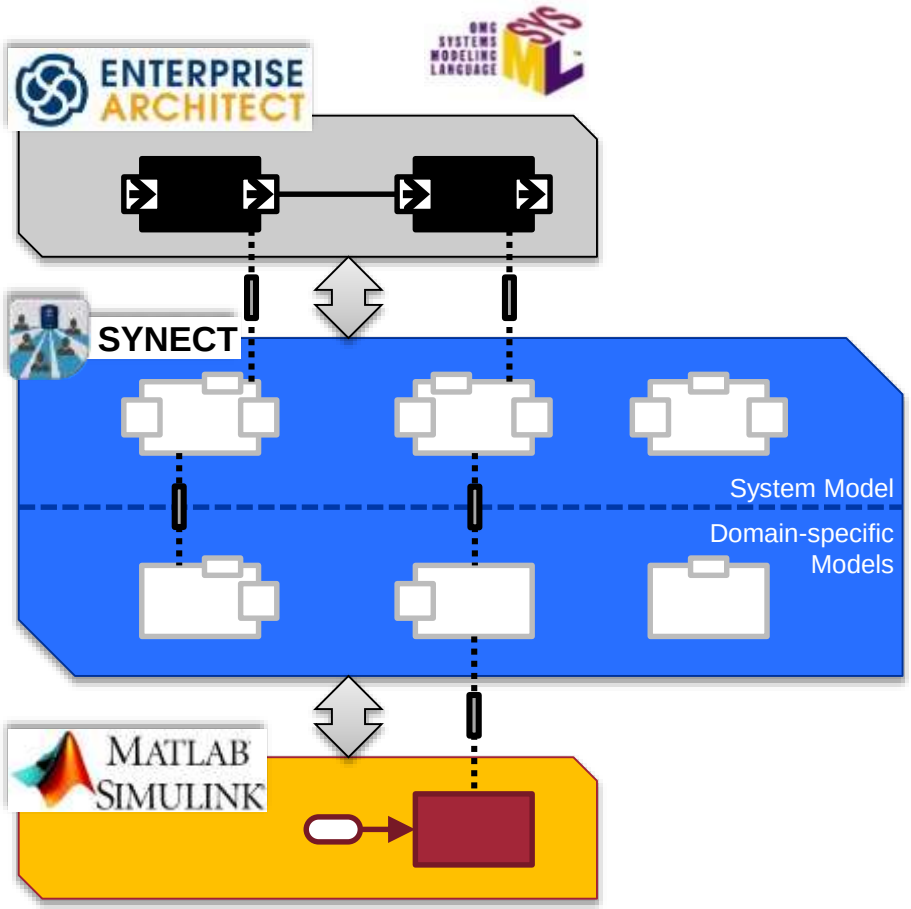
Model-Based Systems Engineering (MBSE)

- Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle
- Different domains (Avionics, Chassis, Electrical, …) use different development tools
- SysML – OMG Open Standard (UML)
- AADL: Architecture Analysis & Design Language
- International standard promoted by SAE, AS-2C committee (2004-2012 V2.1)





Managing System Models and Domain Models



- Funded project together with German research institute specialized in systems engineering
- SYNECT as link between system models and domain-specific models
- SysML system models designed in Enterprise Architect
- Tool demonstrator and first publication around mid 2015

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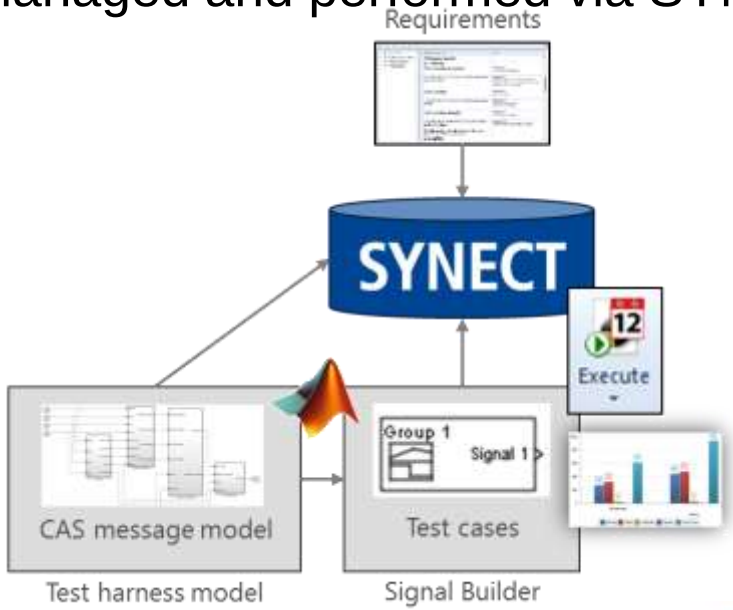
Application: Honda Aircraft Company

- HondaJet program: HA-420 project
  - Real-time test and simulation system (RTSS)
- Fully automated advanced systems integration test facility for verification of crew alerting system (CAS) logic
  - AutomationDesk and SYNECT used to automate the requirements based testing, with links back to requirements in DOORS
  - Approximately 300 CAS-messages tested
  - Nearly 2000 automated verification test cases run over 87 hours on the RTSS

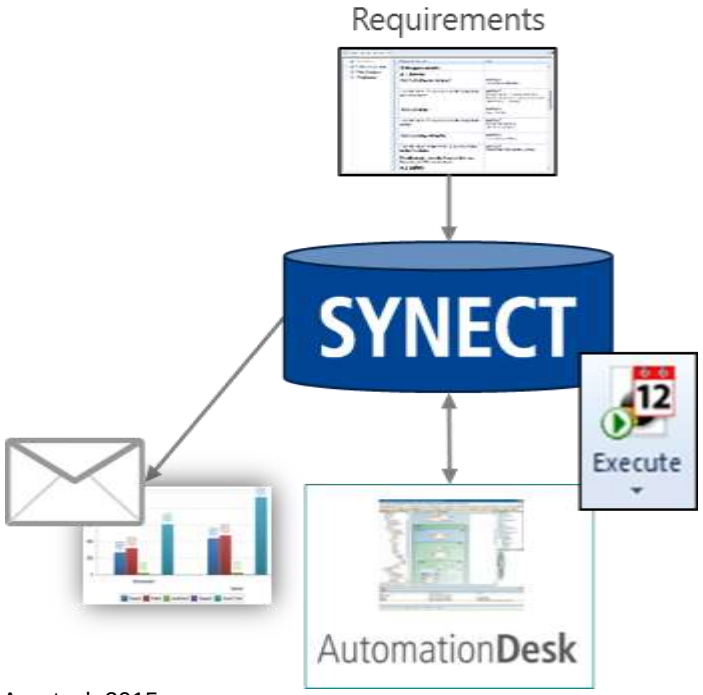
Reference: SAE Aerotech 2015

Test Management Use Case Scenario at Honda Aircraft Company

- Requirements, test cases, results imported and stored in SYNECT
- Simulink test harness and CAS message models imported
- Offline Matlab/Simulink test execution managed and performed via SYNECT



- SYNECT Execution Plans used to plan and manage the test case runs with AutomationDesk on the real-time system



Reference: SAE Aerotech 2015

Moog: MBD V&V Process Overview

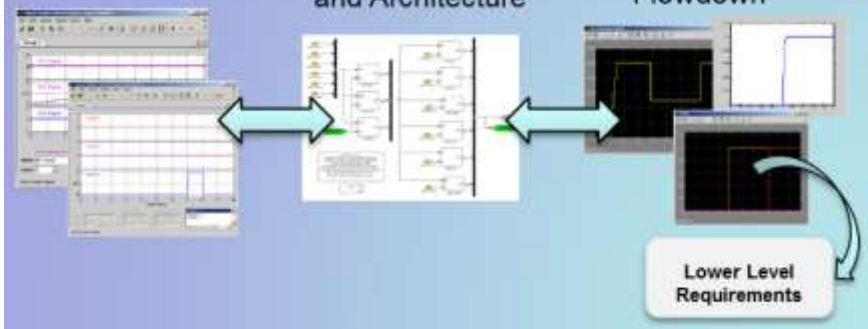
Reference: INCOSE 2015 – David Cook

System Design

Requirements Based Inputs

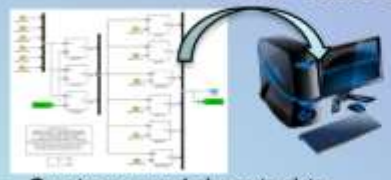
Model Based Analysis, Design, and Architecture

Requirement Derivation and Flowdown

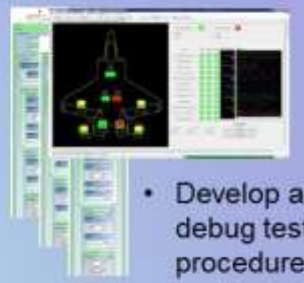


Lower Level Requirements

Real-Time Simulation



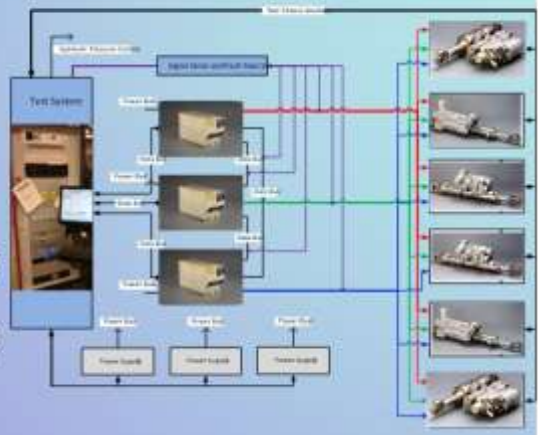
- System model ported to real-time simulator
- Same user interface as test lab
- Simulation allows parallel test development with no lab assets



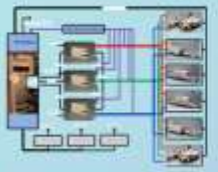
- Develop and debug test procedures and scripts before integration
- Find functional problems early

Formal System Testing

- Utilizes procedures and scripts developed in simulation and dry run in integration
- Formal Verification of requirements
- Modular, scalable lab to accommodate any type of system

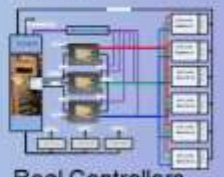


Prototype/Integration Testing

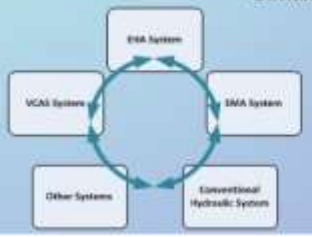


Full System Integration

Real Actuators, Simulated Controllers



Real Controllers, Simulated Actuators



- Common, reconfigurable development and verification lab architecture
- Capable of running with simulations up to full system hardware and anything in between

Application Moog: MBSE and MBD Testing

- Model-Based Systems Engineering - formalized application of modeling to support system requirements, design, analysis, verification and validation activities
- System model becomes the central element of the system design and verification efforts
- Requirements derivation/flow-down based on modeling and simulations
- Requirements validation through model-based analysis and simulation
  - Validation of hardware and software requirements prior to hardware/software build
- Traceability to development artifacts
- Automation through MBSE tools
  - Design information is captured in the model
  - Information is extracted for presentation/delivery and analysis via tool automation

Reference: INCOSE 2015 – David Cook

US OEM: Test Management Integration with HP-QC

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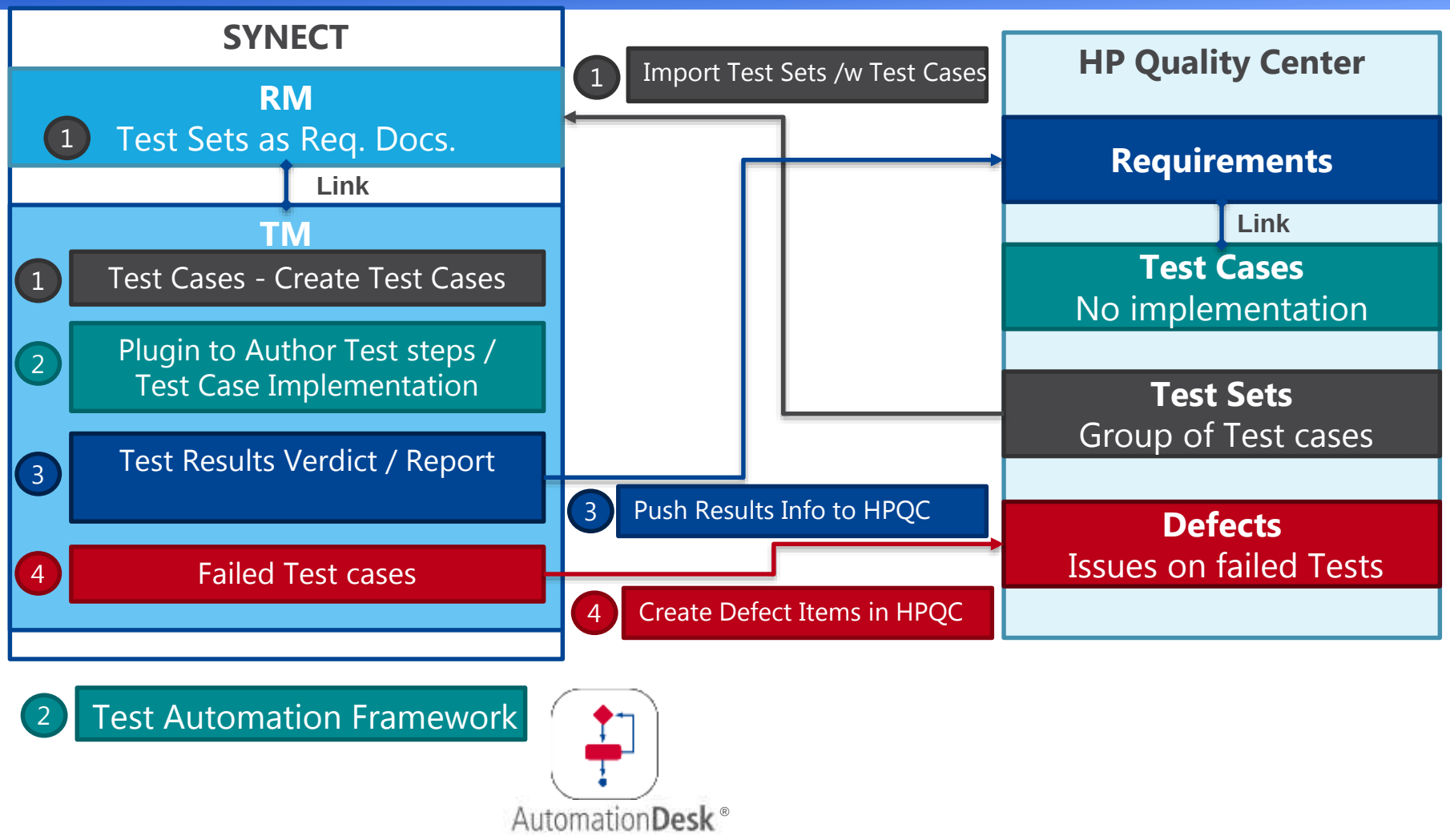
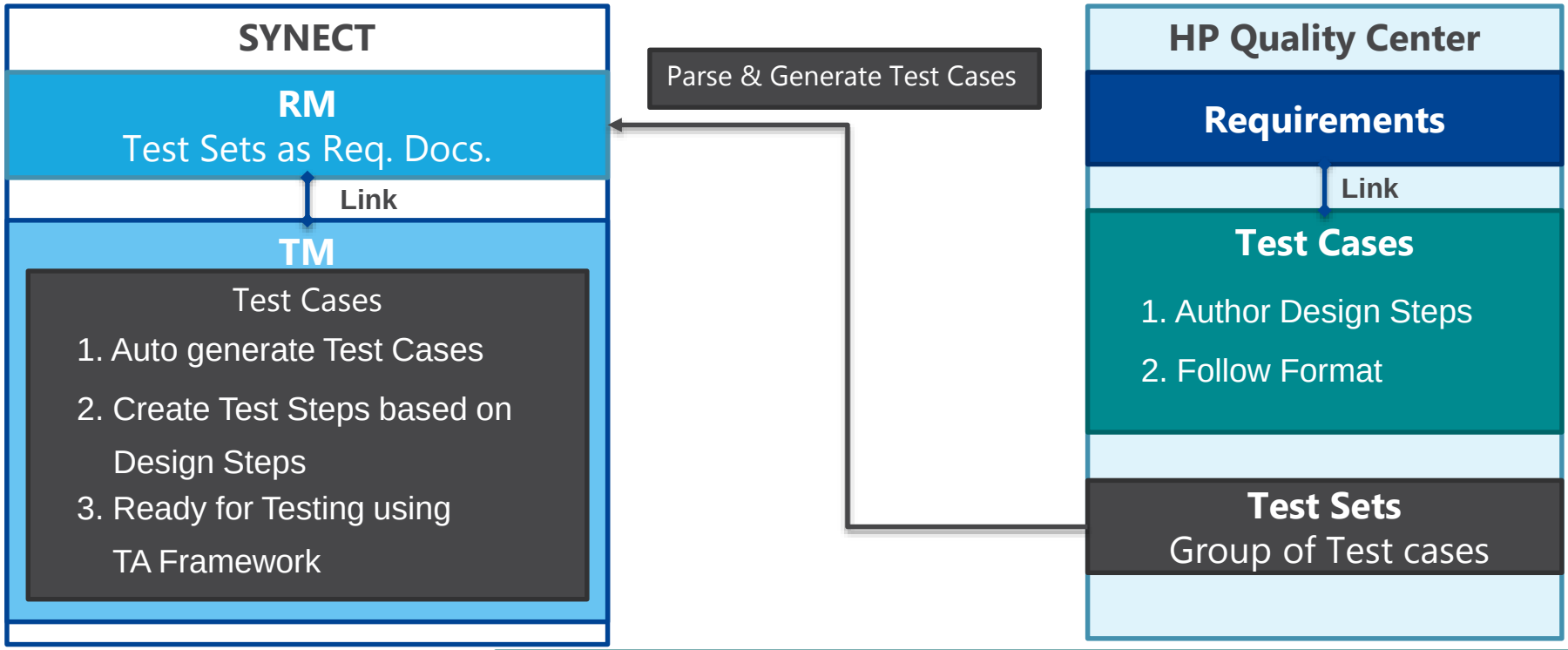


US OEM: Generate Test Steps from Requirements

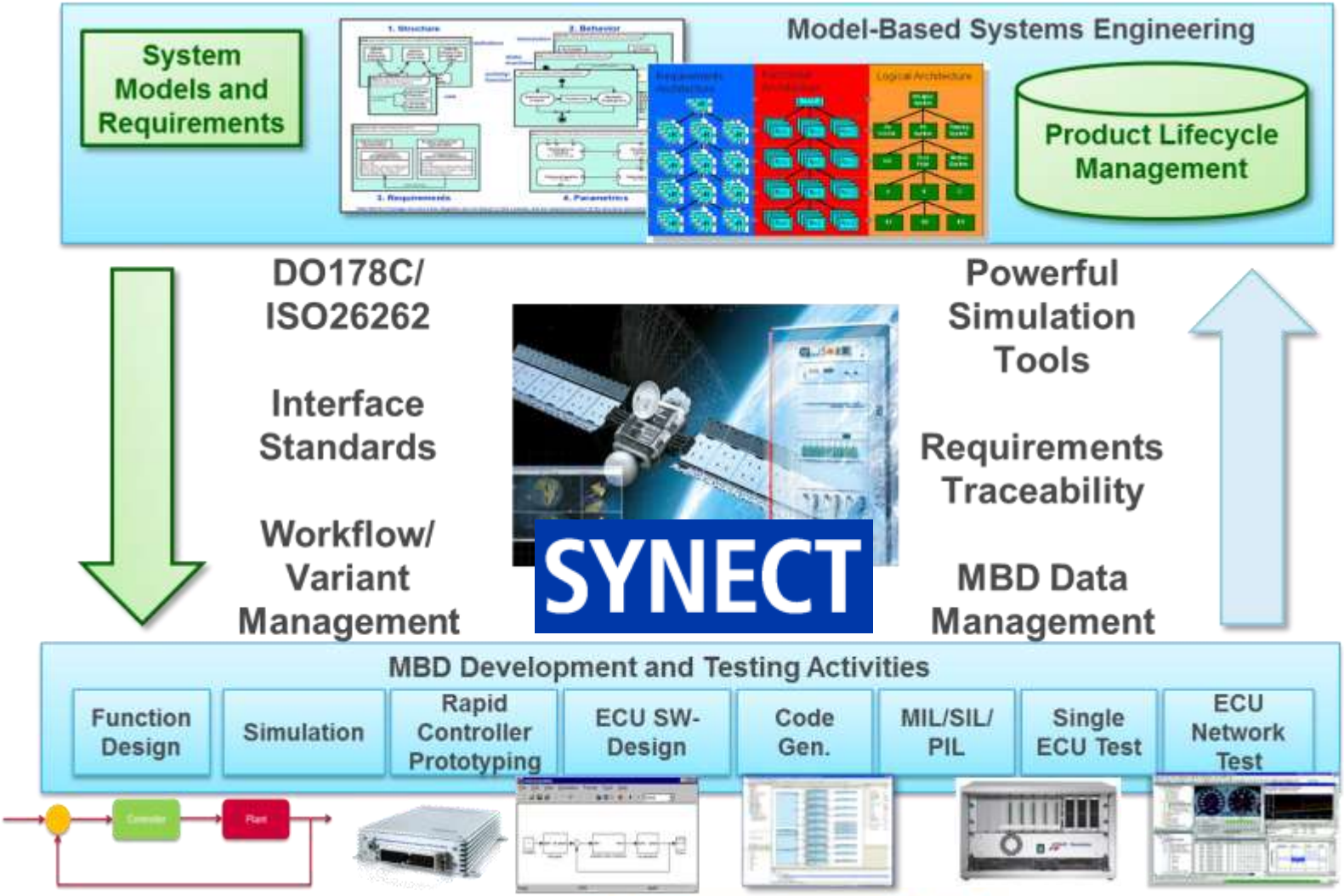


Test Automation Framework

AutomationDesk®

```
/* Comments */
SET <variable_name> TO_VAL <value> (add. info)
VERIFY <variable_name> IS_VAL <value> (add. Info)
WAIT <time in secs>
SEND <variable_name> ON <CAN> FROM <address> OF_VAL <value>
```

Coordinating MBSE and MBD Environments



Thank You

Questions?