Feature-Driven eDrive Development: A Consistent Way to Handle Complexity

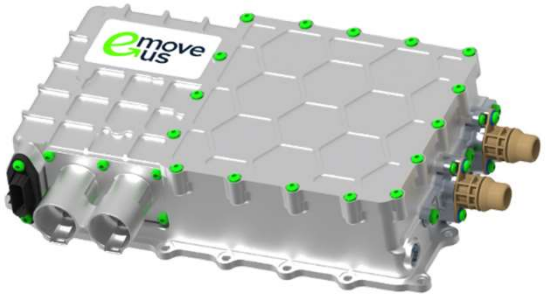
Dr. Matthias Braband, Lead System Architect

MOVE

TOGETHER

ELECTRIC

eMoveUs – who we are



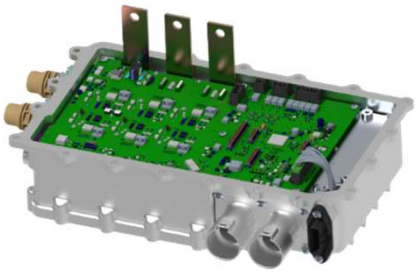
founded in March ´23 located in Kitzingen, Germany

55 employees across the complete V-cycle

85% graduated engineers and PhDs

>70% of operational employees with >10a eMobility experience

3x 30%+ 20a+ seniority 10a+ expertise guided juniors



eMoveUs provides solutions for electrical and electromechanical energy conversion systems in the drivetrain at the level of electronics hardware, software, electromagnetics, and mechanics, aiming to ensure efficient and sustainable mobility for all.

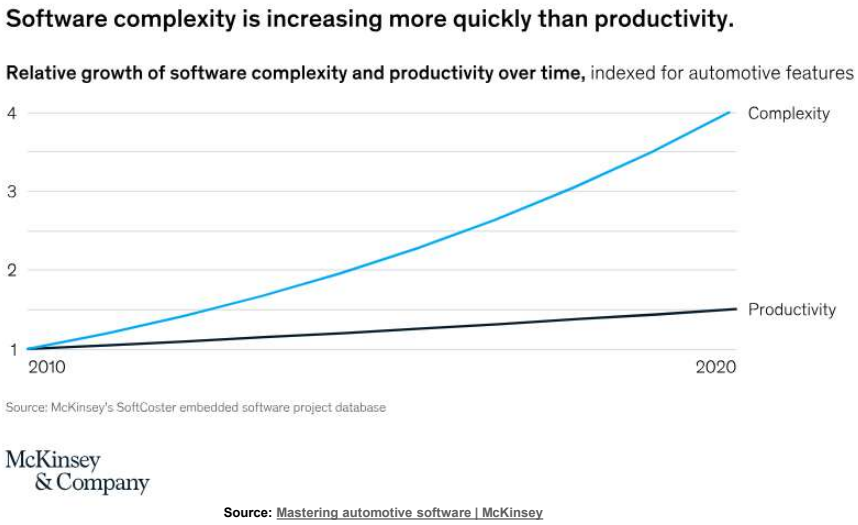
Agenda

1. Motivation
2. Benefits of combining MBSE and MBD approaches
3. Toolchain in practice
4. Conclusion

Market challenges

- Increasing product complexity
- Cost efficiency
- Fast time to market
- High product quality
- Process compliance
  - ASPICE
  - ISO 26262
  - ISO/SAE 21434
- Delivering optimized system level features eDrive systems, e.g.:
  - Optimized switching patterns
  - Optimized torque accuracy
  - Torque Prediction
  - High drive system utilization
  - Efficiency optimization
  - …

→ How can these challenges be managed efficiently?



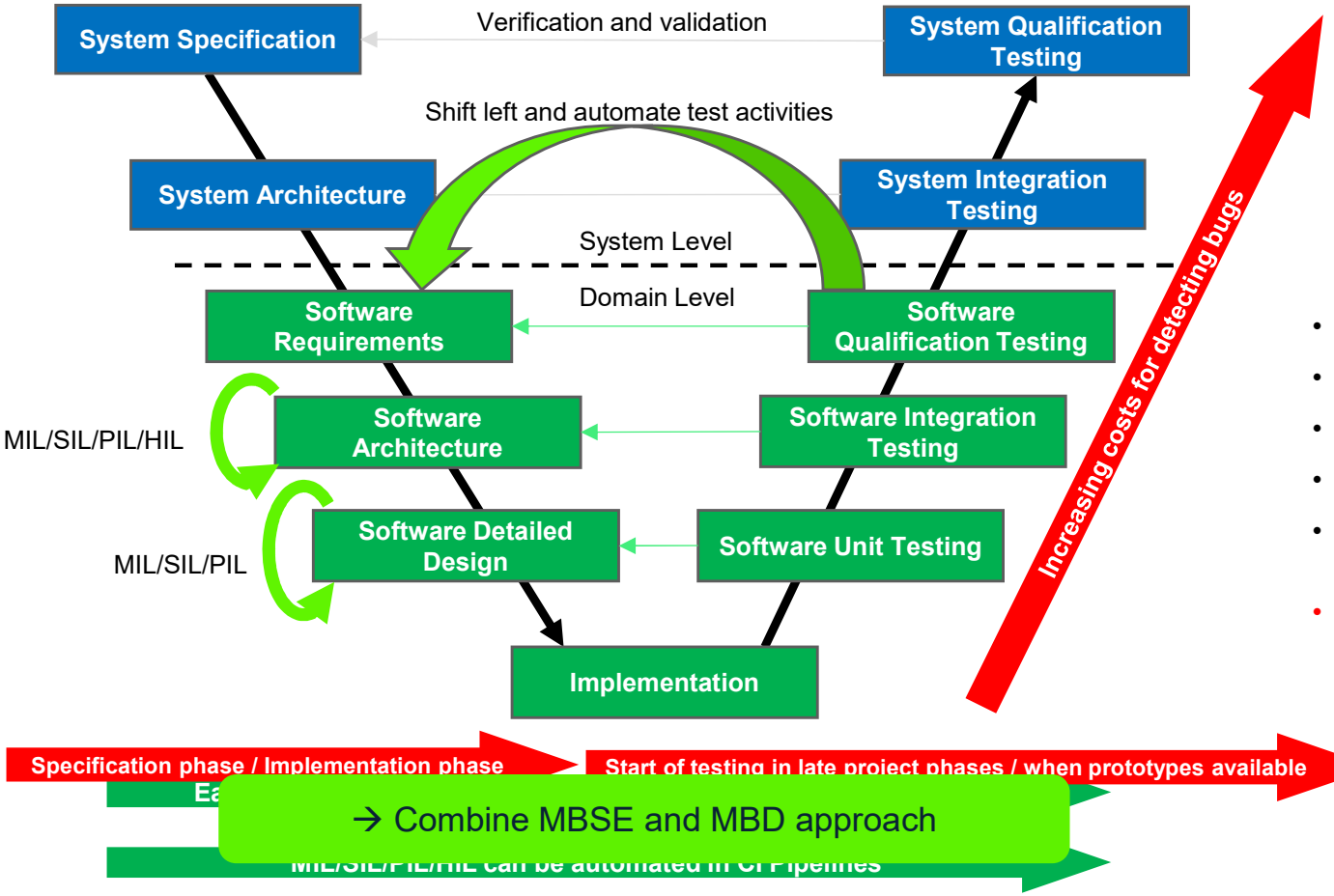
Source: Mastering automotive software | McKinsey

Internal demands

- Single source of truth
- Engineers must have time to focus on feature development and not on process topics.
- High reuse of work products
  - Across disciplines
  - Across projects
- Early and continuous testing of work products to find specification or implementation errors as soon as possible.
- Easy traceability from requirements down to work products / code.
- Detailed simulation capabilities across disciplines:
  - Fast feature development
  - Virtual validation and verification

→ How can a modern development process help to tackle these demands?

Challenges across the V-model



- How to speed up development?
- How to reduce bug fixing costs?
- How to reduce time to market?
- How to improve quality?
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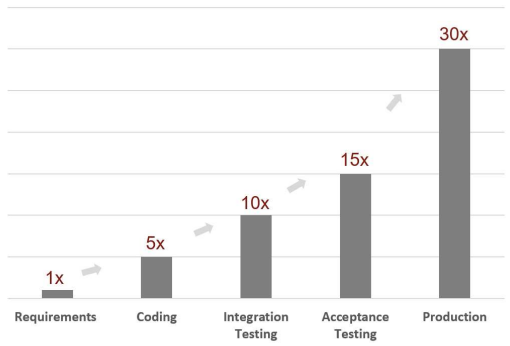
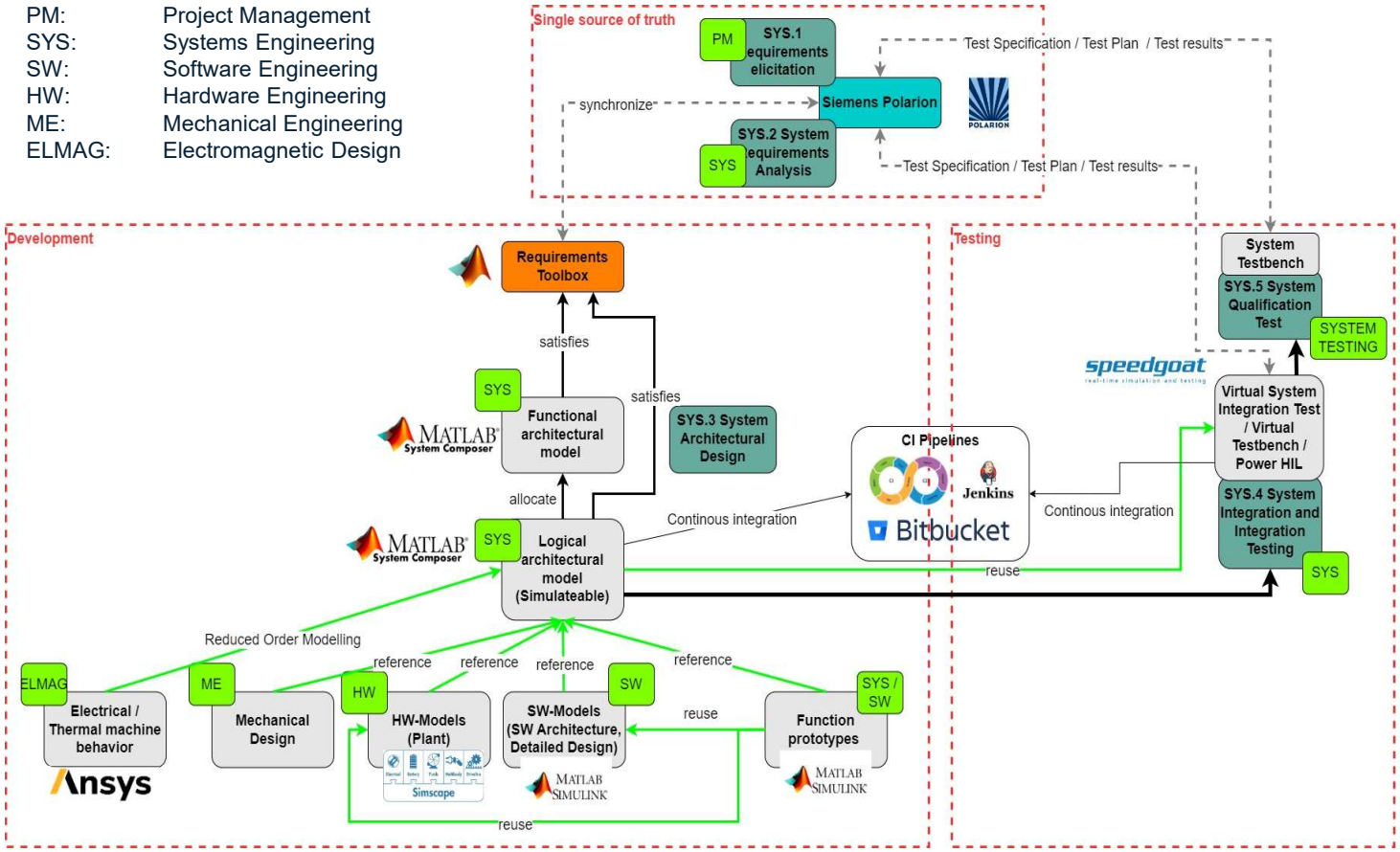


Source: National Institute of Standards and Technology (NIST)

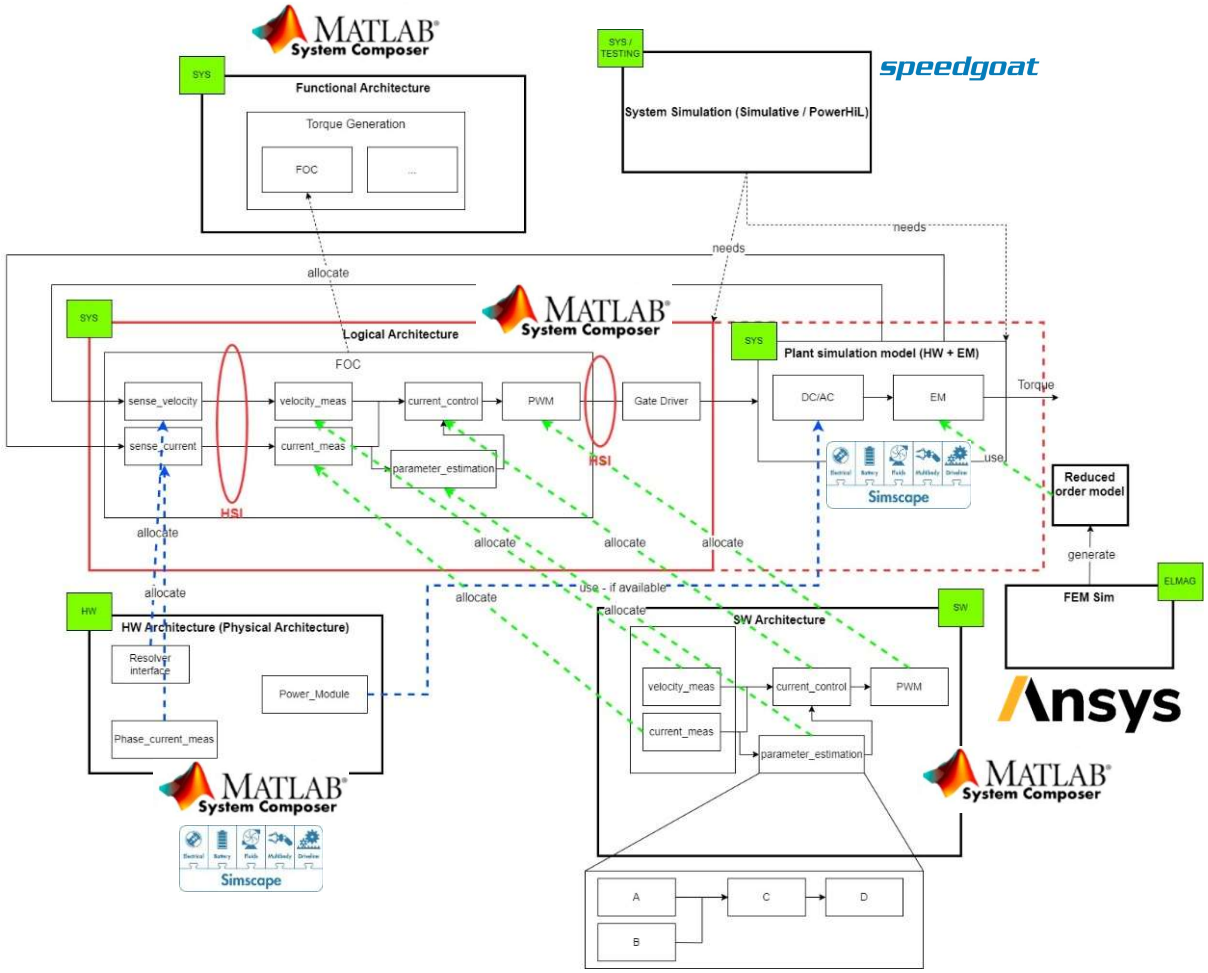
Consistency across the system development process

PM: Project Management
SYS: Systems Engineering
SW: Software Engineering
HW: Hardware Engineering
ME: Mechanical Engineering
ELMAG: Electromagnetic Design



- Single source of truth is Polarion
- Direct connection to Matlab
- System Composer enables for simulatable system architectures
- Reuse of work products across departments
- Continuously test and validate the architecture using CI pipelines
- Test results are transferred to Polarion

MBSE and MBD workflow combined

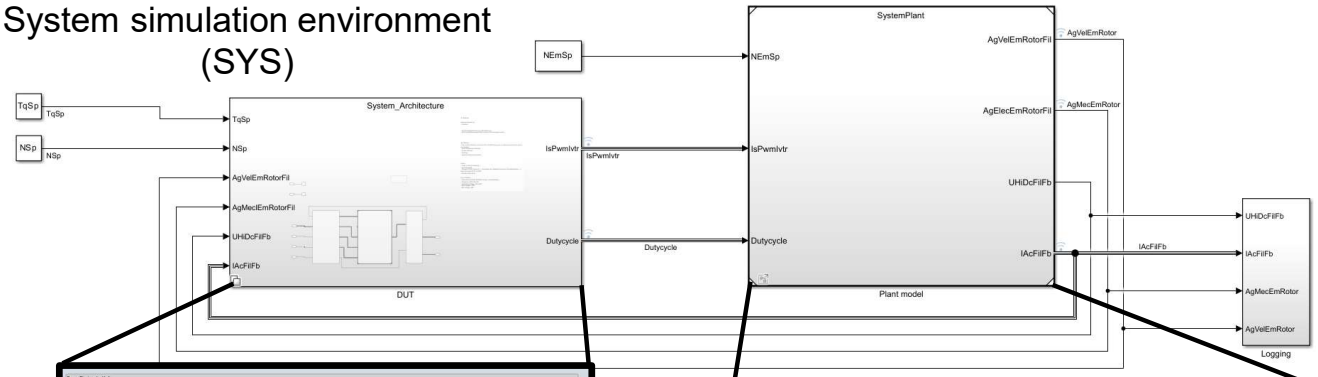


- Modelling system architectures in Mathworks System Composer enables for simulatable system architectures
- 1 to 1 mapping of system functionalities and software features for seamless integration into system architecture
- Models on system level can be used as a draft in SW engineering
- Detailed Designs of the application software are directly used in architectural simulations on system level
- High reuse of work products of other disciplines

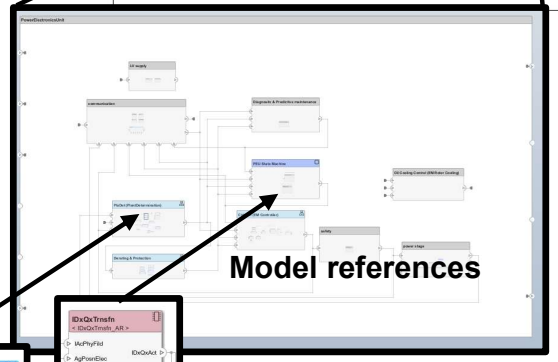
→ Minimized effort to analyze the dynamic system behavior on system level

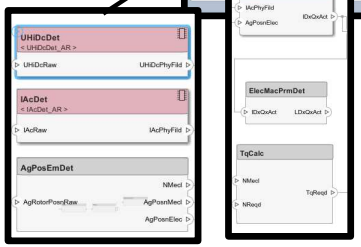
Toolchain in practice – High reuse of workproducts

System simulation environment (SYS)



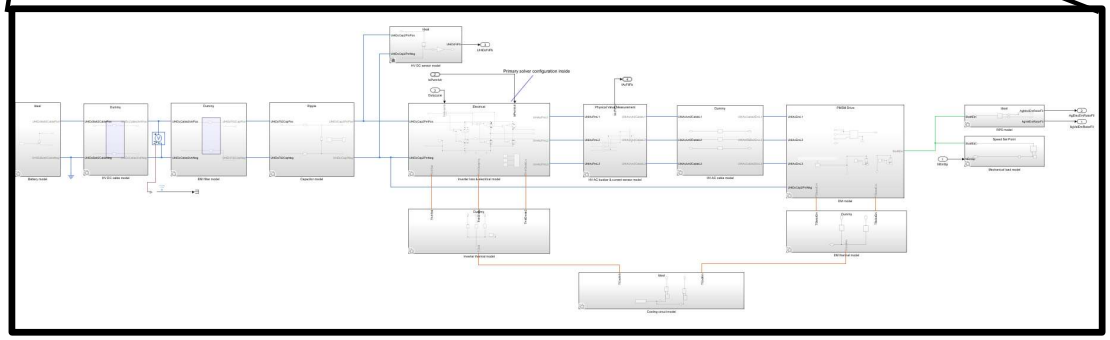
Simulateable System Architecture (SYS)





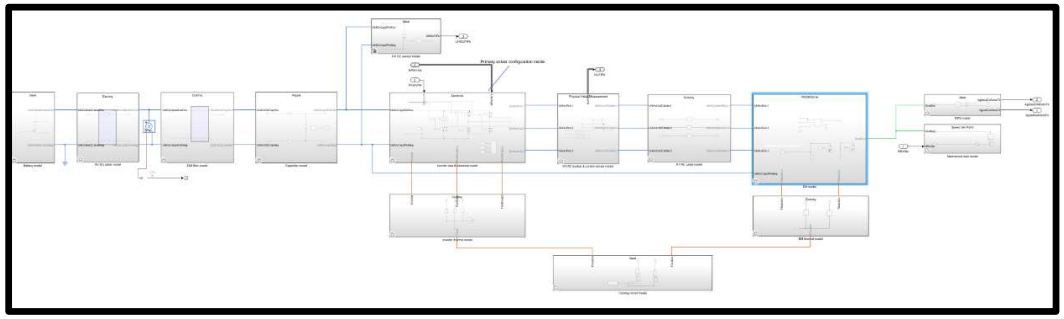
System Behavior Models (SYS)
or
Software Architecture (SW)
or
Detailed Designs (SW)

Detailed, modular plant model (HW)

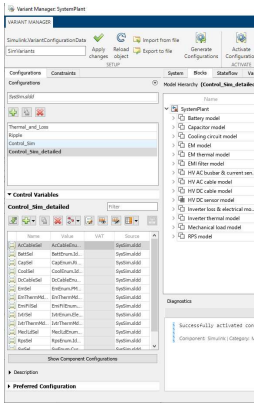


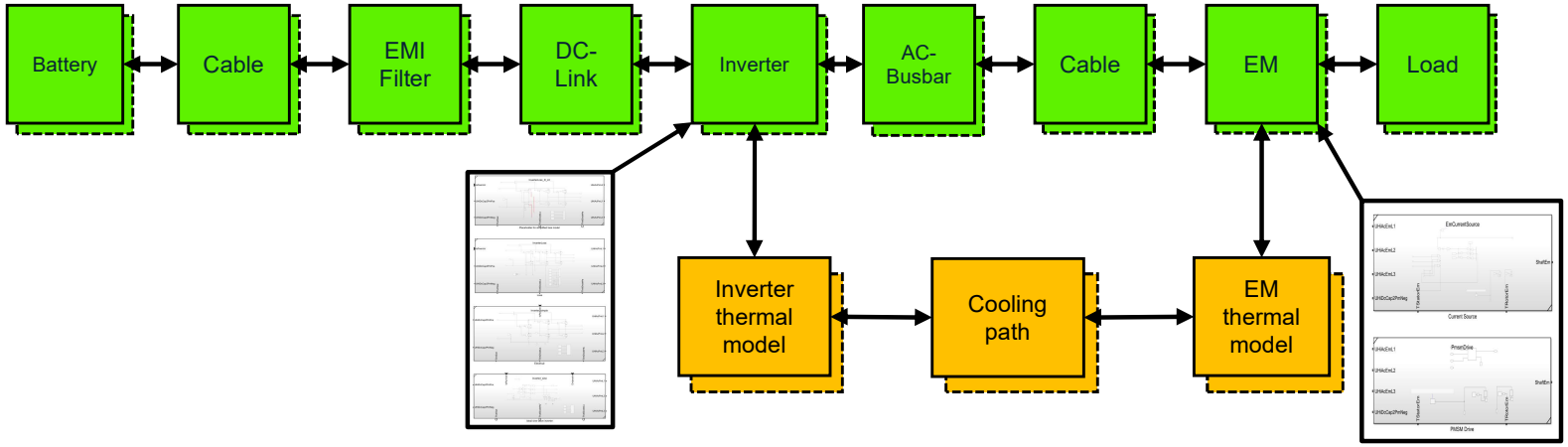
Toolchain in practice – Simulation variant handling

Detailed, modular plant model



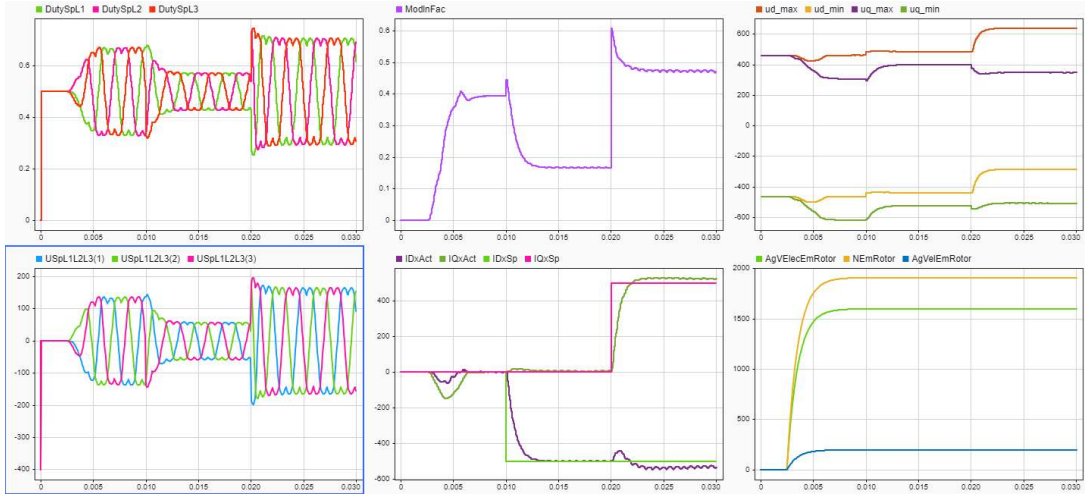
Simulink Variant Manager



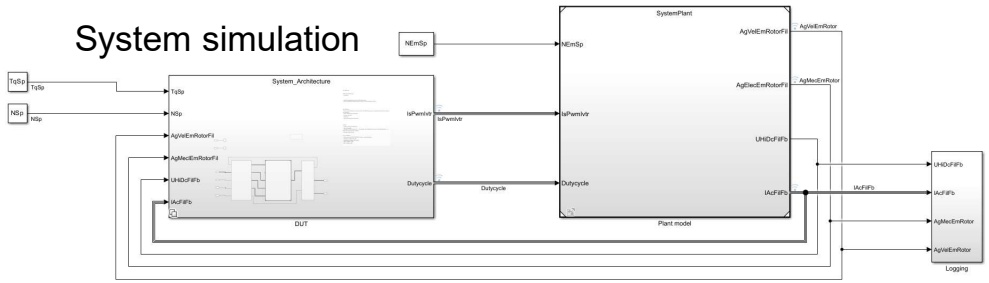


- Each powertrain component is handled as a variant.
- Level of detail can be chosen according to the simulation use case.
- Easy handling of variants using variant management.

Toolchain in practice – System simulation



System simulation

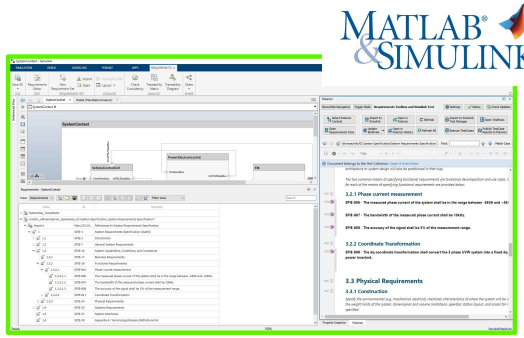


→ Reliable simulation and analysis capabilities on system level

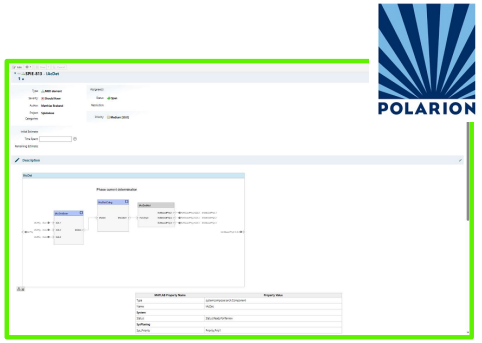
- Dynamic system architecture behavior can be analyzed on system level.
- The software Detailed Designs are integrated into the system simulation.
  - Realistic system behavior even in complex scenarios.
  - Enables for virtual system testing.
- Hardware parts (e.g., sensor paths) can also be modelled with their dynamic behavior, e.g.:
  - Noise
  - Offsets
  - Temperature drifts

Toolchain in practice – Bidirectional traceability with Polarion

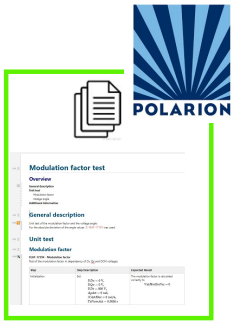
Product specification



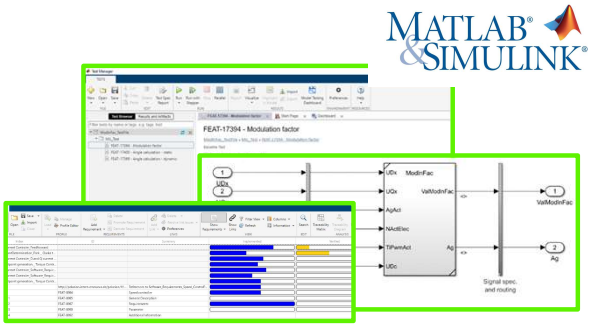
Architecture / Detailed Design



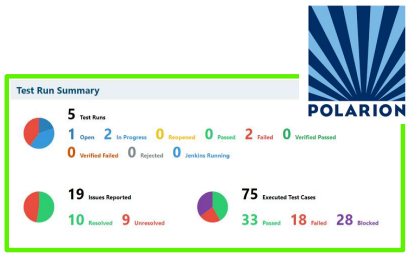
Update Linking and Content in Specifications



Test case specification



Test implementation



Transferred test results to polarion

Conclusion

- ✓ Combined the MBSE and MBD design approach.
- ✓ System simulation on architecture level.
- ✓ High reuse of workproducts across engineering domains.
- ✓ Lean and flexible toolchain design.
- ✓ Easy requirement traceability across the V-cycle.
- ✓ Consistent tracking of project status in one data source (Polarion).

eMove us

Let us eMove your ideas!

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