A model-based design approach applied on a driver monitoring system

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MathWorks Automotive Conference 2021

Elektrobit

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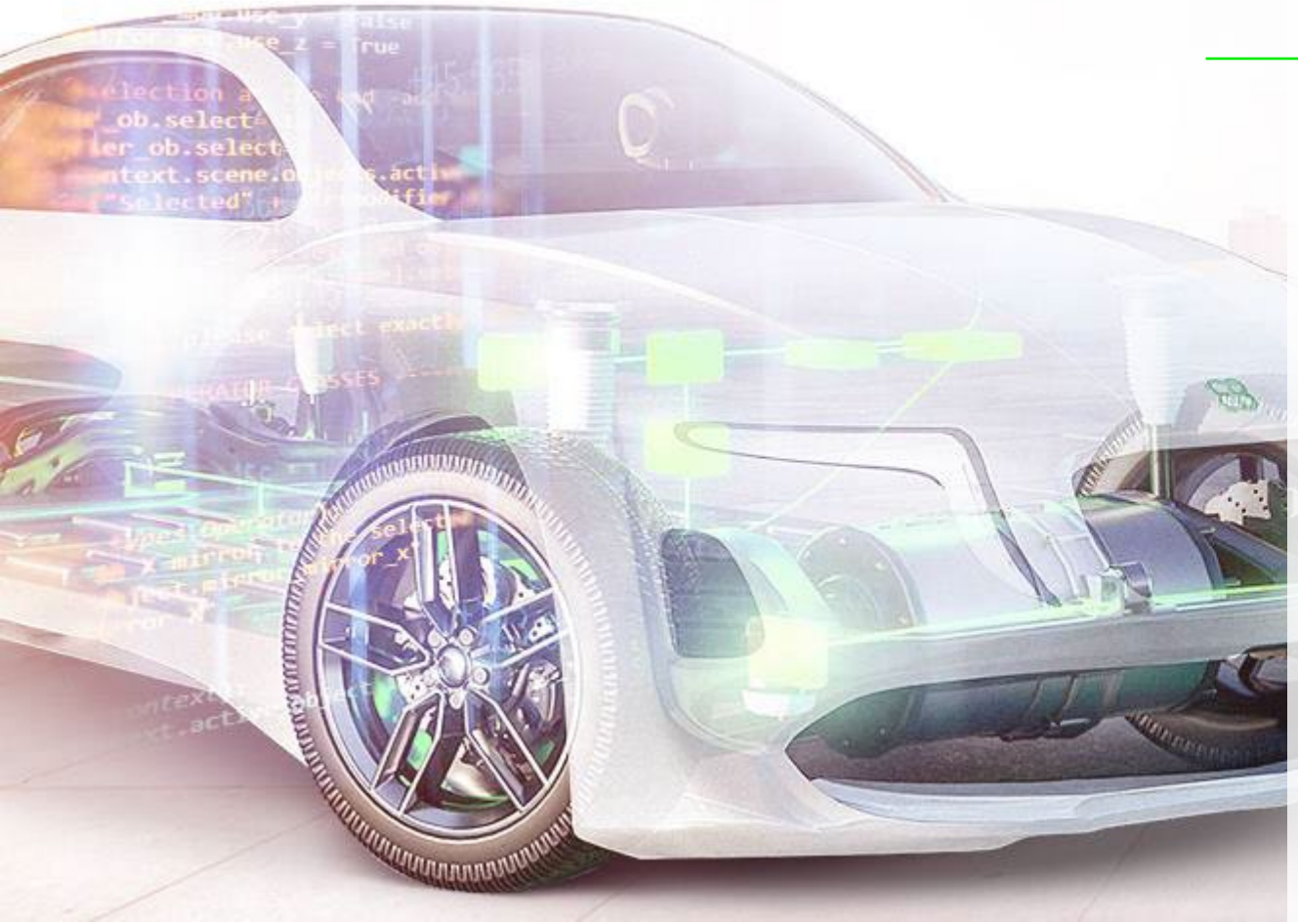
Driving the future of software



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A leader in **automotive software** with over 30 years serving the industry, EB‘s software powers over 1 billion devices in more than 100 million vehicles and offers flexible, innovative solutions for connected car infrastructure, human machine interface (HMI) technologies, and driver assistance.

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Driving the future of software

Technical competencies

EB's technical core competencies are developments of automotive-grade (software) products and engineering services.

Employees

3.400+ employees worldwide.
Spans three continents and eleven countries.

Consistent growth

Average growth (CAGR) > 10 %

Global presence

Development and business offices in Austria, China, Finland, France, Germany, India, Israel, Japan, Romania, South Korea and USA.

Continental AG

Wholly owned subsidiary of Continental AG, acting autonomously.

100+ million

Over 100 million vehicles on the road and 1 billion embedded devices.

ARGUS

ARGUS is a global leader in automotive cyber security providing cyber security solutions and services to protect connected cars and commercial vehicles from cyber attacks. Argus is an independent division of EB.

e.solutions

The joint venture of EB and AUDI. EB holds 51% shares.
e.solutions acts independently.

01 | Motivation

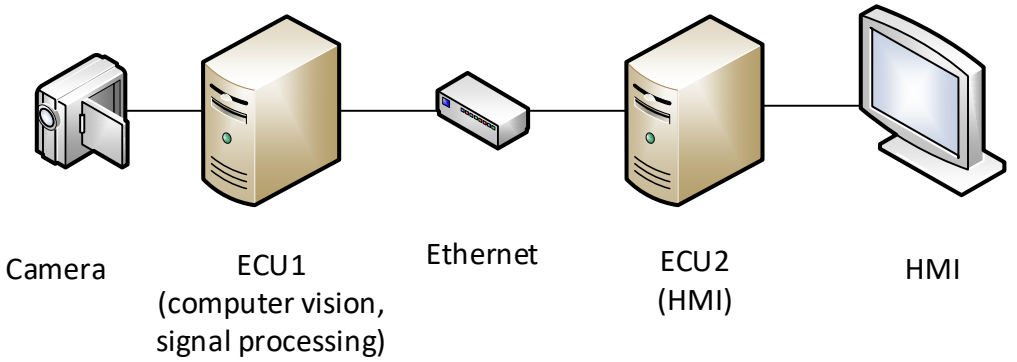
Motivation

- Model-based design can help to improve the efficiency for developing complex automotive software systems
- In a proof-of-concept, we aimed to confirm this statement by developing a driver monitoring system including a camera system, computer vision, and a basic HMI interface
- One important aspect is to automatically generate code for embedded deployment including test benches for system verification and design evaluation according to ISO 26262 and ISO 61508 with the goal to save time
- Further goals were to
  - prove efficiency improvements given by model-based design
  - prove Elektrobit competence to develop end-2-end software systems
  - integrate 3rd party functions (i.e., camera system) in a model and actual system

02 | Driver monitoring system proof of concept

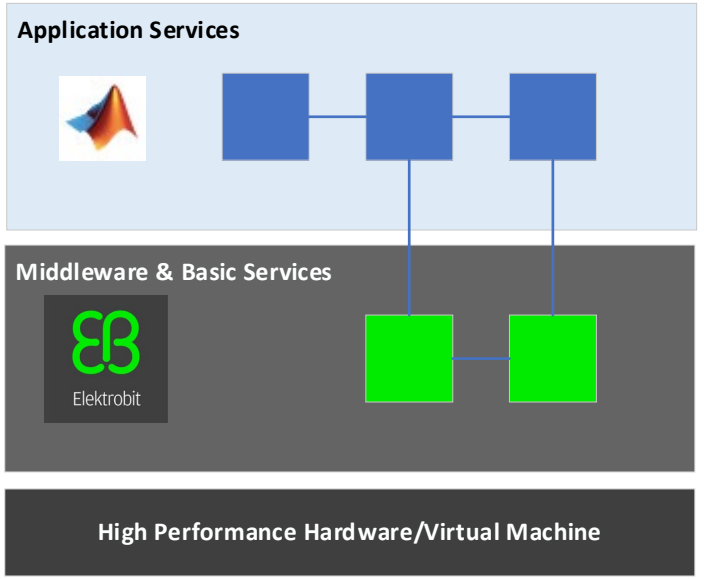
Driver monitoring system proof of concept

- Our proof-of-concept consists of the following components
  - One basic ECU running on a Raspberry Pi 3 and connected with a standard video camera
  - One further ECU running on a second Raspberry Pi 3 board, hosting Elektrobits cadian HMI system
  - Both Raspberry PIs were connected via ethernet



Driver monitoring system proof of concept

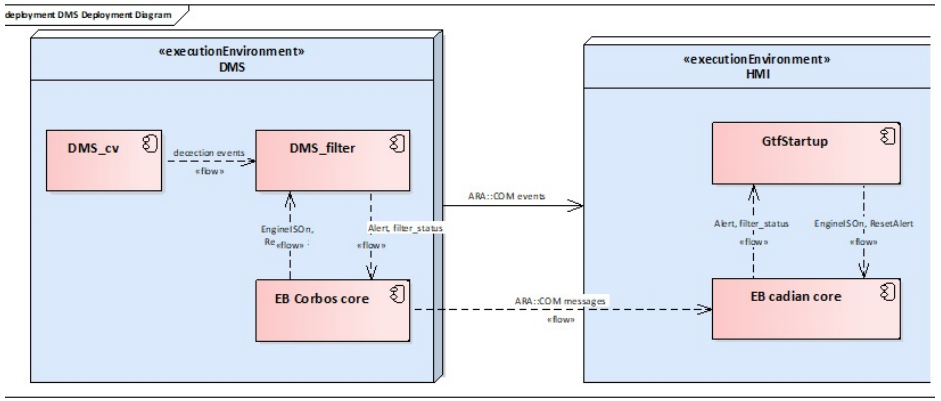
- Our aim was to realize the following functions and procedures
  - The system communicates using an automotive infrastructure based on Elektrobits corbos adaptive AUTOSAR products
  - It shall detect a driver presents and its property like drowsiness in the first ECU and report it to the HMI system, which present this info
  - All application code shall be auto-generated using MathWorks workflow. Only for the Elektrobit cadian HMI system, manually coding of required events shall be done
  - The system shall be tested with a live camera video
  - On the HMI system, the drowsiness generates a warning event
- Using MathWorks, we wanted to cover all steps defined of the V model into the MathWorks model-based design process. This includes requirements definition for software and hardware implementation.

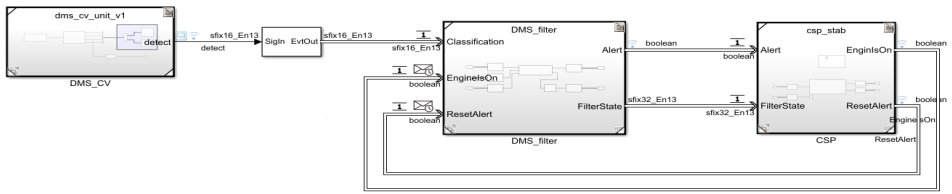


Driver monitoring system proof of concept

The project consists of the following steps

1. Initial design on block diagram level plus definition for requirements
2. Architecture definition of the AUTOSAR adaptive function block and interfaces
3. A computer vision function block that do the image processing real time handling and inference to a Neuronal Network
4. Host simulation to proof the functionality
5. Test of the functions for a set of input videos with different image and actor conditions
6. Code generation and deployment on two Raspberry Pi 3 B+ boards
7. Finally, system testing with a live camera video
8. Report generation of code adviser for “Complete requirement mapping coverage”, ISO 26262, ISO 61508, MISRA C:2012

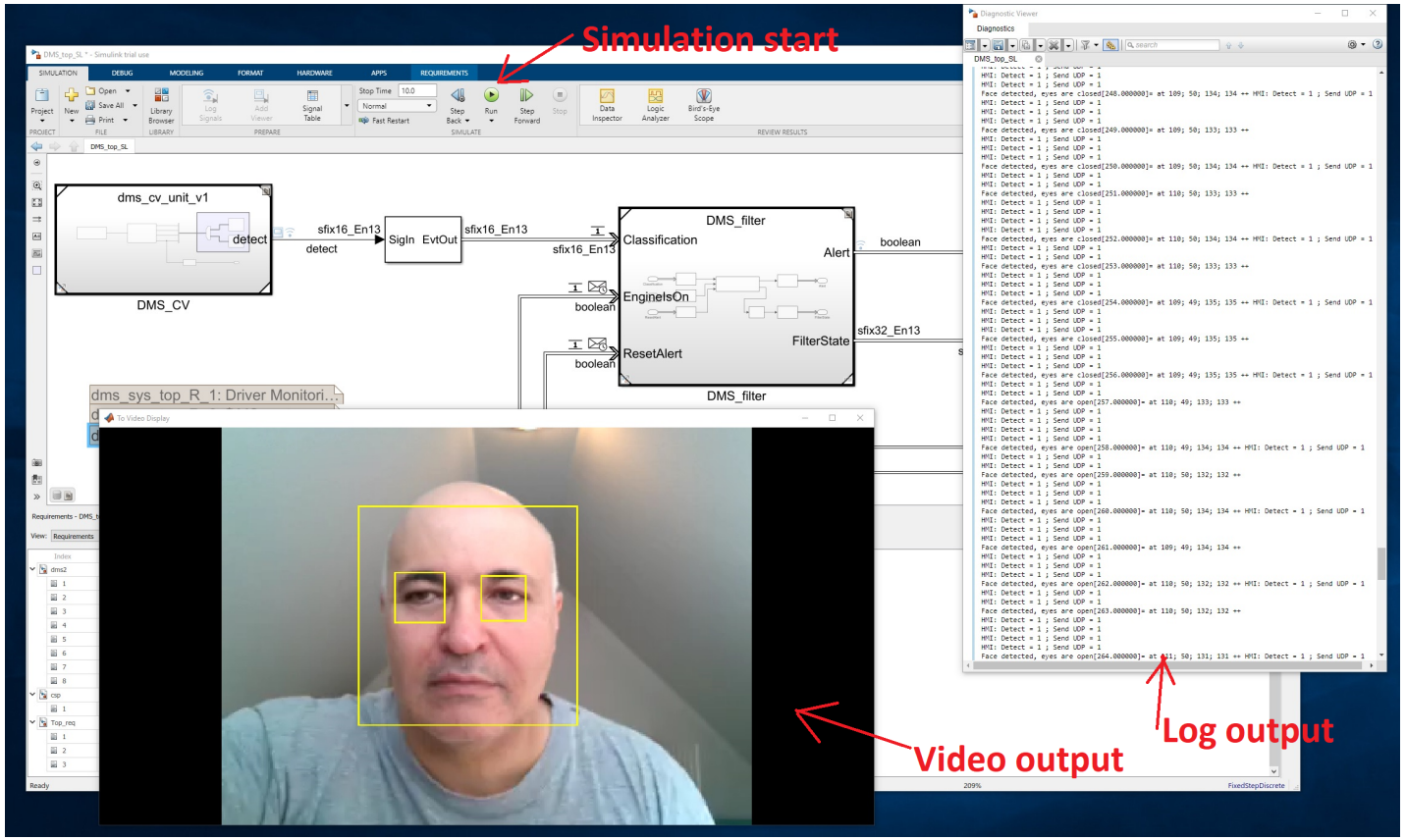




Driver monitoring system proof of concept

Proof of functionality

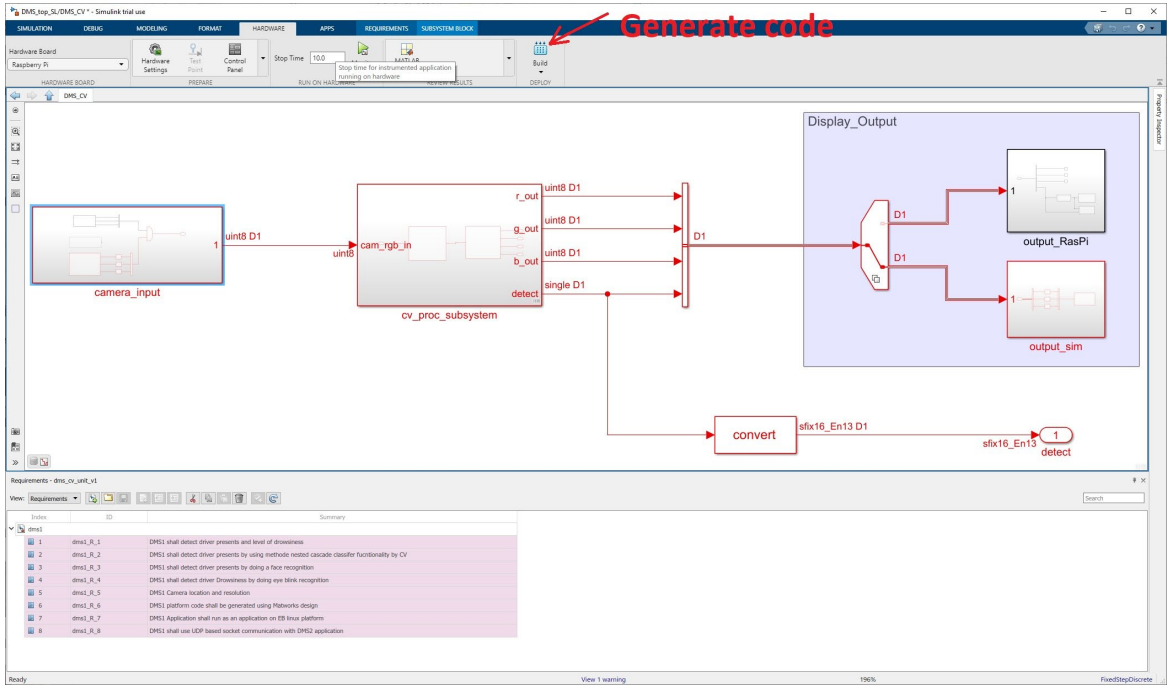
- Several video files were used to have comparable conditions
- After system definition and design readiness at system level with one or several simulation the functionality has been tested and validated.
- The output of the complete system has been validated

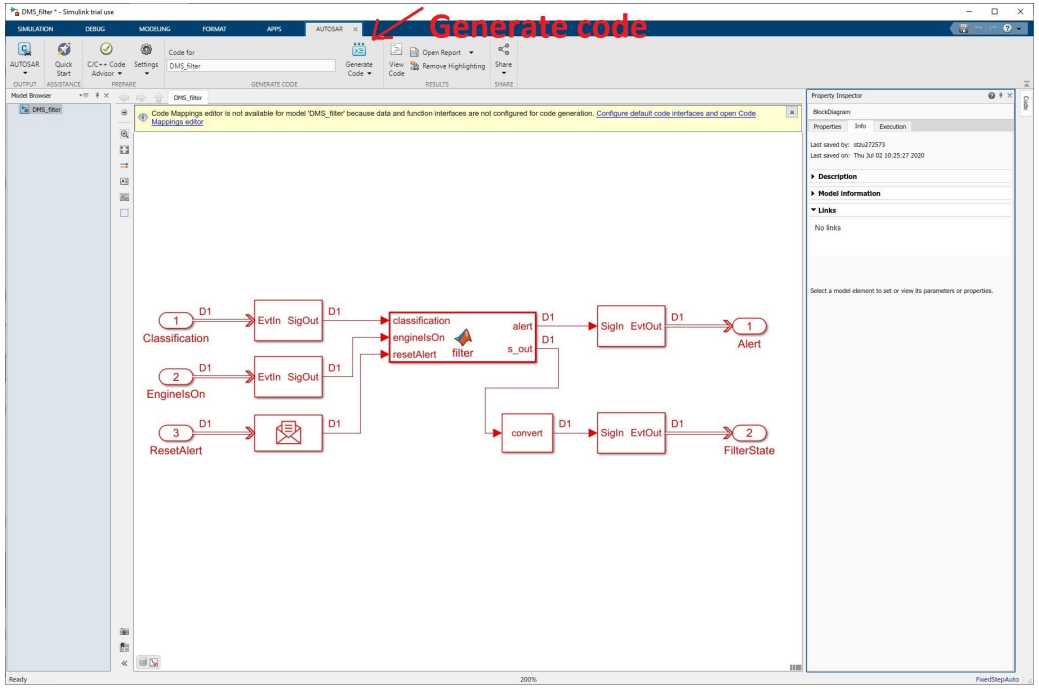


Driver monitoring system proof of concept

Computer Vision & adaptive AUTOSAR software components

- After system definition, design readiness at system level and simulation of the functionality is done, code generation for parts of the system are started
- In this case, this was done for computer vision, and adaptive AUTOSAR software components for signal processing

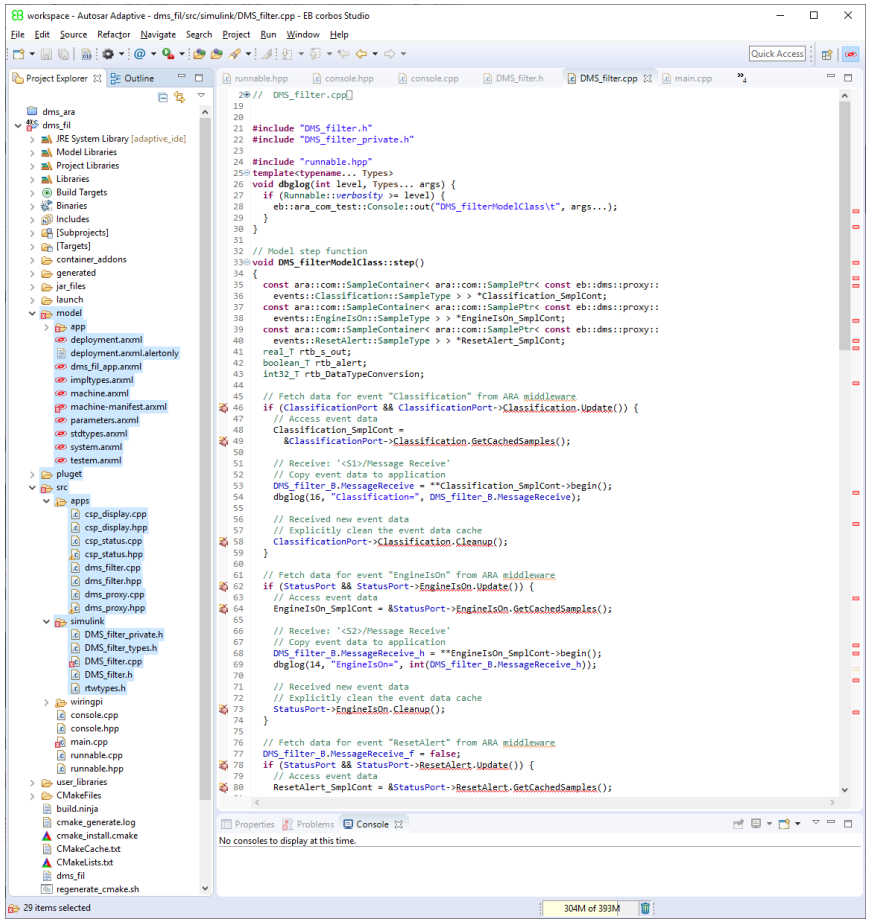




Driver monitoring system proof of concept

Elektrobit corbos adaptive Autosar SWC

- MathWorks generates all code including .cpp, .hpp and .arxml files
- The generated code is imported to Elektrobit corbos studio
- Together with other generated files inside Elektrobit corbos studio the target executable is generated
- The outcome is an executable that can run on target
- Executable have the binding capabilities to Elektrobit corbos core stack



Driver monitoring system proof of concept

- Finally, the generated code is deployed on two Raspberry Pi 3 B+ boards:
- The first Raspberry board is used for
  - hosting the computer vision function. All required code has been generated, compiled and tested
  - hosting the AUTOSAR stack. Again, all required coded has been generated including *.axml file generation. This code was compiled with EB corbos studio, successfully deployed and tested
- On the second Raspberry board, Elektrobit cadian HMI system is deployed
- Both Raspberry PIs were connected via ethernet
- The system was tested with a live camera video
- On the HMI system, the drowsiness generates a warning popup message. The correct functionality of the system could be validated

03 | Conclusion and next steps

Conclusion and next steps

The driver monitoring system PoC proves that

- Model-based design provides mechanism for doing system design of complex systems without increasing costs
- It allows a consistent specification, analyze & interrogate the design, and enable a high level of automation
- It avoids disruptions in the workflow: evolutionary development of models from concept phase to final code generation
- Validation and design advisor help to check the design in all steps
- The design process and needed time is optimized
- MathWorks tool chain includes all necessary tools beside the target compile for specific customize targets

Conclusion and next steps

- Does it help to be faster? Yes, it does!
- Thinking in models & building blocks helps
  - to set the right focus,
  - to be more efficient by re-using what is already invented, and
  - to concentrate on the key value and innovations you would like to achieve
- Next steps
  - Include cyber security aspects into the model-based system design

Contact us

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