# Smart Component Modeling for Complex System Development

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Airbus Central R&T

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# Motivation

## Customers demand

- New product features and capabilities
- With higher cadence

## Development cycles are long and expensive

- Due to complexity
- Due to interdisciplinarity
- Due to customization
- Due to certification

## Getting a product quick to the market

- Important for business success
- Customers tend to stop ordering old products in case a new one is announced

# Challenge & Approach

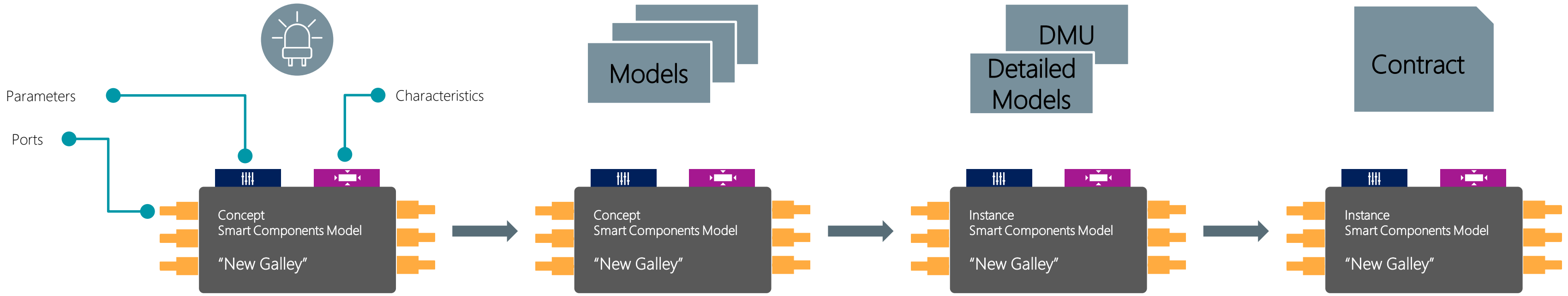
Increase development velocity and product quality without negative impacts on performance or certification

- Introduction of a new development process (Out of cycle)
- Digitalization of all process steps (MBSE)
- Automation where possible (supporting tool infrastructure)

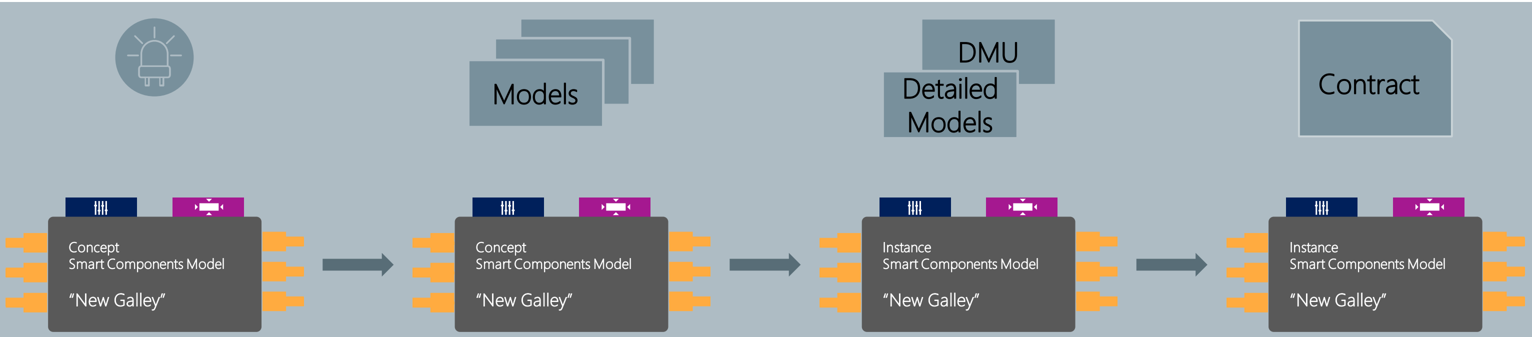
Way of Working

- Central R&T to work independently from current tool vendor policy
- Ideal, greenfield approach
- Regular exchange with bigger Airbus initiatives; but not directly part of it

# Out of Cycle Process


Parameters
Ports
Characteristics
Concept
Smart Components Model
"New Galley"
Models
Concept
Smart Components Model
"New Galley"
DMU
Detailed Models
Instance
Smart Components Model
"New Galley"
Contract
Instance
Smart Components Model
"New Galley"

# Out of Cycle Process



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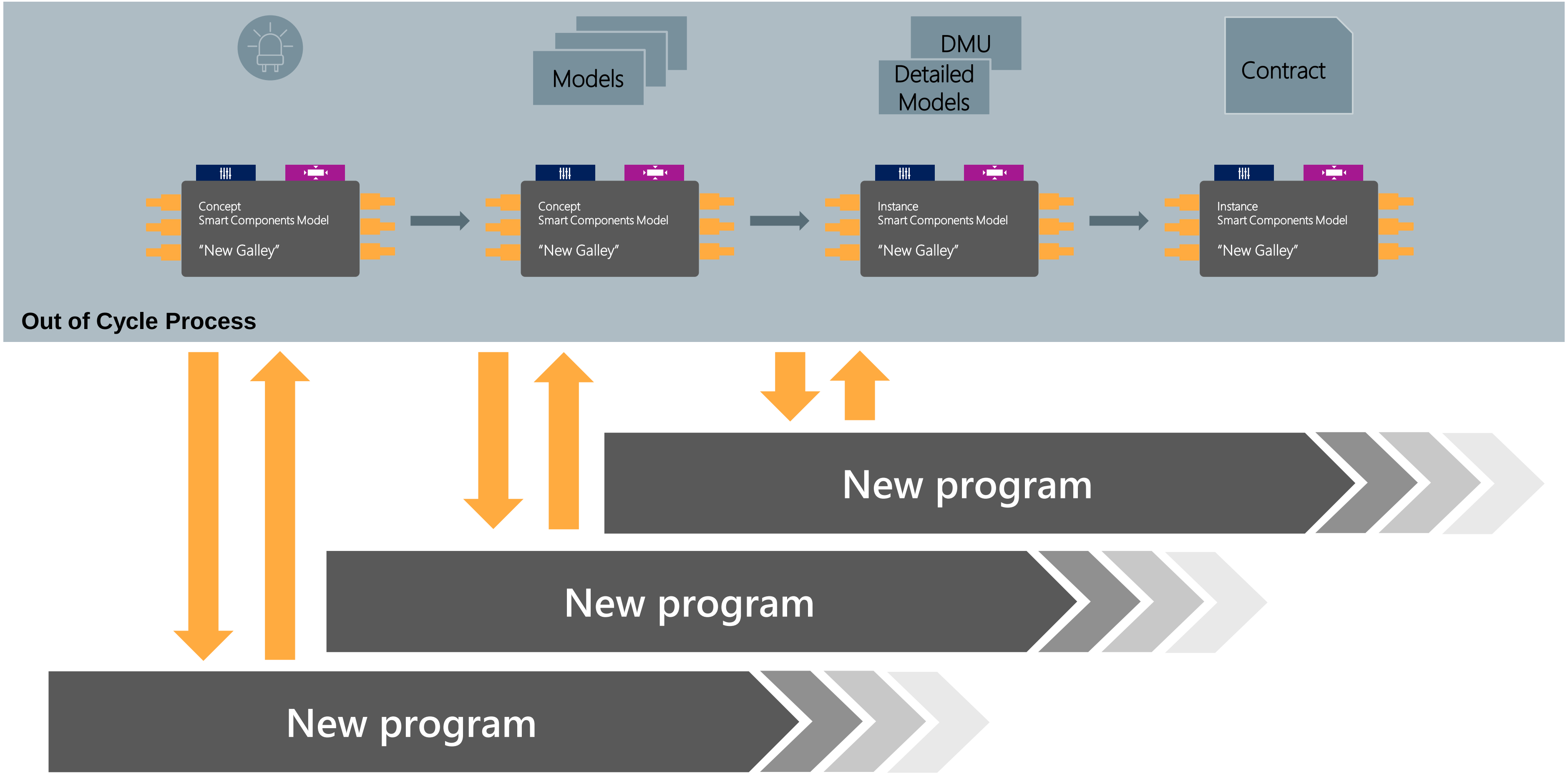
**Out of Cycle Process**

# Out of Cycle Process



Models

DMU

Detailed Models

Contract

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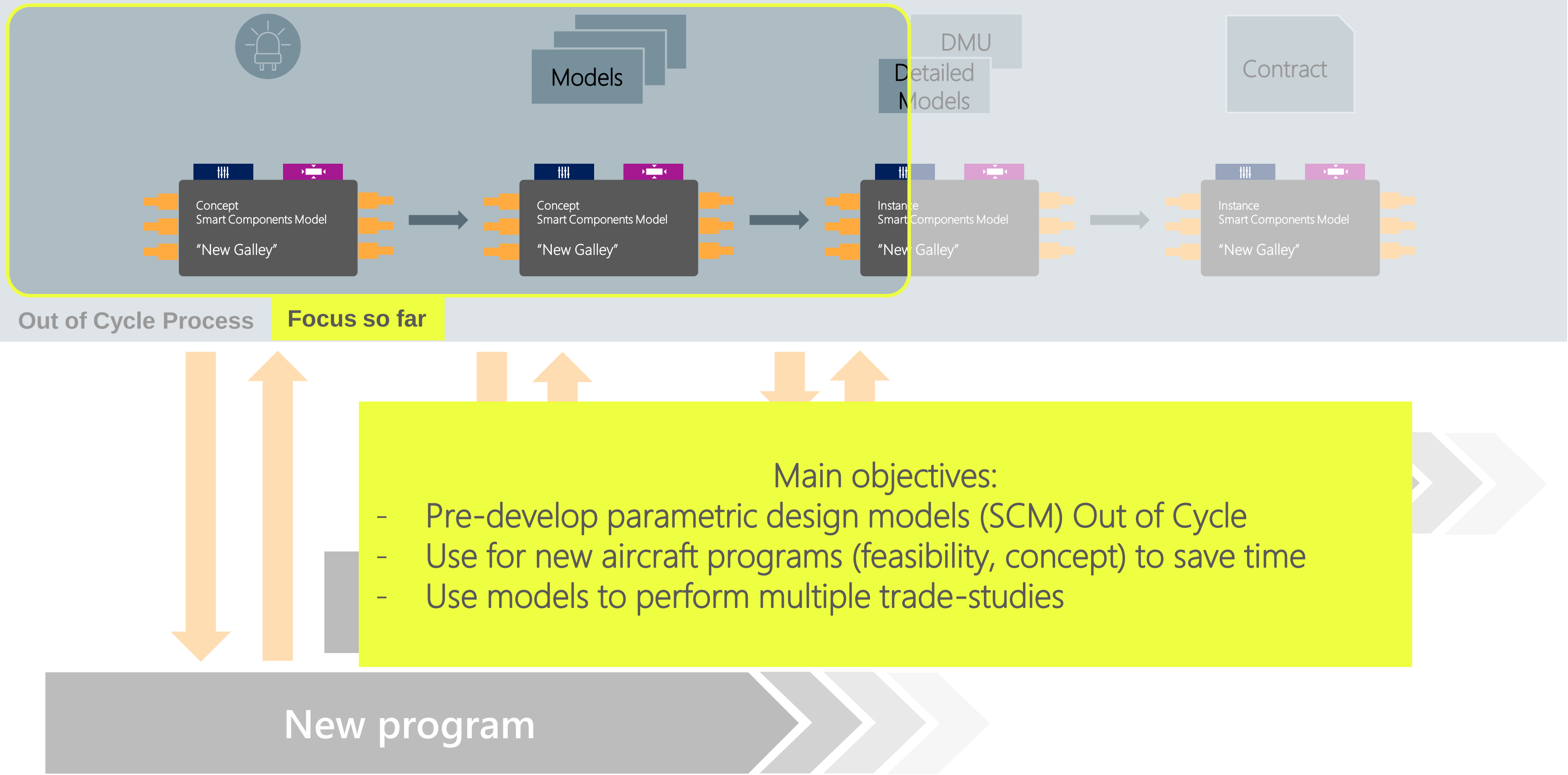
**Out of Cycle Process**

New program

New program

New program

# Out of Cycle Process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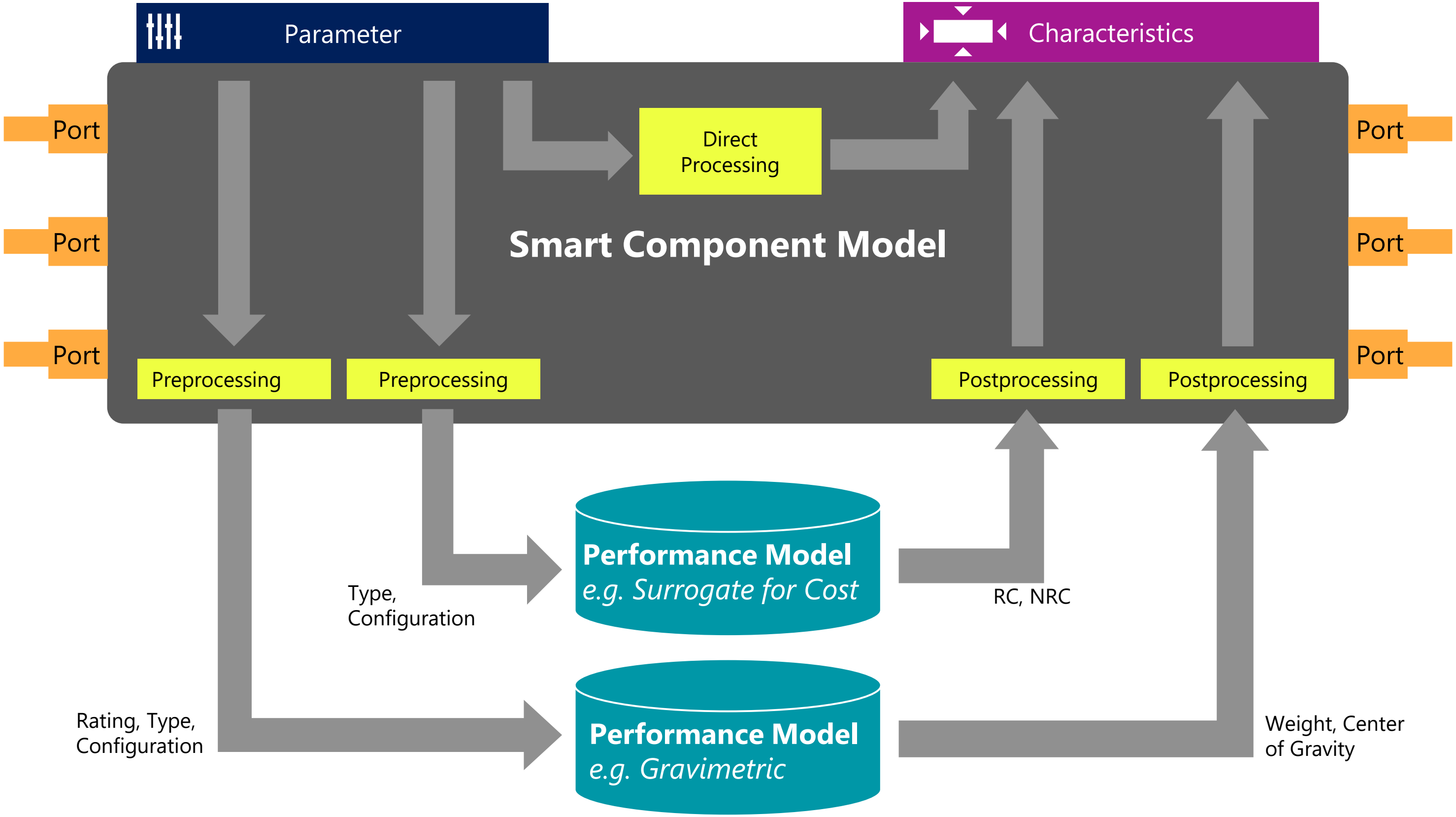
Instance Smart Components Model
"New Galley"
Out of Cycle Process
Focus so far
New program

Main objectives:

- Pre-develop parametric design models (SCM) Out of Cycle
- Use for new aircraft programs (feasibility, concept) to save time
- Use models to perform multiple trade-studies

# What is a Smart Component Model?


Parameter
Characteristics
Port
Port
Port
Port
Port
Port
Direct Processing
**Smart Component Model**
Preprocessing
Preprocessing
Postprocessing
Postprocessing
**Performance Model**
*e.g. Surrogate for Cost*
**Performance Model**
*e.g. Gravimetric*
Type, Configuration
RC, NRC
Rating, Type, Configuration
Weight, Center of Gravity

# Mechanisms of Smart Component Models

**Parameter**
Input variables that configure the model

**Characteristics**
Output variables that are calculated from input parameters

**Parts/Occurrences**
Allow decomposition of models

**Transfer / Computation**
Transfer information between model elements, potentially performing transformations

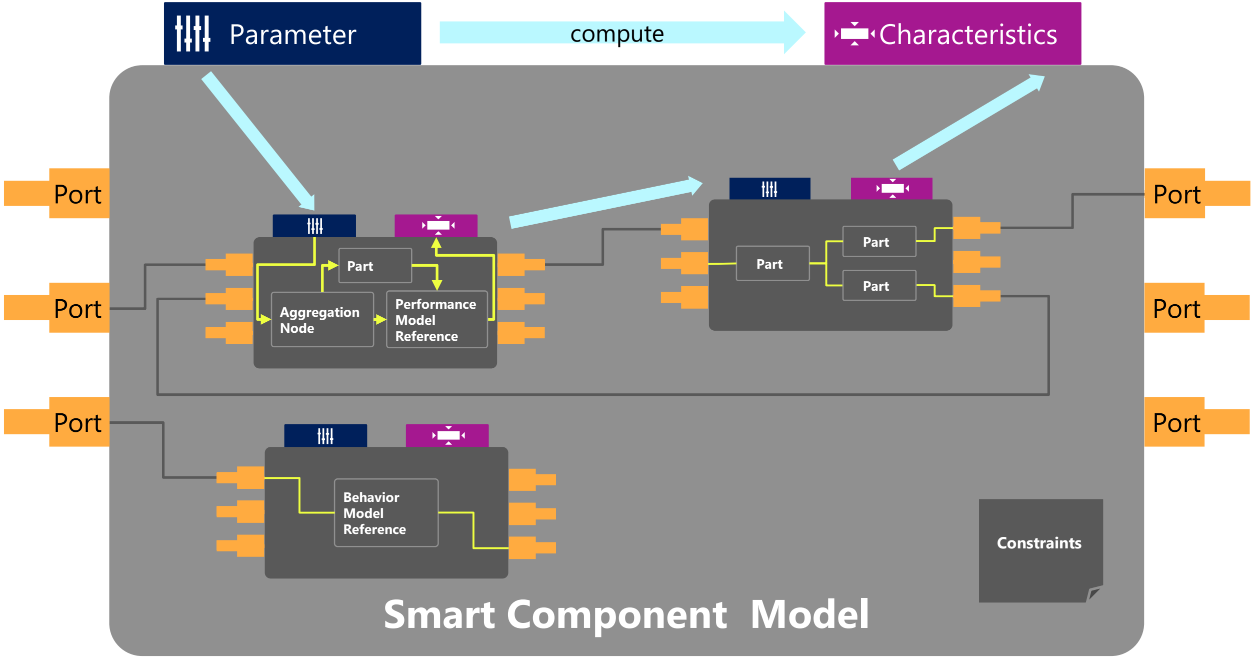
**Model References**
Specify external discipline models used to calculate performance or behavioral indicators

**Aggregation Nodes**
Perform internal computations

**Constraints**
Specify value or structural requirements for all model elements

**Ports**
Represent interfaces of the modelled entity

**Connectors**
Connects pair of ports


Parameter
compute
Characteristics
Port
Port
Port
Port
Port
Port
Part
Aggregation Node
Performance Model Reference
Part
Part
Part
Behavior Model Reference
Constraints
Smart Component Model

# Differentiating Features of Smart Component Modeling

- Explicit parameterization of models
- Occurrence modeling for deep nested modeling
- Formal type system with type and value checking
- References to external domain models
- Constraint definition and checking based on OCL[1]/AQL[2]
- Flexible relation modeling
- Supporting tool infrastructure

[1] Object Constraint Language
[2] Acceleo Query Language

# Model editor – SCM Workbench

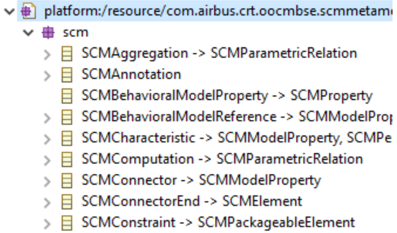
Formal Ecore meta model → automatic → Eclipse plugins for model editing

Eclipse plugins for model editing → use → Diagram, tools and services definitions

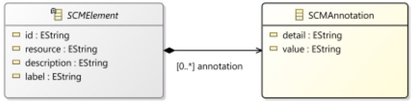
Eclipse plugins for model editing + Diagram, tools and services definitions → automatic → Graphical editor for SCM models

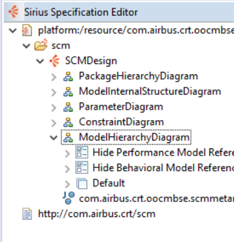
SCM Workbench

Airbus Central R&T



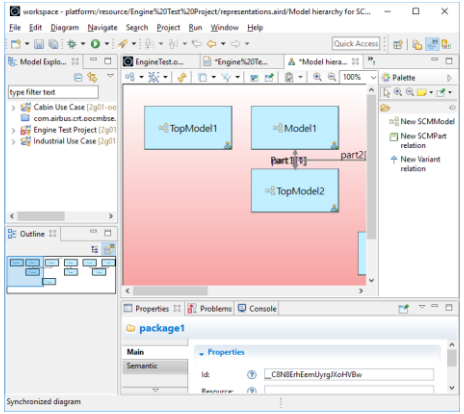
- platform:/resource/com.airbus.crt.oocmbse.scmmetam
  - scm
    - SCMAggregation -> SCMParametricRelation
    - SCMAnnotation
    - SCMBehavioralModelProperty -> SCMProperty
    - SCMBehavioralModelReference -> SCMModelProp
    - SCMCharacteristic -> SCMModelProperty, SCMPe
    - SCMComputation -> SCMParametricRelation
    - SCMConnector -> SCMModelProperty
    - SCMConnectorEnd -> SCMElement
    - SCMConstraint -> SCMPackageableElement


SCMElement
id : EString
resource : EString
description : EString
label : EString
[0..*] annotation
SCMAnnotation
detail : EString
value : EString



Sirius Specification Editor

- platform:/resource/com.airbus.crt.oocmbse
  - scm
    - SCMDesign
      - PackageHierarchyDiagram
      - ModelInternalStructureDiagram
      - ParameterDiagram
      - ConstraintDiagram
      - ModelHierarchyDiagram
        - Hide Performance Model Refere
        - Hide Behavioral Model Referen
        - Default
      - com.airbus.crt.oocmbse.scmmeta
- http://com.airbus.crt/scm



workspace - platform:/resource/Engine%20Test%20Project/representations.aird/Model hierarchy for SC...

File
Edit
Diagram
Navigate
Search
Project
Run
Window
Help
Quick Access
Model Explo...
type filter text
Cabin Use Case [2g01-oo
com.airbus.crt.oocmbse.
Engine Test Project [2g01
Industrial Use Case [2g01
Outline
EngineTest.o...
*Engine%20Te...
*Model hiera...
100%
Palette
New SCMModel
New SCMPart relation
New Variant relation
TopModel1
Model1
TopModel2
Part 1[1]
part2[
Properties
Problems
Console
Main
Semantic

package1

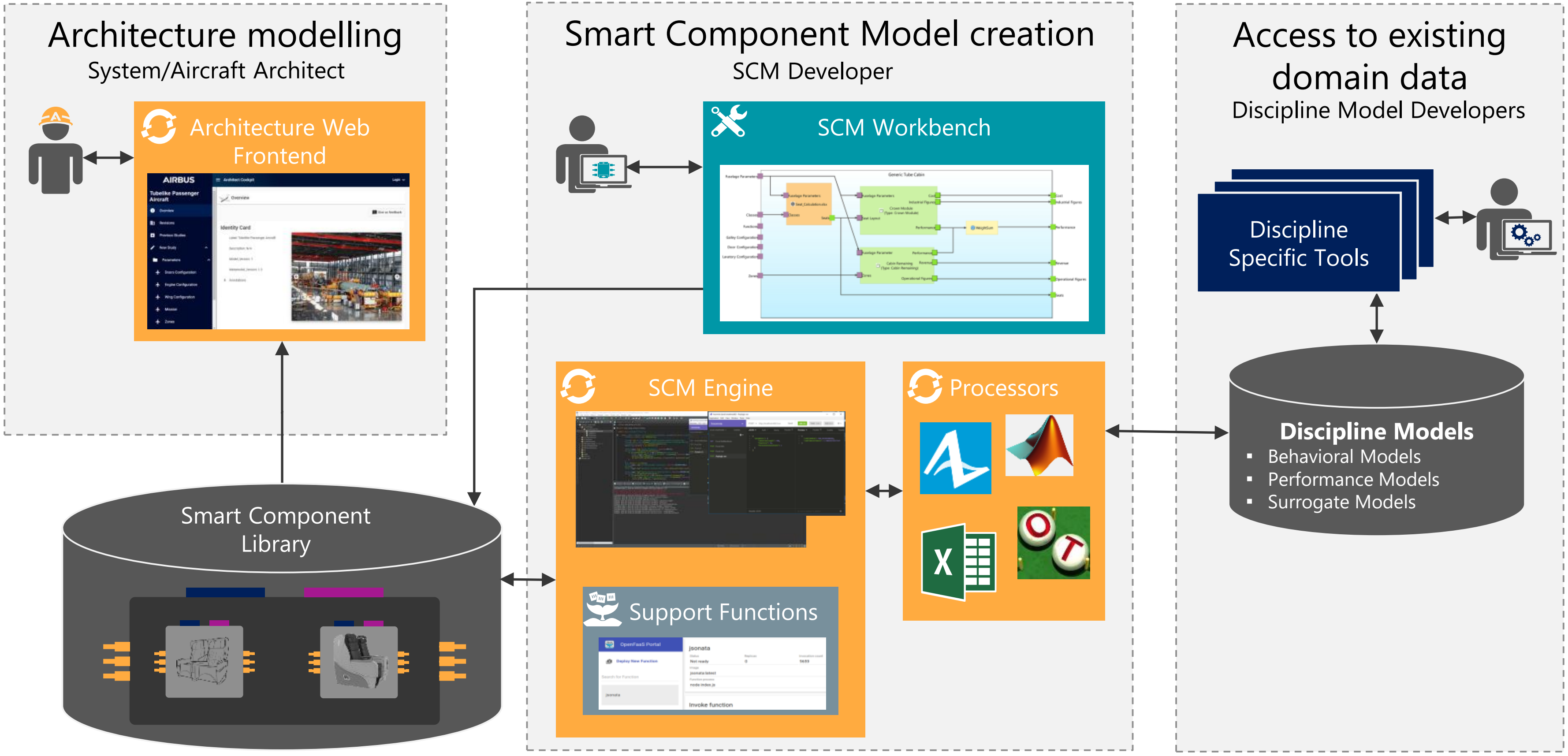
Properties

Id: _C8N8ErhEemUyrgJXoHVBw

Resource:

Synchronized diagram

# Supporting Tool Infrastructure



## Architecture modelling

System/Aircraft Architect

Architecture Web Frontend

Smart Component Library

## Smart Component Model creation

SCM Developer

SCM Workbench

SCM Engine

Processors

Support Functions

## Access to existing domain data

Discipline Model Developers

Discipline Specific Tools

**Discipline Models**

- Behavioral Models
- Performance Models
- Surrogate Models

# Conclusion

- New development with Out of Cycle development of components requires fitting metamodel
- EMF/Sirius allow agile metamodel and model editor development
- Evaluation of SCM approach in various use cases from different domains like manufacturing, design and operations successful
- Next steps: handover for industrialization of method & tools

# Thank you!