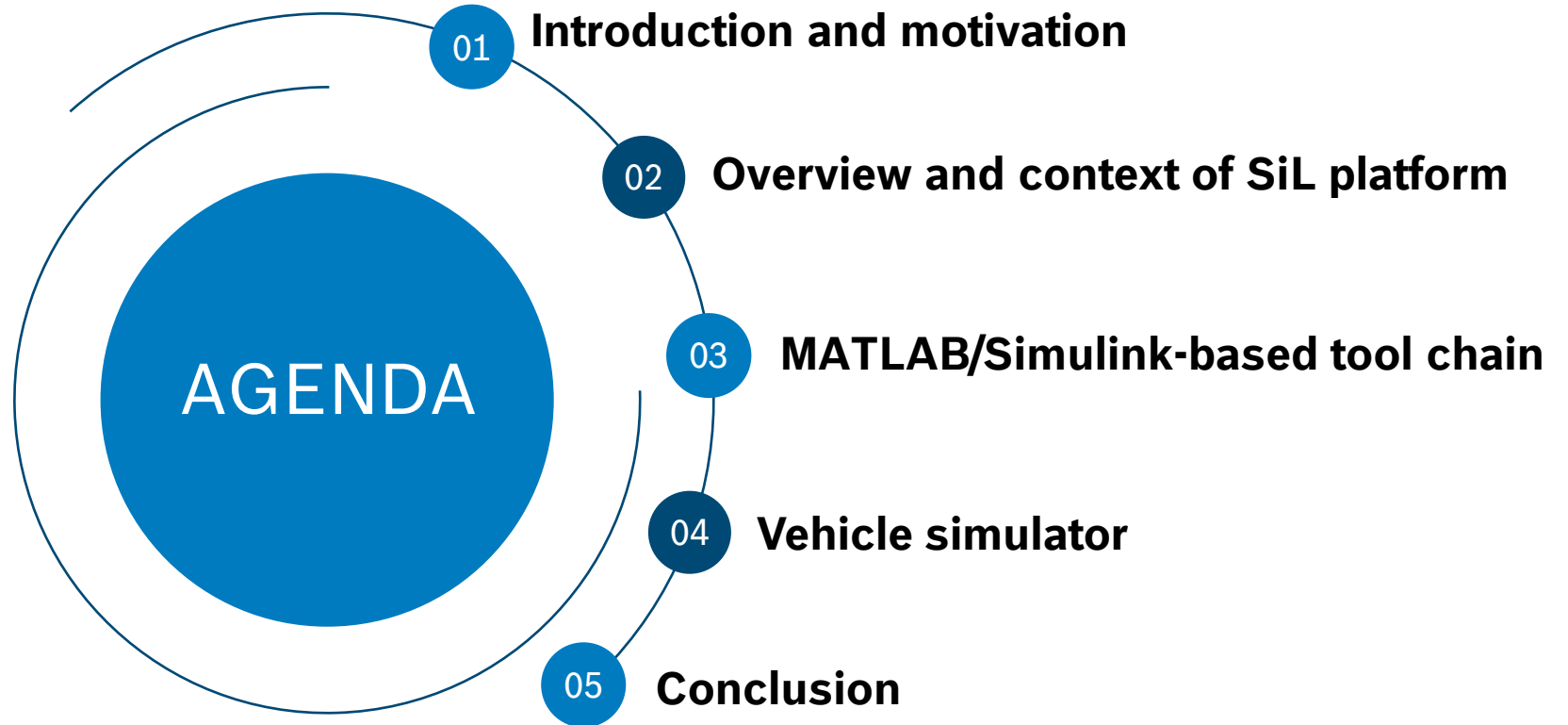**Bosch Engineering GmbH**
Dr.-Ing. Irina Kaiser

MATLAB/Simulink-based cross-domain simulation platform for Advanced driver assistance systems (ADAS)

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MATLAB/Simulink-based Cross-Domain SiL platform
Agenda

AGENDA

01 **Introduction and motivation**

02 **Overview and context of SiL platform**

03 **MATLAB/Simulink-based tool chain**

04 **Vehicle simulator**

05 **Conclusion**

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MATLAB/Simulink-based Cross-Domain SiL platform
Introduction and motivation

Project challenges of today ...

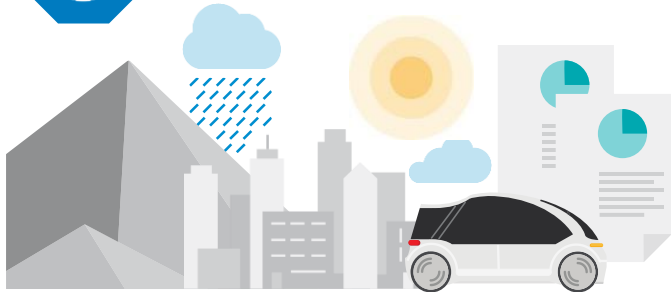- *Calibration and prototype development need vehicle*

- *An increase in testing leads to an exponential increase in costs*

- *Some safety critical and complex tests are not possible or need special equipment*

- *Iterations and long release cycles*

Bosch Engineering provides the solution!

Simulation approach that speeds up the system engineering and prototype development by tests in virtual validation and verification platform.
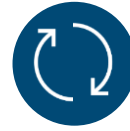

Your benefits with ADAS simulation ...

- *Use your physical resources only for required final verification and calibration*

- *Continuous testing, low-risk execution of extreme tests*

- *Reduce of costs for development and testing: reduction of iterations, release cycles*

- *Virtual demonstration of features*

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MATLAB/Simulink-based Cross-Domain SiL platform
Introduction and motivation: Use Cases

Development of virtual ADAS ECUs and delivery to customer

24/7 Automation

Development, first application, verification and validation of ECU software in virtual simulation environment

Software calibration in virtual environment

Virtual prototype development

Highly reproducible testing environment

Simulation services (e.g. virtual join test, SiL qualification, test analysis)
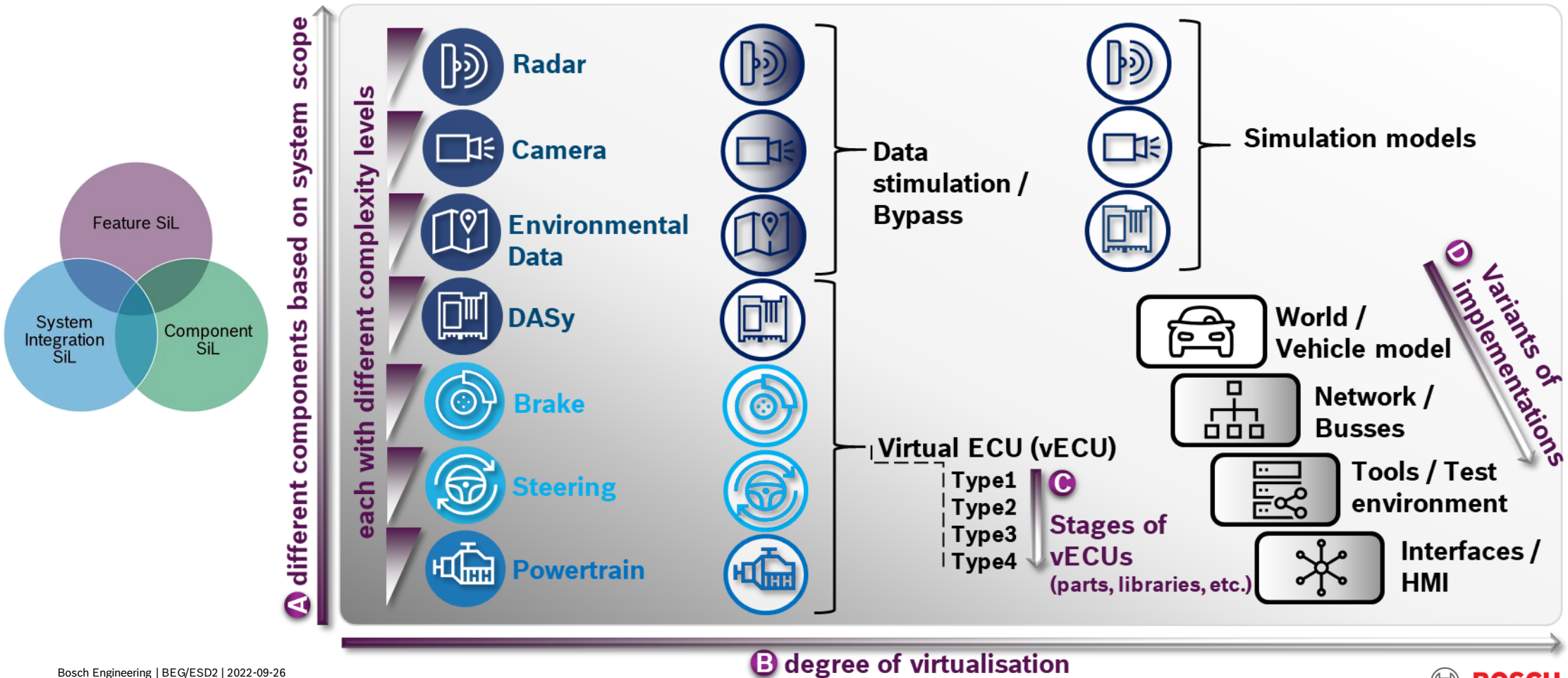
Validation & verification of safety critical situations

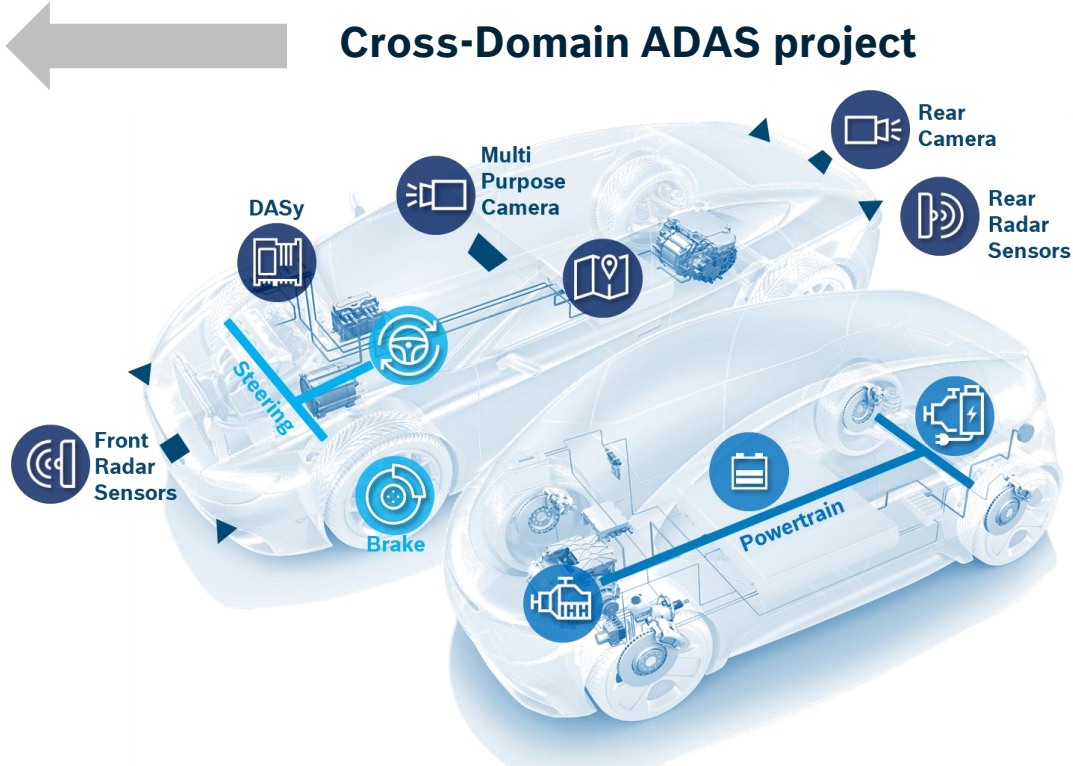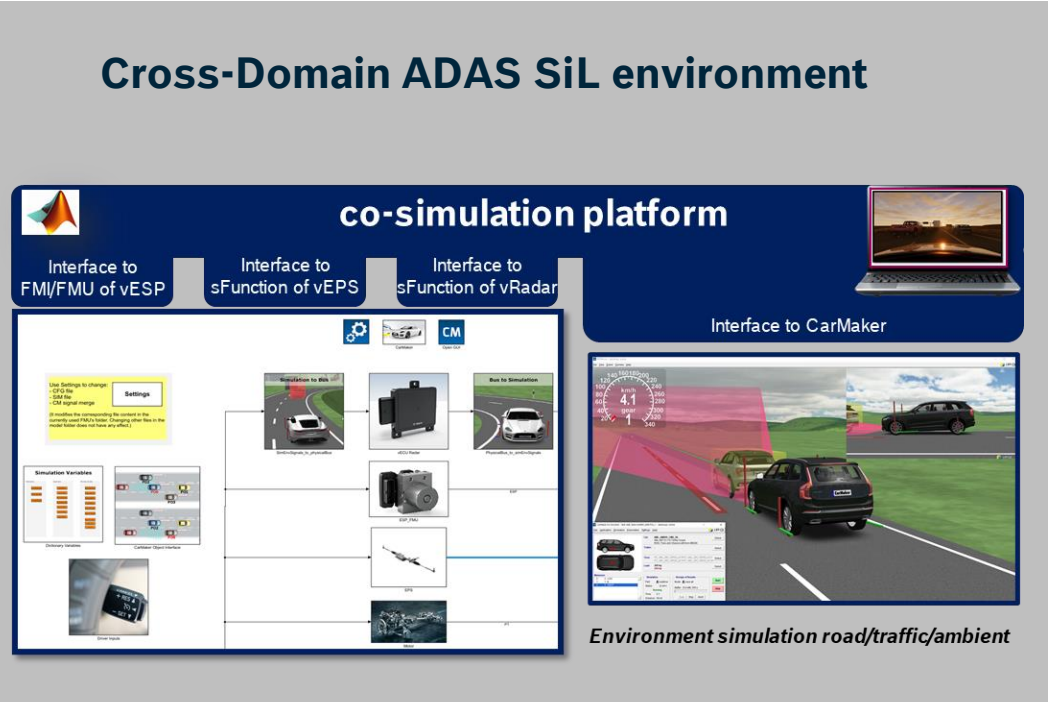**Benefit:** Decoupling development from vehicle availability and reduced time on track required to calibrate a feature

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MATLAB/Simulink-based Cross-Domain SiL platform
Overview and context of SiL platform: ADAS complexity

MATLAB/Simulink-based Cross-Domain SiL platform
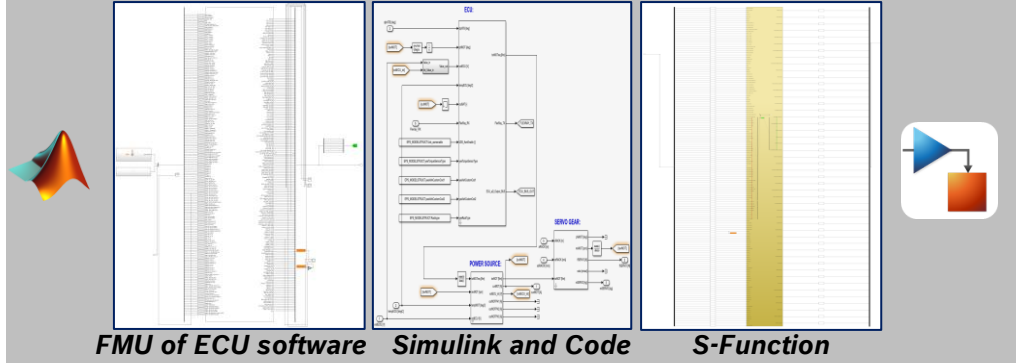## Overview and context of SiL platform

Cross-Domain ADAS SiL environment

co-simulation platform

Interface to FMI/FMU of vESP

Interface to sFunction of vEPS

Interface to sFunction of vRadar

Interface to CarMaker

Environment simulation road/traffic/ambient

Cross-Domain ADAS project

DASy

Multi Purpose Camera

Rear Camera

Rear Radar Sensors

Front Radar Sensors

Steering

Brake

Powertrain

IHH

MathWorks provides necessary building blocks and interfaces to be used as a foundation for SiL platform

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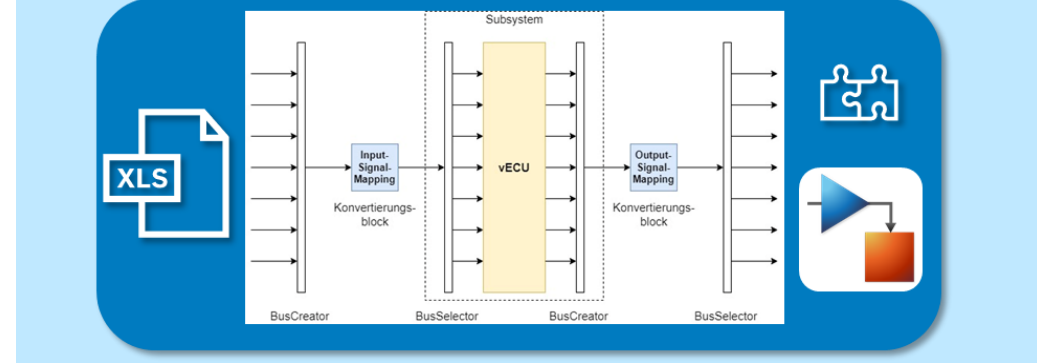# MATLAB/Simulink-based Cross-Domain SiL platform
MATLAB/Simulink-based tool chain

Creation of virtual ECUs (Radar, Camera)

FMU of ECU software   Simulink and Code   S-Function

Automated integration of SiL models

CDA - Tool for evaluation of measurements

d97

blf

asc

mat

mf4

incadat

Cloud-based data analysis and creation of reports

PEAS – Tool for automated simulations

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MATLAB/Simulink-based Cross-Domain SiL platform
MATLAB/Simulink-based tool chain: CI/CT context

Continuous Integration and Testing of project-specific virtual ECUs:

▶ Container constructs with docker for Cross-Domain SiL platform

▶ Integration in Jenkins

▶ Automated execution of test scenarios implemented in CarMaker

▶ Data storage

▶ Automated feature-specific evaluation in CDA (Bosch tool)

▶ Creation of reports

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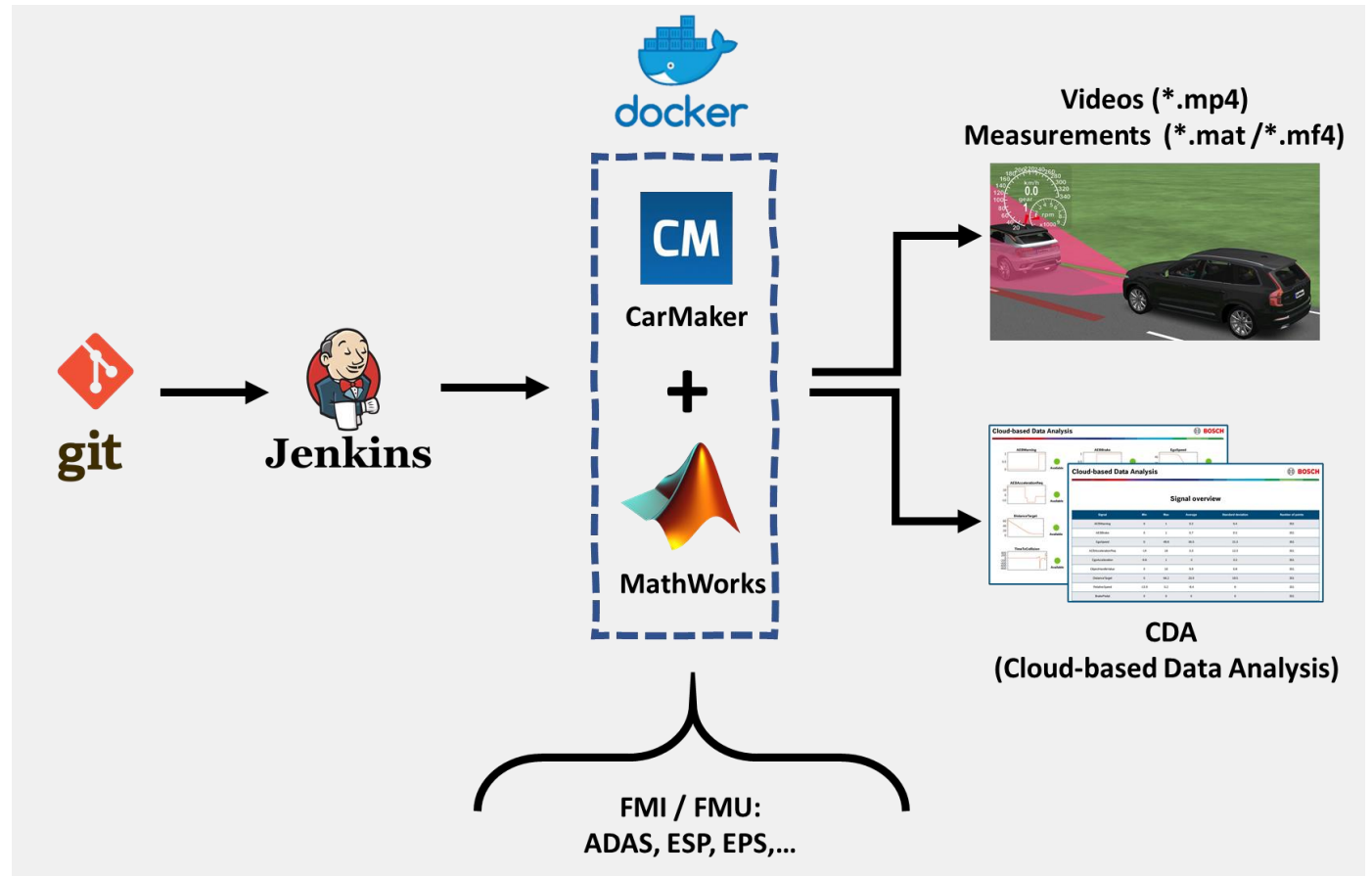
MATLAB/Simulink-based Cross-Domain SiL platform
Vehicle simulator: Feature demonstrator and training platform

Facts & Features

- Ideal for concept validations
- No physical prototypes needed
- Extensive, real-world ADAS function libraries
- Realistic sound reproduction

01 Define system conditions

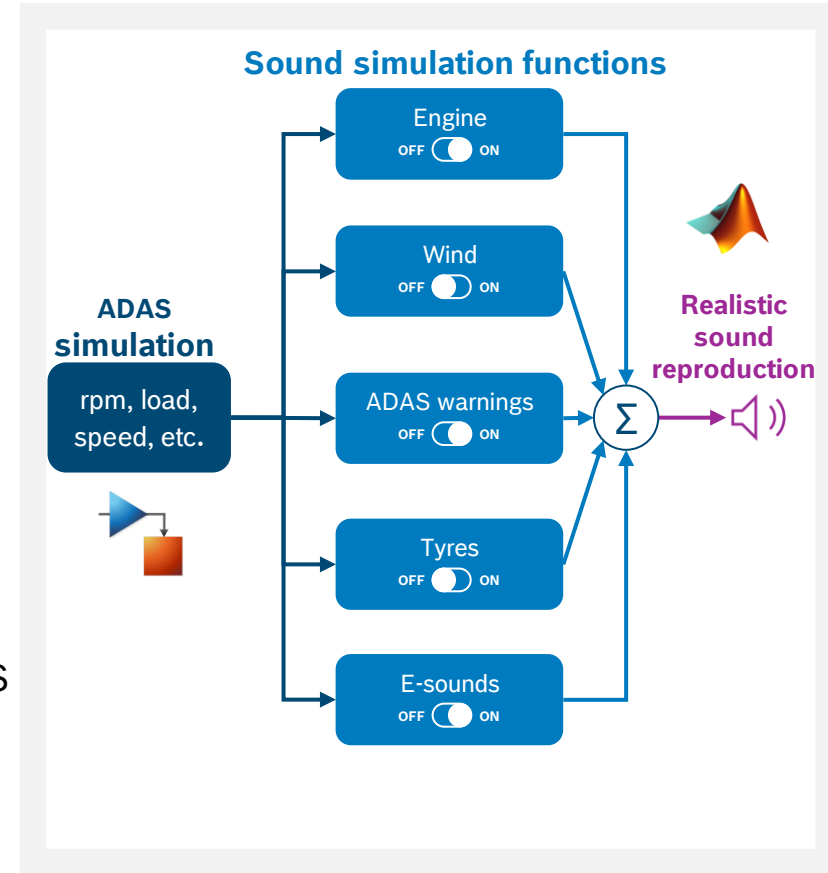Different libraries for vehicle types, Tracks, Bosch features and sounds

02 Real-time acoustic feedback

Drive your vehicle inside your virtual environment and have a full immersive ADAS experience

03 Develop faster

Execute pre-validations in your ADAS software functions and evaluate your sound design strategies

Sound simulation functions

ADAS simulation

rpm, load, speed, etc.

Engine OFF / ON
Wind OFF / ON
ADAS warnings OFF / ON
Tyres OFF / ON
E-sounds OFF / ON

Σ

Realistic sound reproduction

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MATLAB/Simulink-based Cross-Domain SiL platform
Conclusion

Bosch Engineering provides an innovative digital engineering Software in the Loop (SiL) approach for the virtualization of ADAS features and continuous testing

MATLAB/Simulink environment is used for test-driven design, application and V&V strategy

SiL environment can be extended for vehicle driving simulator and sound simulation

ADAS feature can be evaluated and calibrated in cross-domain simulation environment

Automated tool chain for test execution and evaluation was developed with MathWorks products

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THANK YOU

LET'S STAY IN TOUCH

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