COLLABORATIVE MODEL DEVELOPMENT FOR SYSTEM SIMULATION

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Self Introduction

Department: Controls Development & Validation

Team: XiL Simulation & Software Test Methods

- Provision of turn-key XiL Benches
- XiL Base Models & Tools Development
- Test Automation Tools & Methods Dev.
- Test Automation Scripts & Libraries
WHAT IS THE CHALLENGE TO SYSTEM SIMULATION?

- Dramatically increasing system complexity
- Reduction of development costs
- Strong move towards virtual development methods

→ Simulation based engineering is getting more and more important
→ Collaboration between departments becomes a prerequisite
→ Common fundament for model development, methods & tools
→ Need of collaborative Simulation Framework
AGENDA

• What is a Simulation Framework?
• Characteristics of a collaborative framework?
• Modular system modeling approach
• Practical examples for model integration
  • Model Interface Management
  • Model Configurator
• Summary
SYSTEM SIMULATION APPROACH

Which way to choose?

Base Software

MATLAB
SIMULINK
dSPACE
LMS
IPG
ECU-TEST
GitHub
WHAT IS A SIMULATION FRAMEWORK?

A framework is a puzzle of solutions for various disciplines

- Library concept
- Model integration
- Variant handling
WHAT IS A SIMULATION FRAMEWORK?

A framework is a puzzle of solutions for various disciplines

- Parameter initialization
- Definition of tunable parameters
- Parameter inheritance
- Maintenance of meta data
WHAT IS A SIMULATION FRAMEWORK?

A framework is a puzzle of solutions for various disciplines

- Following agile principles
- Git for version control
- JIRA for planning & issue tracking
- Continuous Integration & Testing
A framework is a puzzle of solutions for various disciplines

- Standards for model interface (e.g. FMU/FMI) and co-simulation methods
- Interface to external test automation tools
- Standard interfaces to RCP/HIL systems
- Data exchange with PLM/ALM systems
A framework is a puzzle of solutions for various disciplines

- Common documentation for tools & models
WHAT IS A SIMULATION FRAMEWORK?

A framework is a puzzle of solutions for various disciplines

- Naming convention
- Modeling rules & style guides
- MAAB Standard
What is a Simulation Framework?

A framework is a puzzle of solutions for various disciplines

- Common Look & Feel
- Automatic UI generation
WHAT IS A SIMULATION FRAMEWORK?

A framework is a puzzle of solutions for various disciplines

It’s not the What
It’s the How to ...

It’s not the content
It’s the method
COLLABORATIVE FRAMEWORK

Turn-key Application Models
(with different purpose)

Various Simulation Frameworks
(tailored to purpose)

Base Software

- MATLAB/SIMULINK
- dSPACE
- GT Gamma Technologies
- ECU-TEST
- GitHub

Powertrain
ADAS
Alternative Propulsion

MIL
SIL
HiL

and more
COLLABORATIVE FRAMEWORK

Turn-key Application Models
(with different purpose)

Powertrain
ADAS
Alternative Propulsion

Common Simulation Framework
(across various domains and departments)

Automotive
XIL
Objectoriented
Modelframework

Base Software

MATLAB
SIMULINK
dSPACE
LMS
IPG
GitHub

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WHAT ARE THE GOALS OF AXIOM?

- Coordinated development of new features to avoid multiple decoupled solutions
- Improved speed & robustness of model integration
- Reusability of models, tools and conventions
- Quick deployment of new features
- Standardized model access for test automation
- Management & Traceability of Models
- Efficient Maintainability of Models
- Common „Look & Feel” for model users
- Share deliverables between different teams & regions
- Follow Agile Principles to enable Continuous Integration & Testing
HOW TO SPECIFY AXIOM ENVIRONMENT?

Template vs. Library repository

**Template Repository**
- Simulink Top Level Structure
- Model Settings (e.g. Solver)
- Matlab/Simulink Settings
- Definition of used Libraries

**Library Repository**
- Model Library
- Toolboxes
- Other Data

Environment  
Content
HOW TO SPECIFY AXIOM ENVIRONMENT?

Turn-key Application Models

- Application 1
- Application 2
- Application 3
...

Template approach

Usage of object orientation and inheritance to create various stages of expansion

Base Software
MODULAR APPROACH

• Modular approach as main principle of Axiom
• Key enabler for collaborative work
• Module consists of a model together with it’s parameters and interface definition
  • It is standalone capable and completely independent of other modules
  • Module interfaces are tunable parameters and signal ports

→ Powerful toolchain required to...
  • connect modules to each other
  • load application specific parametrization
  • maintain different configurations (variants)
EXAMPLE 1: CONNECTION MANAGER

Adapter to connect multiple models

- Enabler for decoupled model development
- Well defined interface: prerequisite for model split
- Small busses realized by intelligent bus creation
- Automatic satisfaction of open module interfaces
Demo

Step 1

Add Connection Manager Blockset
EXAMPLE 1: CONNECTION MANAGER

Demo

**Step 1**
Add Connection Manager Blockset

**Step 2**
Assign Connection Manager
EXAMPLE 1: CONNECTION MANAGER

Demo

Step 1
Add Connection Manager Blockset

Step 2
Assign Connection Manager

Step 3
Open Connection Manager

EXAMPLE 1: CONNECTION MANAGER

Step 1
Add Connection Manager Blockset

Step 2
Assign Connection Manager

Step 3
Open Connection Manager

Demo
EXAMPLE 2: MODEL CONFIGURATOR

Management of parametrization

- Maintenance of parameter files (auto-generation, checks etc.)
- Apply specific parameterization by
  - Tunable parameter files
  - Overrides
  - References
- Automatic workspace initialization

Management of model variants

- Runtime switchable
- Provide functionality to store configurations → traceability, reuse
- Support of “Model Referencing”
EXAMPLE 2: MODEL CONFIGURATOR

Parametrization via GUI

Parameter Files

Model Component Libraries
With base Parametrization

Application Model

EXAMPLE 2: MODEL CONFIGURATOR

Parametrization via GUI

Parameter Files

Model Component Libraries
With base Parametrization

Application Model
SUMMARY

Work across domains
Compatibility

Reusability
Powerful Toolchain

Agile principles
Continuous Integration

Model assembly line

Cost
Efficiency
Quality
SUMMARY

Model Factory

Model Development Process

Framework

Model Configurations

Model Assembly Line

Model Libraries

Product

Turn-key Application Models

Change and Release Management

JIRA

Version Control

git

Model Factory

SUMMARY
Collaborative Model Development for System Simulation

THANK YOU

Q & A