COLLABORATIVE MODEL DEVELOPMENT FOR SYSTEM SIMULATION

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XiL Simulation & Software Test Methods
Stuttgart, MathWorks AUTOMOTIVE CONFERENCE 2019 EUROPE, 11. April 2019
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

System Requirements

System Design

Implementation

Integration Test

Unit Test

System Test

Release
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

Turn-key Application Models

MIL Models

MiL

SIL Models

SiL

HIL Models

HIL

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
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
WHAT IS A SIMULATION FRAMEWORK?

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
WHAT IS A SIMULATION FRAMEWORK?

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

Conventions

Documentation

Interface Definition

Model Configuration

Parametrization

Process
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

Powertrain
ADAS
Alternative Propulsion

and more

Powertrain
ADAS
Alternative Propulsion
COLLABORATIVE FRAMEWORK

Turn-key Application Models
(with different purpose)

Powertrain
ADAS
Alternative Propulsion

Common Simulation Framework
(across various domains and departments)

Automotive
XIL
Objectorienteed
Modelframework

Base Software

MATLAB
SIMULINK
dSPACE
LMS
IPG
Git
ECU-TEST
GitHub
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

Application Model

Model Component Libraries
EXAMPLE 1: CONNECTION MANAGER

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 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 \(\rightarrow\) traceability, reuse
- Support of “Model Referencing”
EXAMPLE 2: MODEL CONFIGURATOR

Parametrization via GUI

Model Component Libraries
With base Parametrization

Parameter Files

Application Model

EXAMPLE 2: MODEL CONFIGURATOR

Parametrization via GUI

Model Component Libraries
With base Parametrization

Parameter Files

Application Model
SUMMARY

Work across domains

Compatibility

Test

Automation

Simulation

Reusability

Powerful Toolchain

Agile principles

Continuous Integration

Model assembly line

Efficiency

Quality

Cost

A X I O M

Documentation

Interface Description

Conventions

Process

Model Configuration

Parametrization

User Interface

Powerful Toolchain

Agile principles

Continuous Integration

Cost

Efficiency

Quality
GLOBAL WAREHOUSE

LOGISTICS

Product

Places: objects, people
Costs: time, quality, customers

Car Configurations

Platform & Tooling

Parts Warehouse

Assembly Line

Car Factory

Processes
SUMMARY

Model Factory

- Framework
- Model Configurations
- Model Libraries
- Model Assembly Line
- Turn-key Application Models
- Product

Model Development Process
- Change and Release Management
- Version Control
Collaborative Model Development for System Simulation

THANK YOU

Q &A