AUTOMOTIVE SPICE WITH MODEL BASED SYSTEMS ENGINEERING

Automotive SPICE With Model Based Systems Engineering
Motivation

Automotive Spice is applied in all developments of Electronic Control Units of Robert Bosch powertrain systems. For SYS.3 system architectural design the following base practices are defined:

- BP1 Develop system architectural design.
- BP2 Allocate system requirements.
- BP3 Define interfaces for system elements.
- BP4 Describe dynamic behavior.
- BP5 Evaluate alternative system architectural design.
- BP6 Establish bidirectional traceability.
- BP7 Ensure consistency.
- BP8 Communicate agreed system architectural design.

Special challenges in our development are the high amount of projects and design variance which require an efficient tooling to gain user acceptance. As Simulink is a well known tool for software engineering, Robert Bosch powertrain systems developed a Model Based Systems Engineering solution using the Mathworks toolchain.

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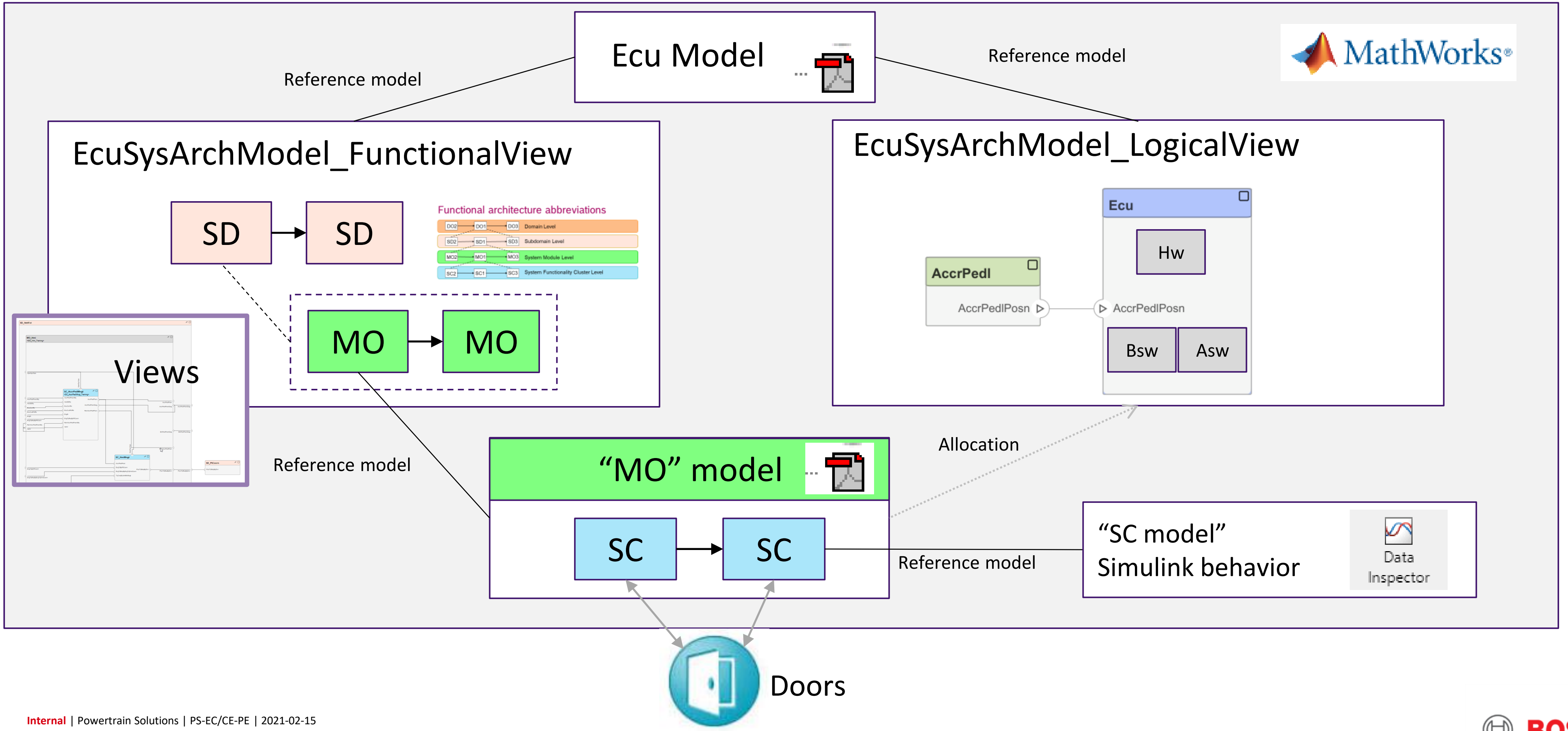
SYS.3 System architectural design - Overview of model structure



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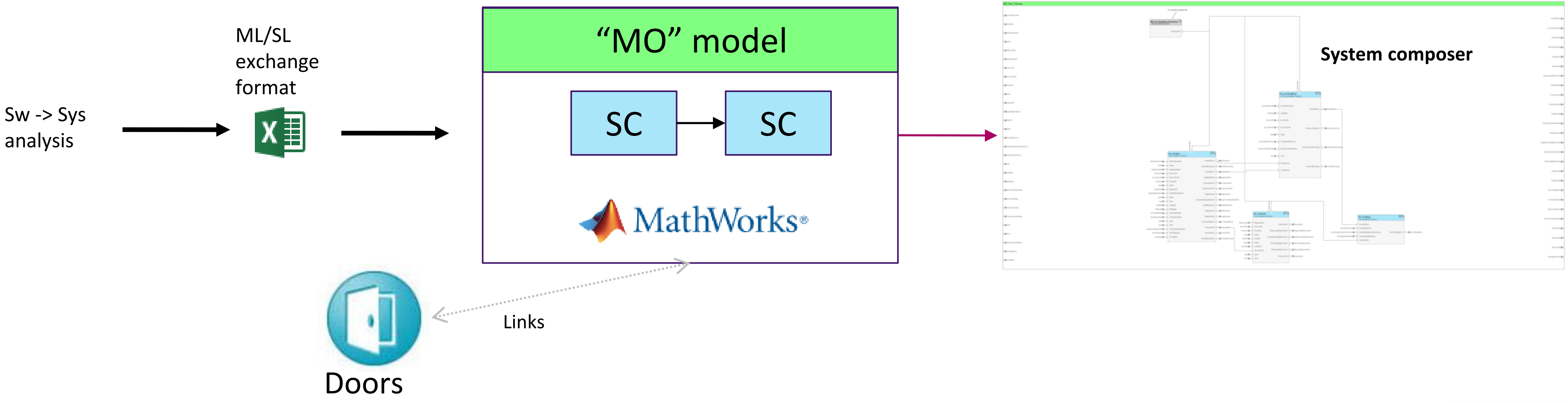
SYS.3 BP1 Develop System Architectural Design

- The ECU system elements are identified through analysis of an existing software against the reference architecture database. In the database the software elements are mapped against system elements.
- For each sub-system = “MO” the initial System architecture model is created through System Composer architecture import including links to requirements and interfaces.



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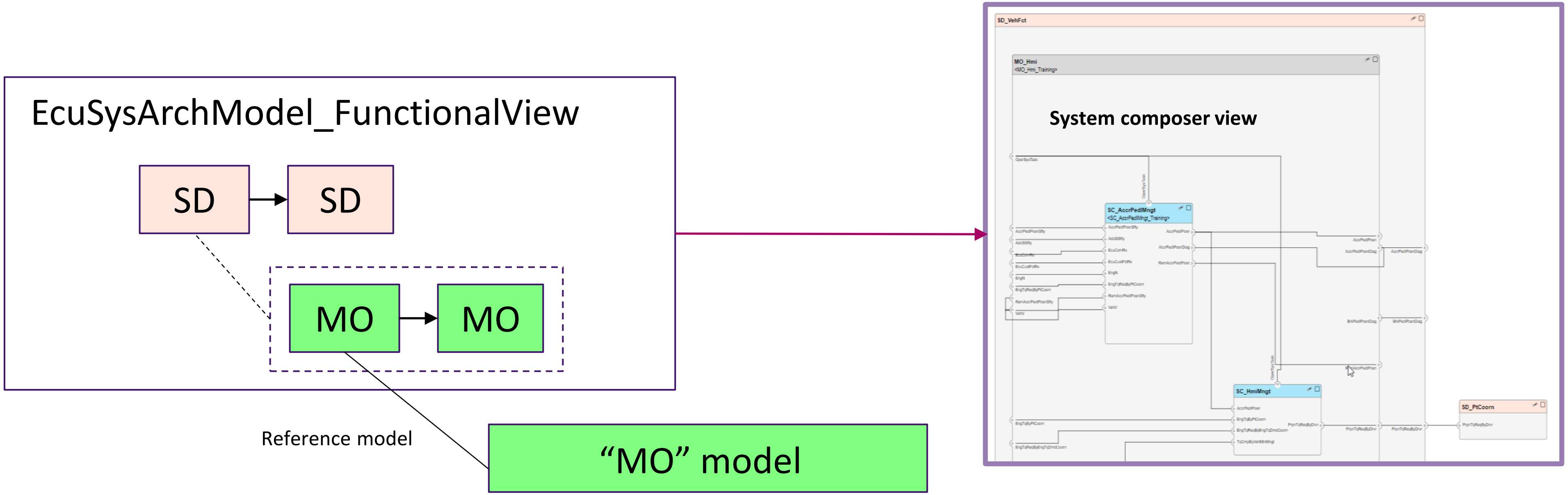
SYS.3 BP1 Develop System Architectural Design

- The full functional architecture of the system is defined by the referenced subsystem models including feature views to focus on the relevant interactions.



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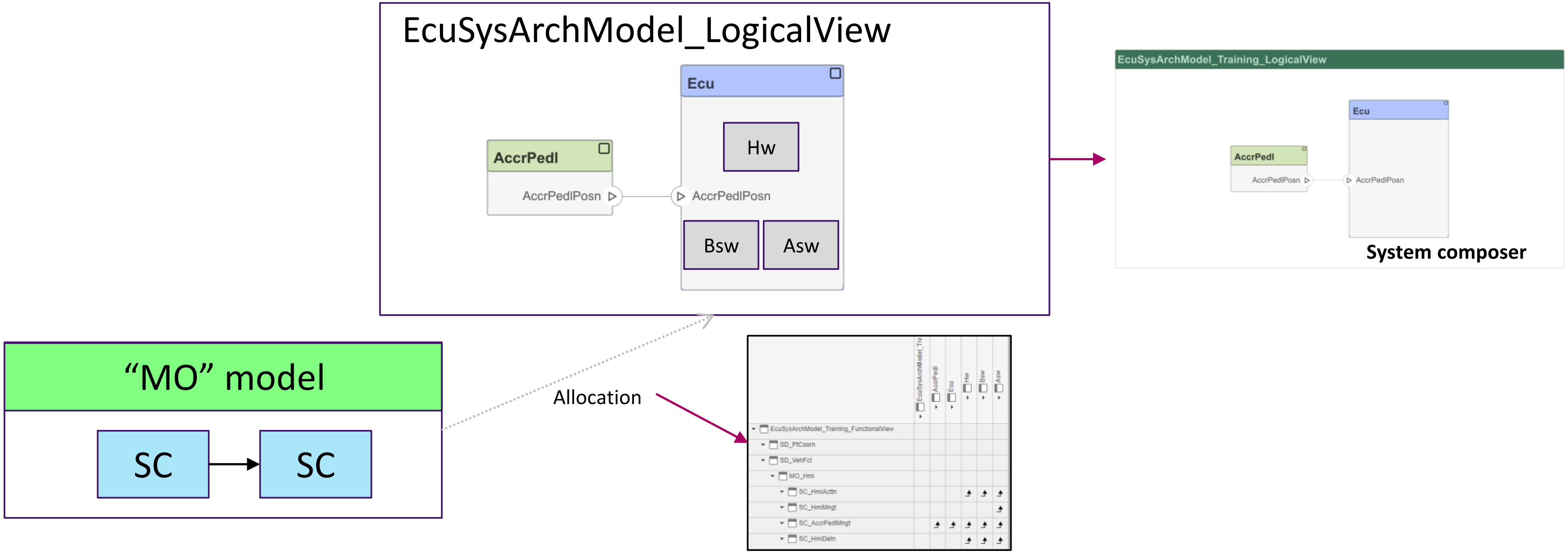
SYS.3 BP1 Develop System Architectural Design

- The logical elements of the ECU and the system context is defined in a separate model.
- The functional elements are allocated to the logical view.
- This is especially useful to evaluate different system architectural designs (SYS.3 BP5)



BOSCH

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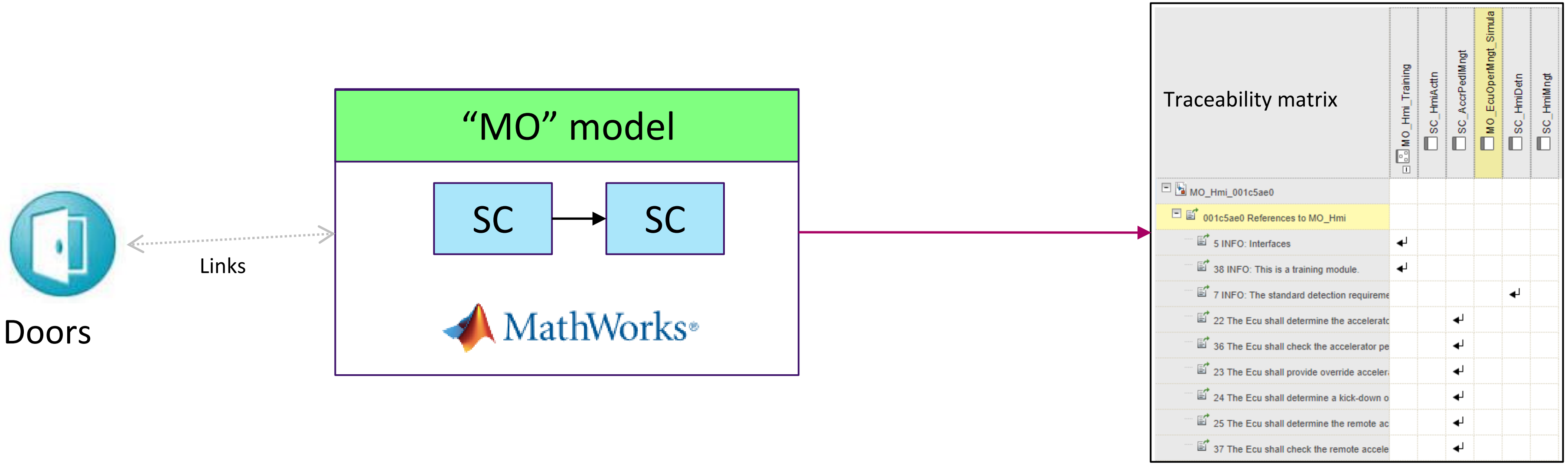
SYS.3 BP2 allocation, BP6 traceability and BP7 consistency of system requirements

- Bidirectional links to DOORS with help of the Simulink requirement toolbox.
- Easy take over of requirements allocations between projects, as requirements are included in the architecture import/export.
- Consistency is checked by the traceability matrix.



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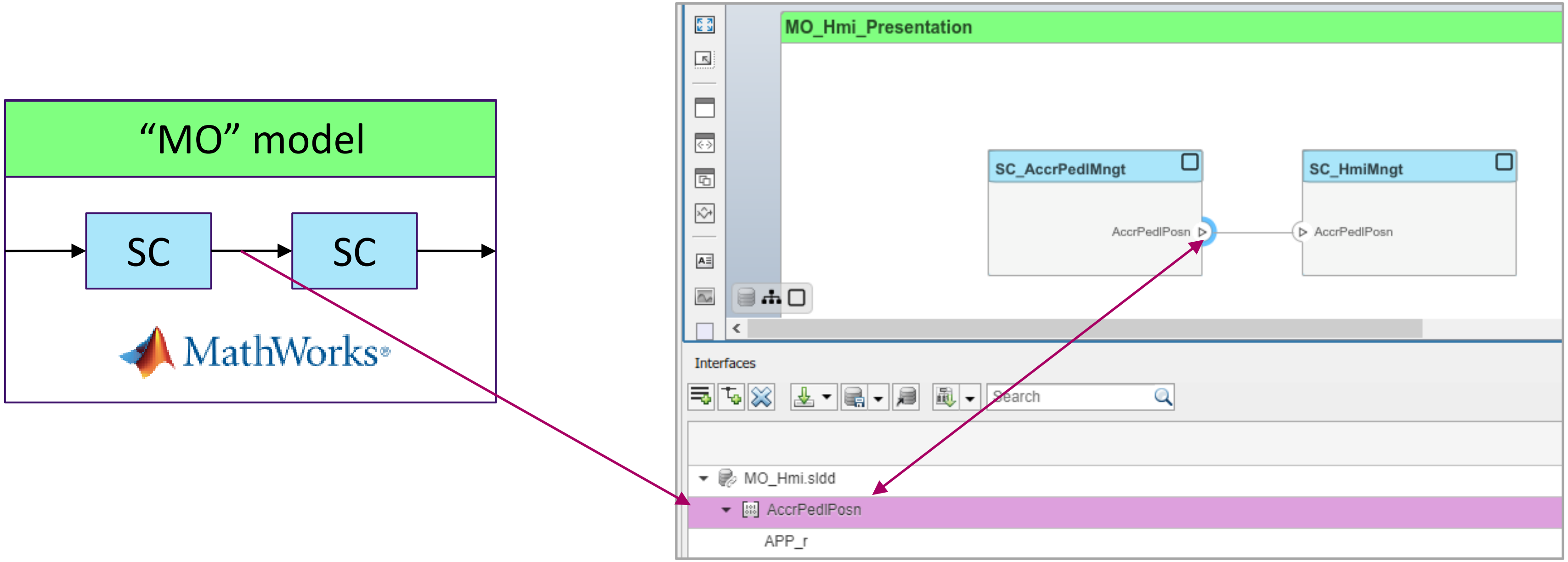
SYS.3 BP3 Define interfaces of system elements

- System interfaces are included in the System Composer architecture import and defined as part of the “MO” model in a dedicated data dictionary.
- The consistency between the static SystemComposer model and the referenced behavior models in Simulink is ensured by Simulink diagnostics.



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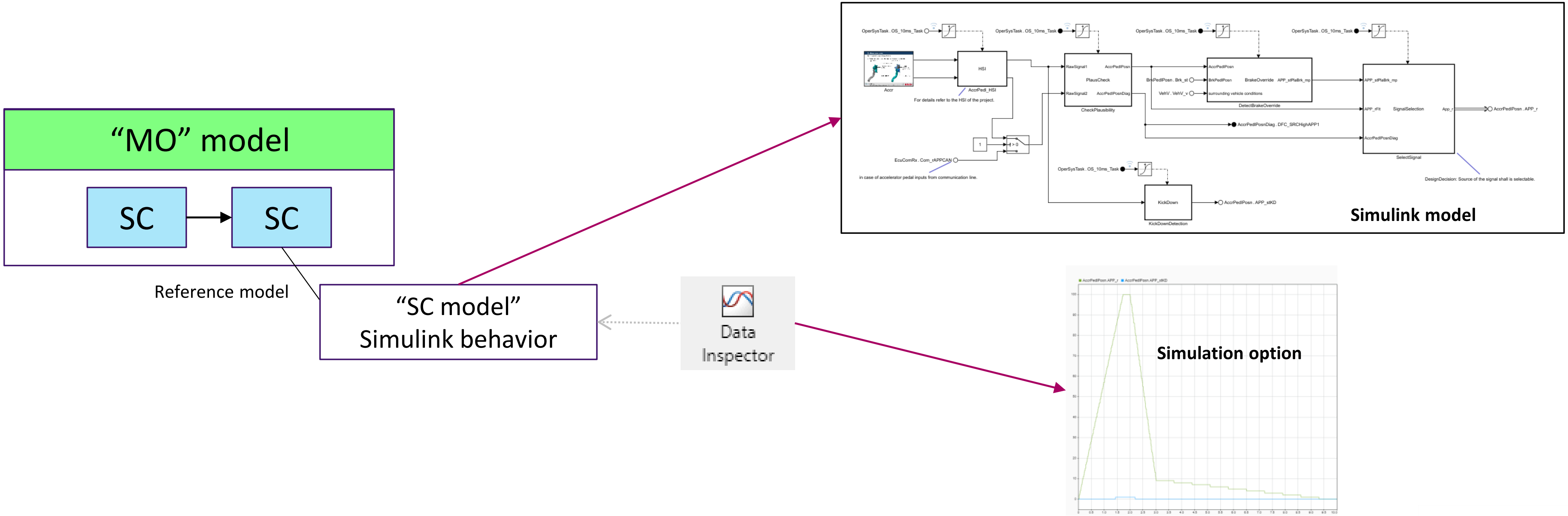
SYS.3 BP4 Describe dynamic behavior

- Dynamic behavior models in Simulink, Stateflow or other tools, e.g. UML.
- Simulation is optional – recommended for major new system developments.



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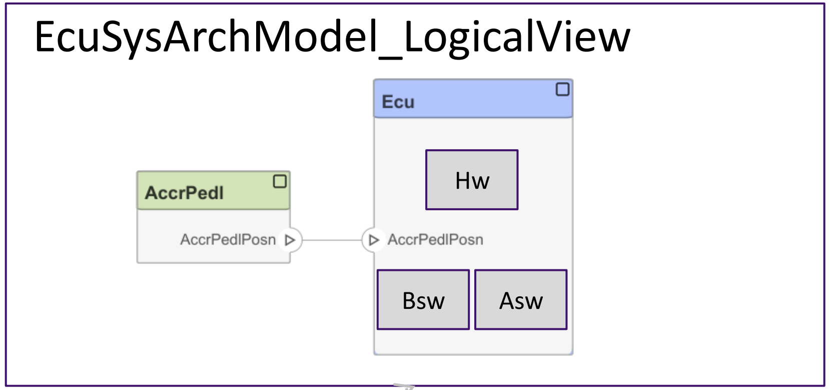
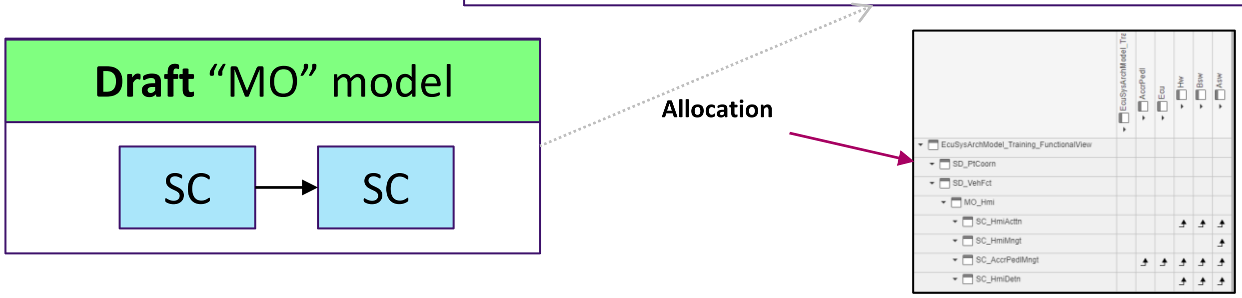
SYS.3 BP5 Evaluate alternative system architectures

- For the evaluation of alternative system architectures a draft model or analysis is created based on the respective use case. In addition to the traditional tools like power point and Excel, System Composer models gain user acceptance. The model analysis feature of System Composer and the allocation scenarios strengthen this approach.





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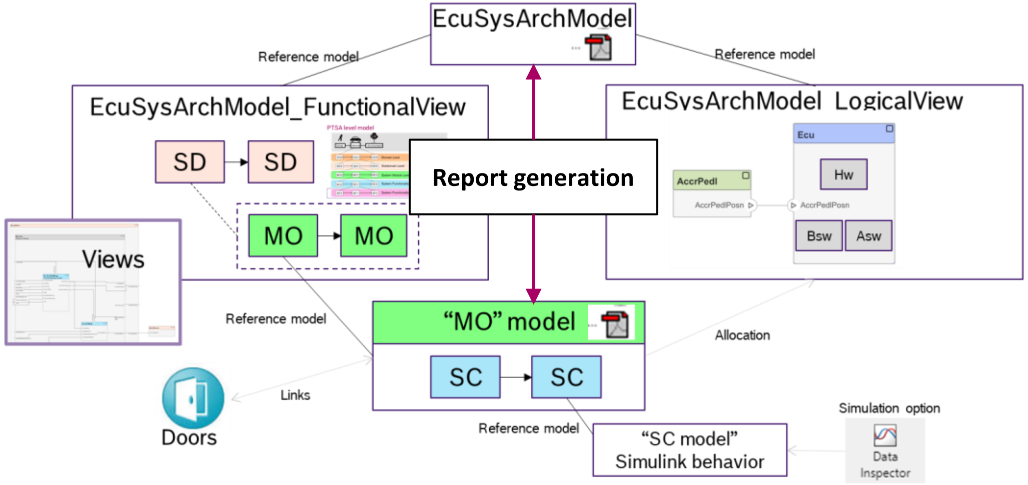
SYS.3 BP8 Communicate agreed system architectural design

- Reporting of the individual “MO” sub systems or the complete model of the ECU through “Report generator”.
- The report includes the linked requirements and all reference models.
- The pdf report option is selected for the Robert Bosch review tool and our standard documentation exchange format.



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Conclusion

The Model Based Systems Engineering solution using the Mathworks toolchain achieves high user acceptance. It is proven by use in several customer accounts including an Automotive Spice assessment.

All Automotive Spice is SYS.3 system architectural design base practices are met:

- BP1 Develop system architectural design. → System Composer
- BP2 Allocate system requirements. → System Requirements
- BP3 Define interfaces for system elements. → System Composer
- BP4 Describe dynamic behavior. → Simulink & Stateflow
- BP5 Evaluate alternative system architectural design. → Option to use System Composer.
- BP6 Establish bidirectional traceability. → System Requirements
- BP7 Ensure consistency. → Simulink Requirements
- BP8 Communicate agreed system architectural design. → Report Generator

High user acceptance is achieved as the special challenges are addressed.

- High amount of projects → Re-use of reference models in both System Composer and Simulink.
- Design variance → Automated creation of models with System Composer architecture import meeting the individual design.