Product modeling @ SC Villach

Using SystemC and Coside to enable effective IC development and customer support

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2017-10-19

confidential

Agenda

1. Introduction on Magnetic Sensors & Product Modeling
2. Some examples from the last two years
3. Why we do like Coside?
4. Conclusions

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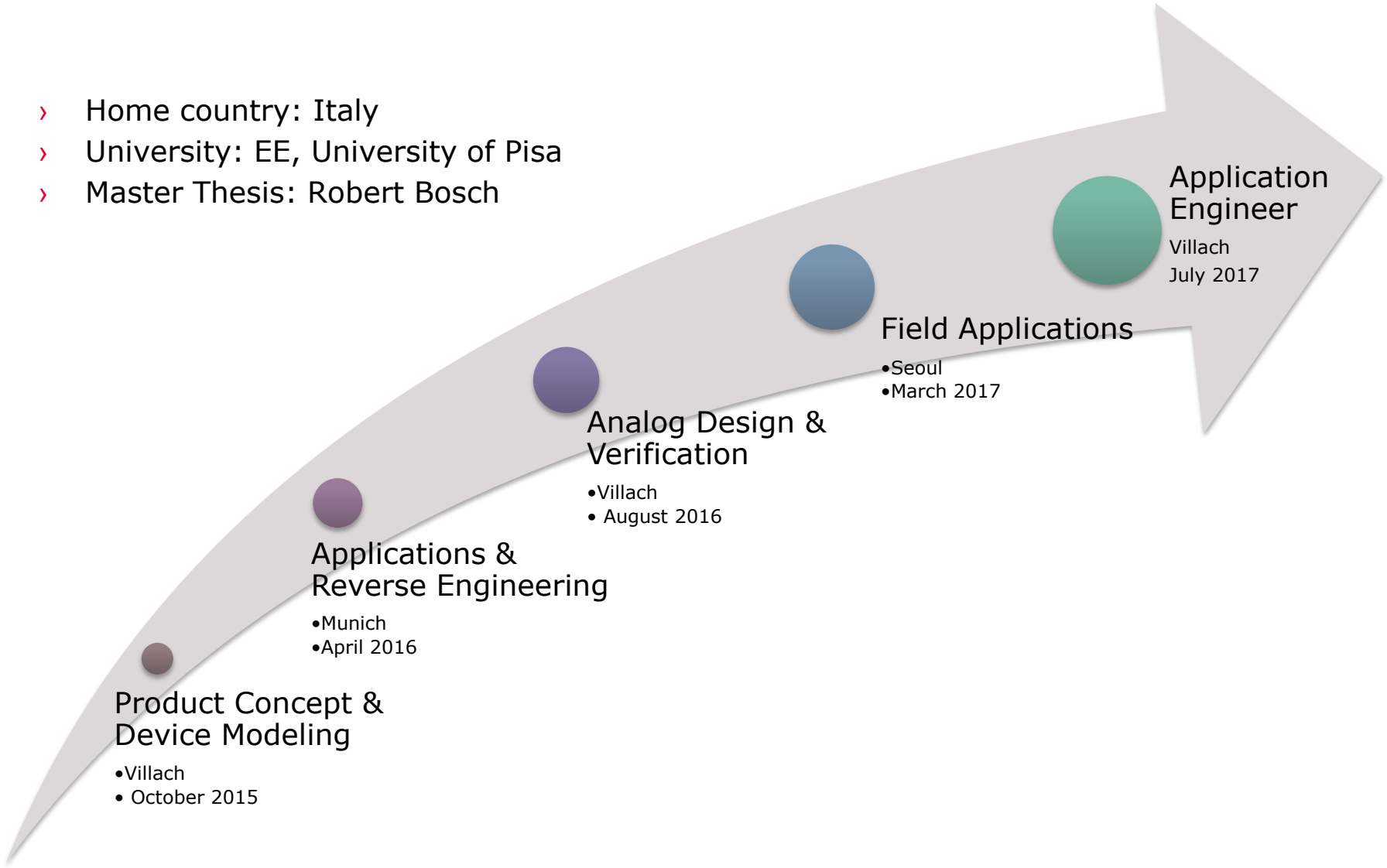
24 months @ Sense and Control ATV

- Home country: Italy
- University: EE, University of Pisa
- Master Thesis: Robert Bosch



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Infineon Technologies Austria AG (Villach)

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Infineon Villach divisions and products

Automotive (ATV)

- Power Semi-conductors
- Power ICs
- Microcontrollers
- Sensors
- Electric Drivetrain

Industrial Power Control (IPC)

- IGBT Modules
- IGBT (Chips & Discretes)
- Driver ICs and boards
- Module Systems

Power Management & Multimarket (PMM)

- Power Discretes & Driver ICs
- Power ICs
- ASICs
- RF & Protection Devices
- Silicon MEMS-Microphones

Chip Card & Security (CCS)

- Payment
- Communication
- Transport, Access & Object ID
- Government ID
- Platform Security
- Entertainment

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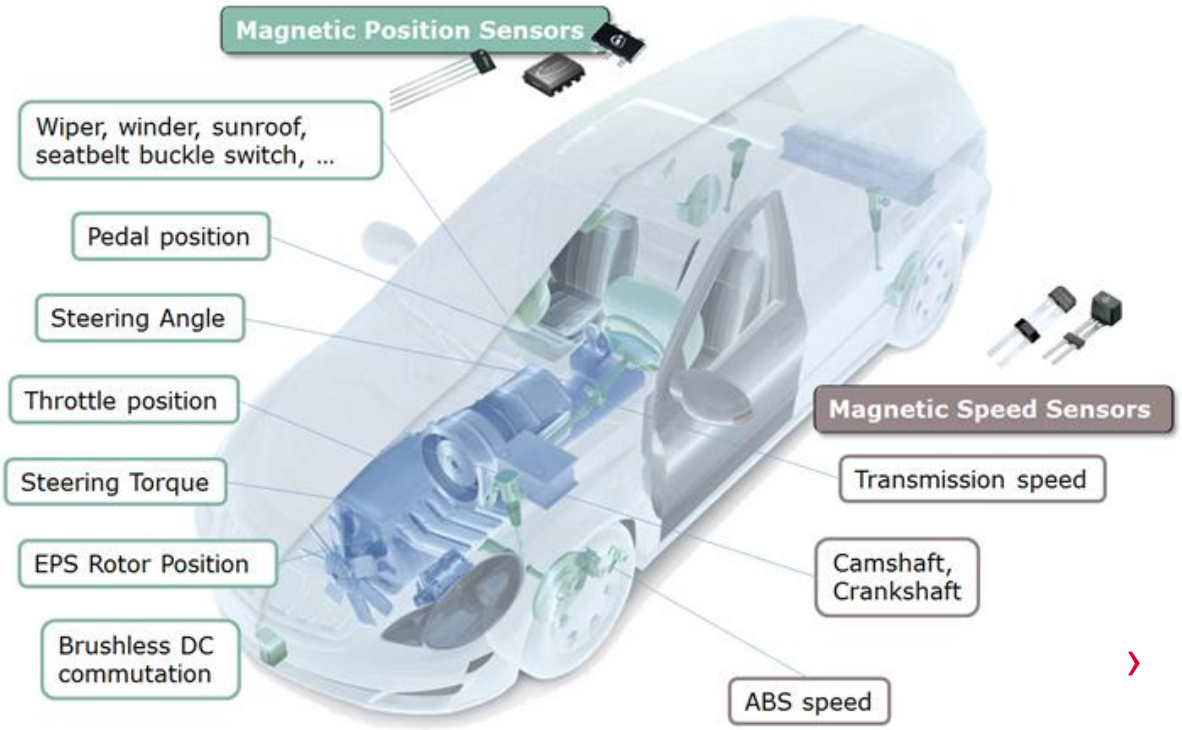
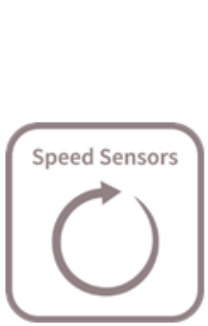
Magnetic sensors in automotive market

› Application: contactless measurement of mechanical quantities





› **Benefits**

› Contactless

› Robust

› Standard material housing

› Low-cost

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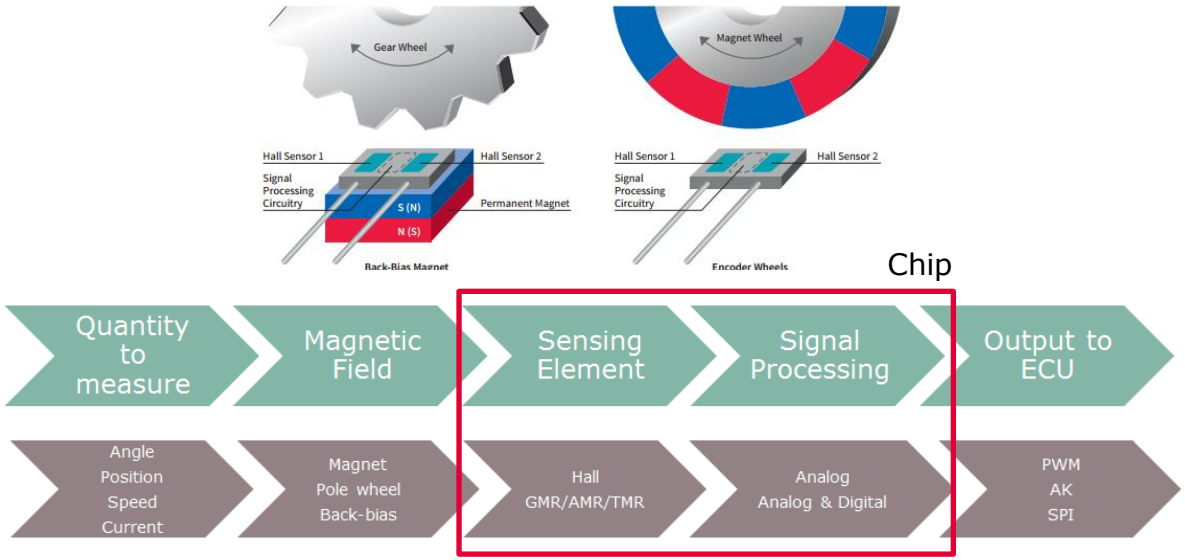
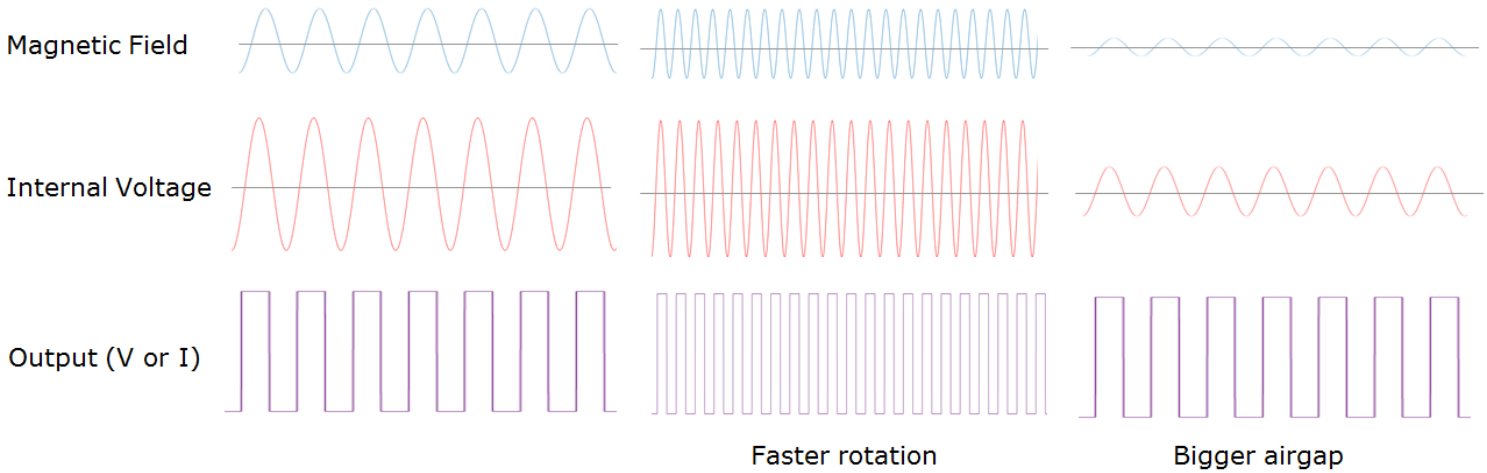
Magnetic sensors working principle



› Example: speed sensors



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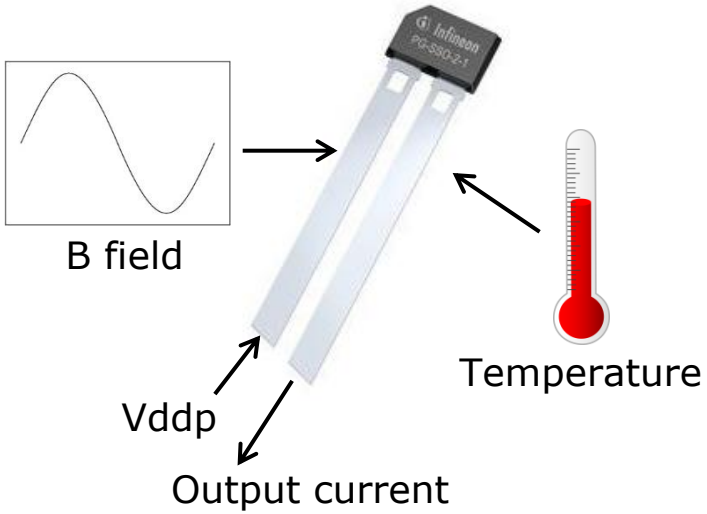
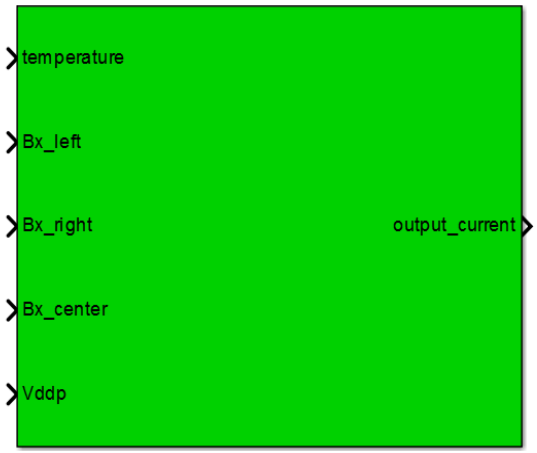
What is a product model?

› Definition of **model**:

"Graphical, mathematical, physical, or verbal representation or simplified version of a concept, phenomenon, relationship, structure, system, or an aspect of the real world"





› Read more: http://www.businessdictionary.com/definition/model.html

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What does a model include?

- *"Since most objects and phenomenon are very complicated (have numerous parts) and much too complex (parts have dense interconnections) to be comprehended in their entirety,* ***a model contains only those features that are of primary importance to the model maker's purpose****"*
- Read more: http://www.businessdictionary.com/definition/model.html

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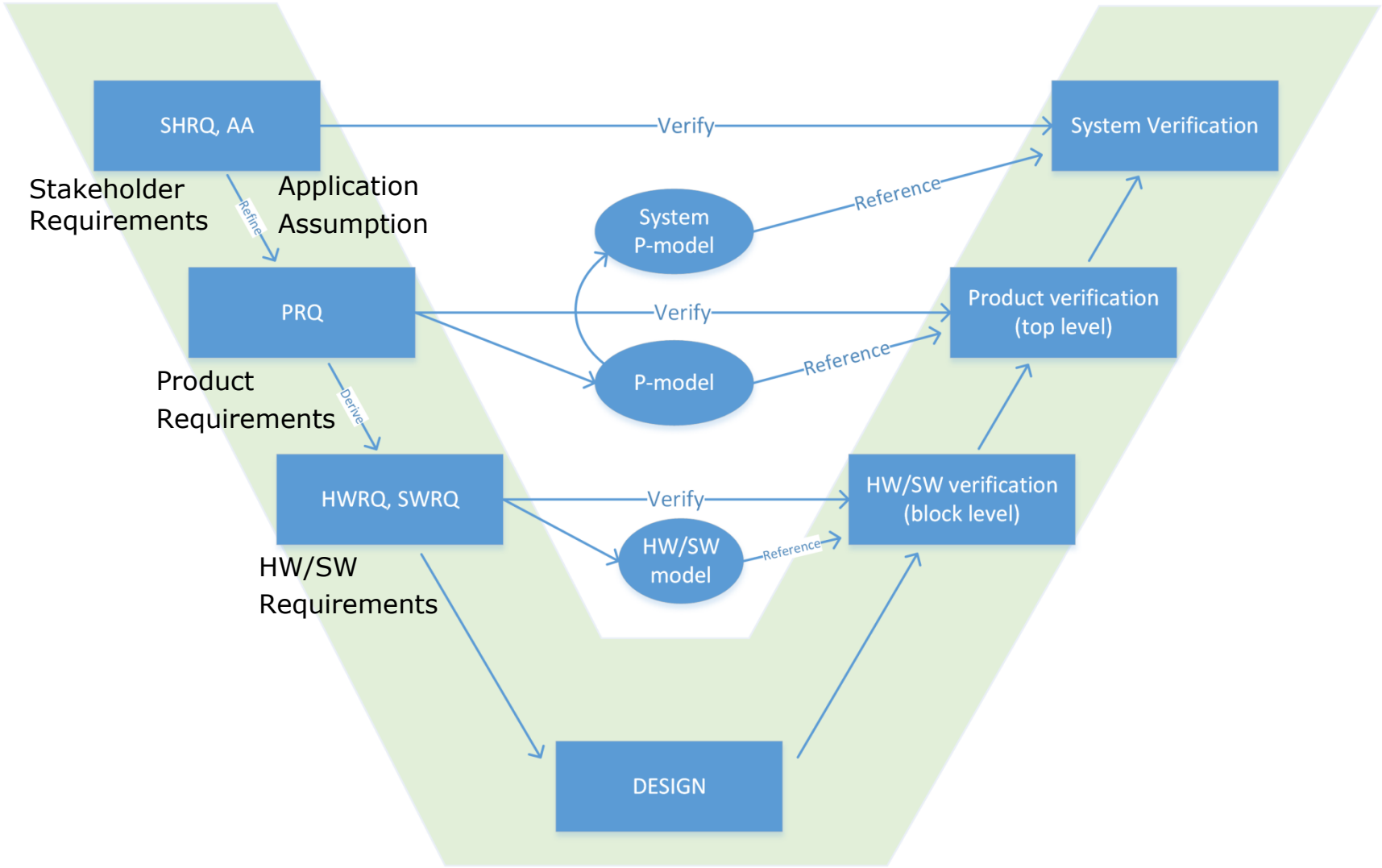
V-model methodology



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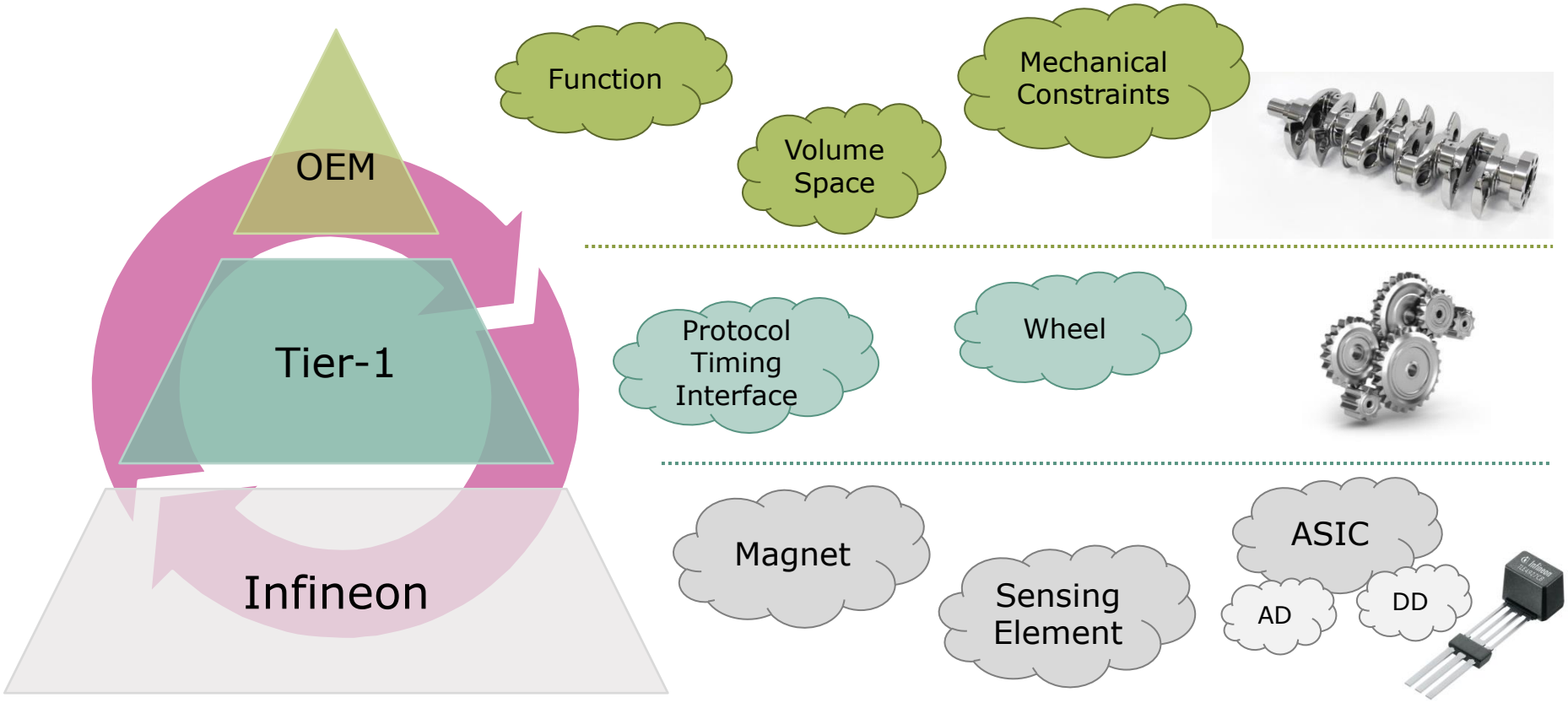
Modeling driven by P2S strategy



› Goal: increase our contribution on the system definition, which enables us to offer optimized sensor solutions in terms of performance, value and costs

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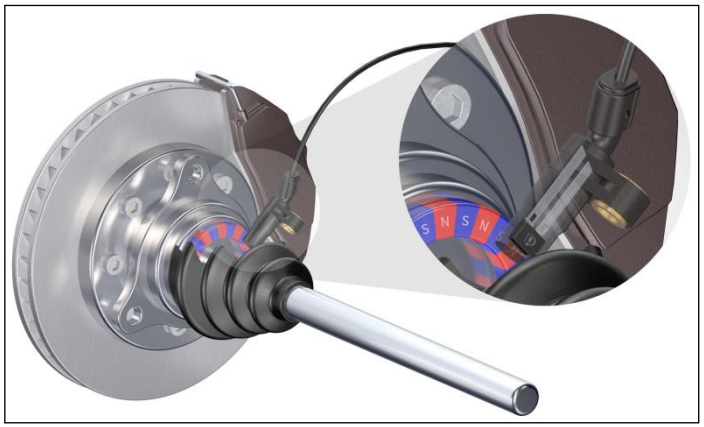
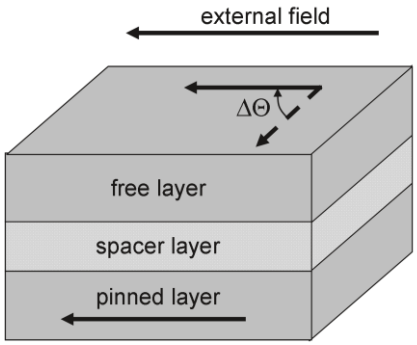
Combined simulation flow
Example from DVCon Europe 2017





- Duty cycle and jitter performance of GMR based sensors may be degraded if By component of the encoder wheel field is too big
- Due to tilt and offset in assembly the By in-plane component of the field may increase
- It is useful to investigate and predict such phenomena via measurements and simulations (faster, cheaper, more flexible)

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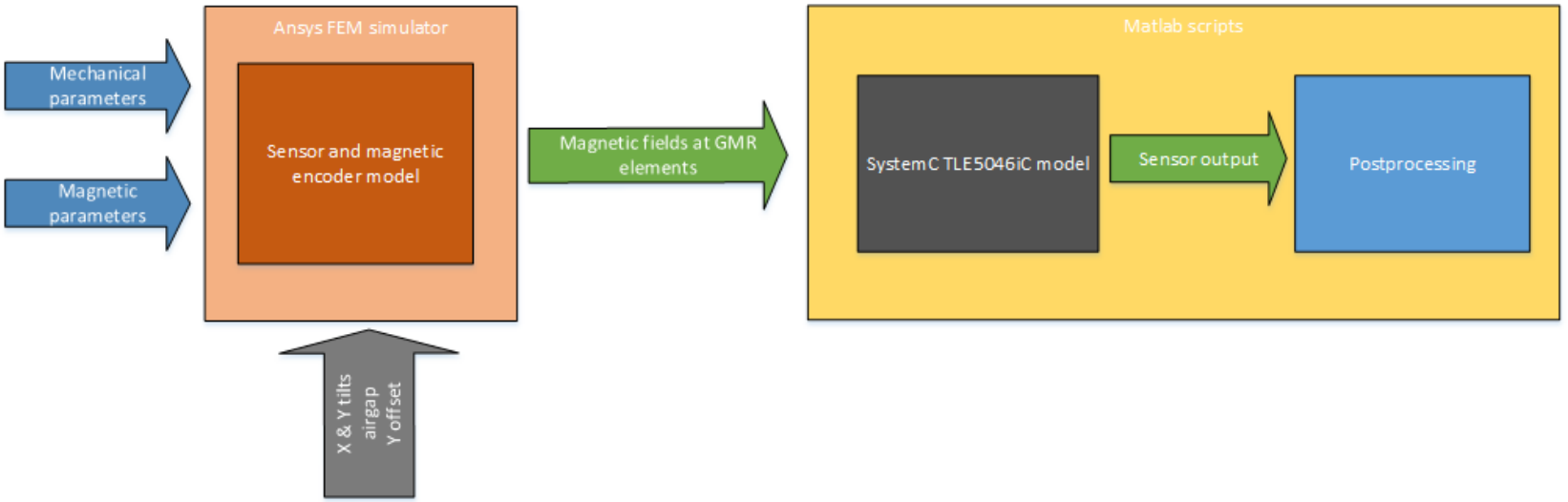
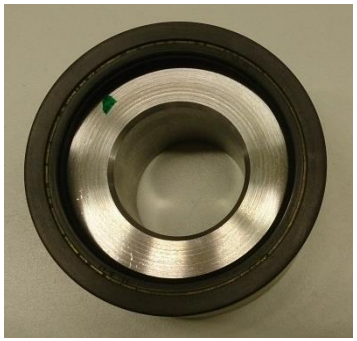
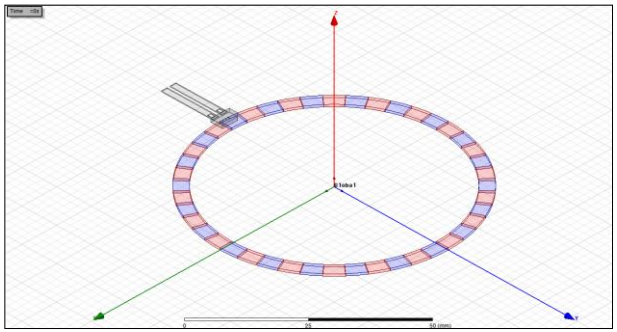
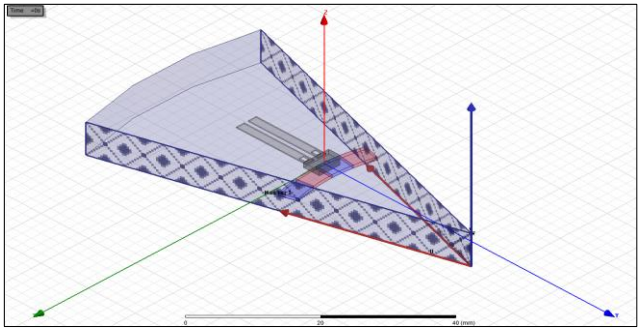
Simulation flow – FEM
Example from DVCon Europe 2017









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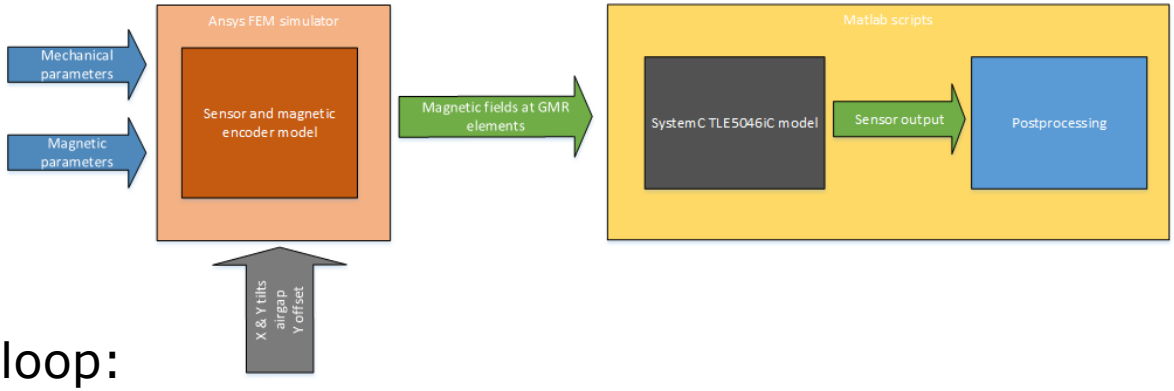
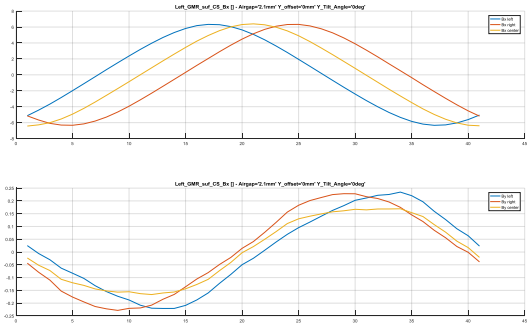
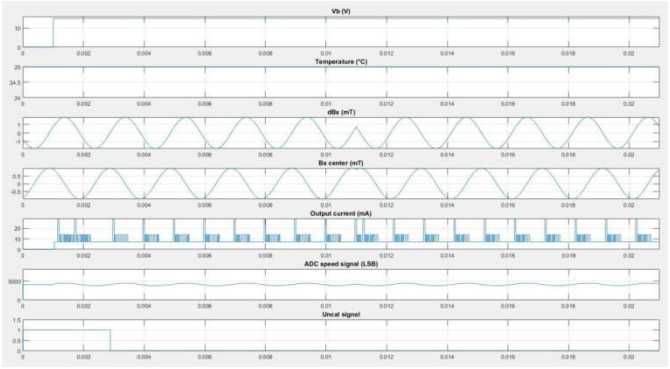
Simulation flow – SystemC + Matlab
Example from DVCon Europe 2017



› Repeat in a loop:

1. Read the results from Ansys FEM simulations
2. Post-process the results in a SystemC friendly format
3. Run the SystemC simulation
4. Perform automatic pass/fail tests on the simulation output





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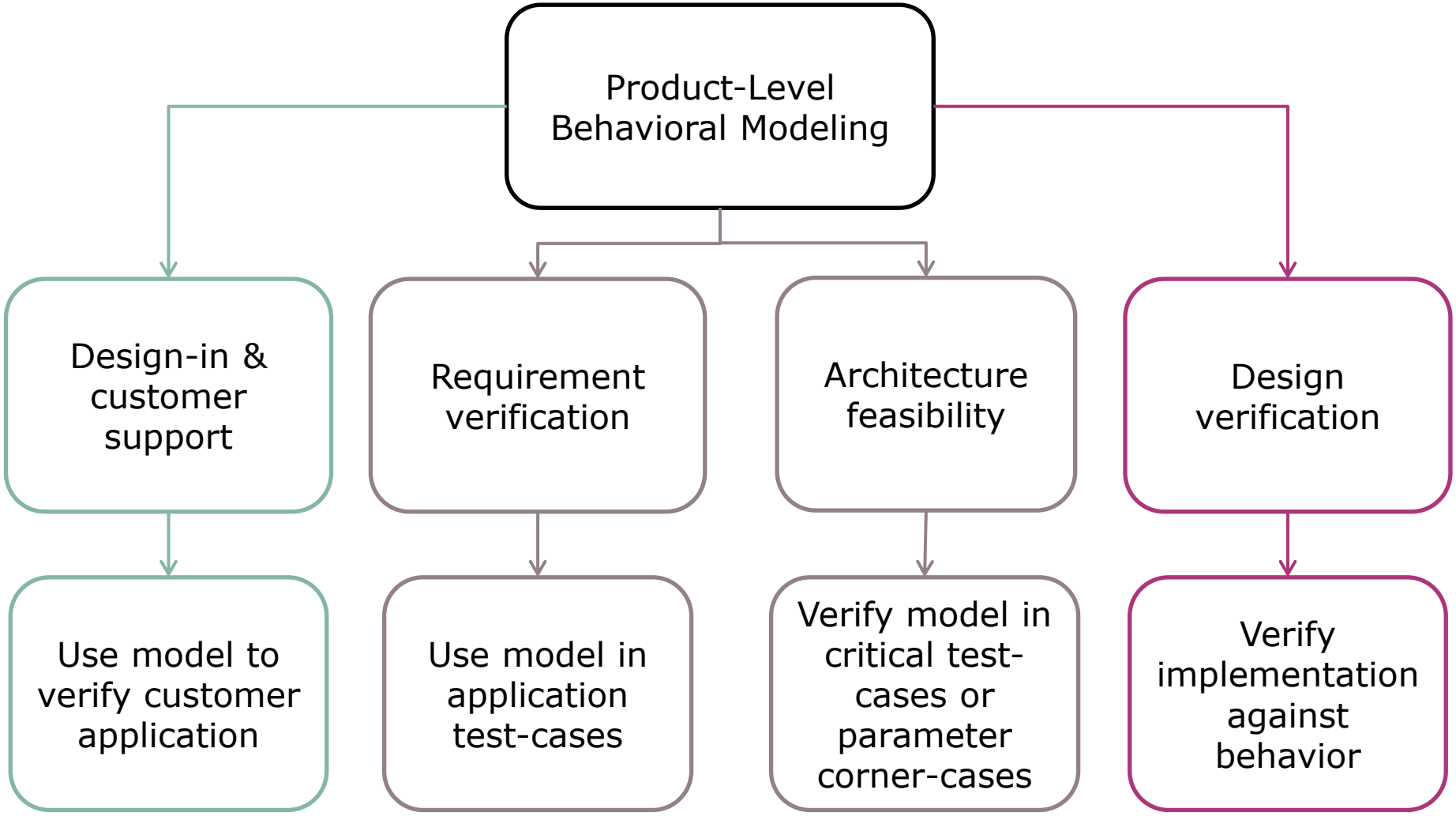
Product modeling use cases



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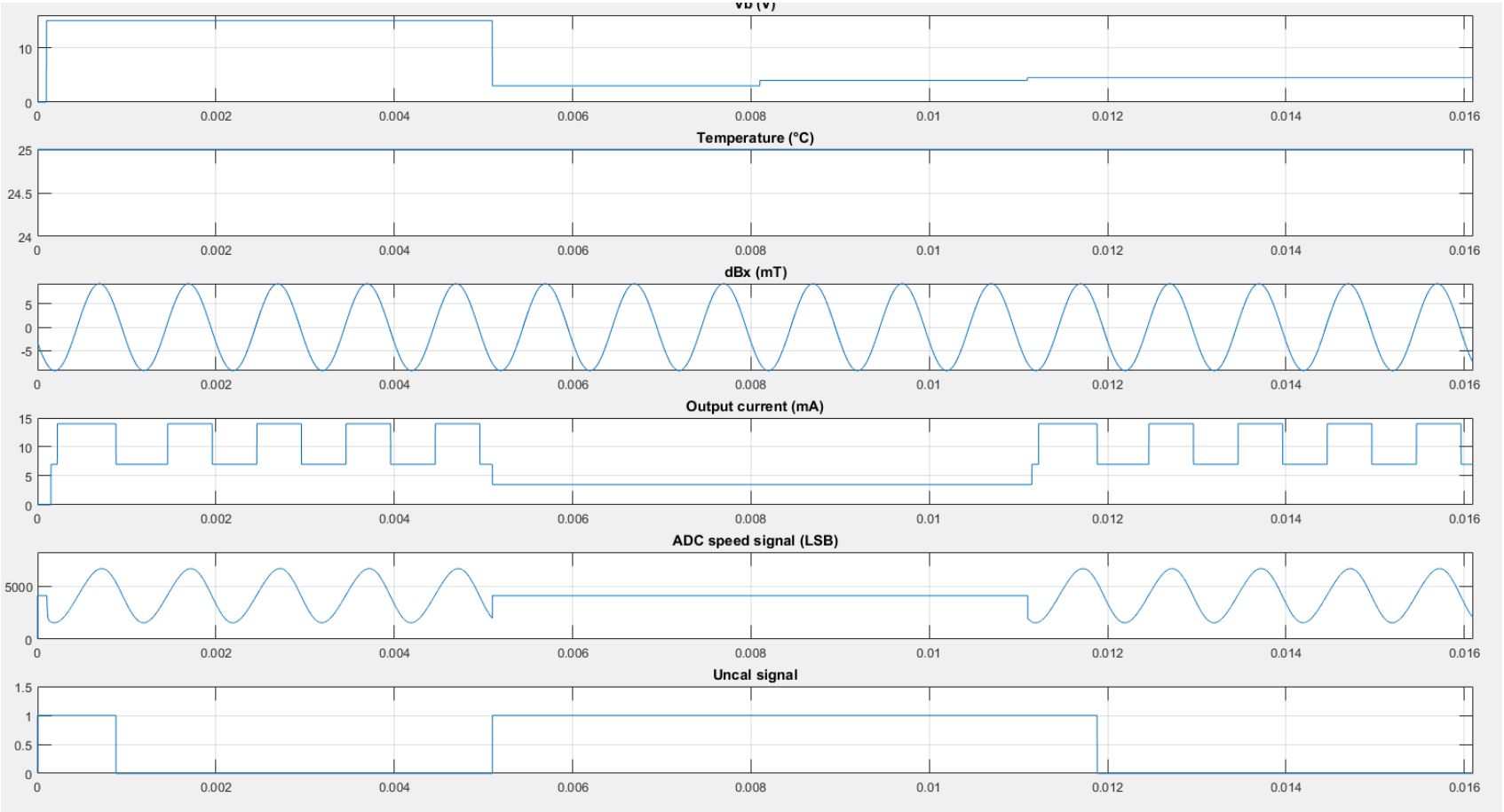
TLE5045iC/46iC models
Customer questions answered via simulations

› Ex 1: Undervoltage behavior of TLE5045iC



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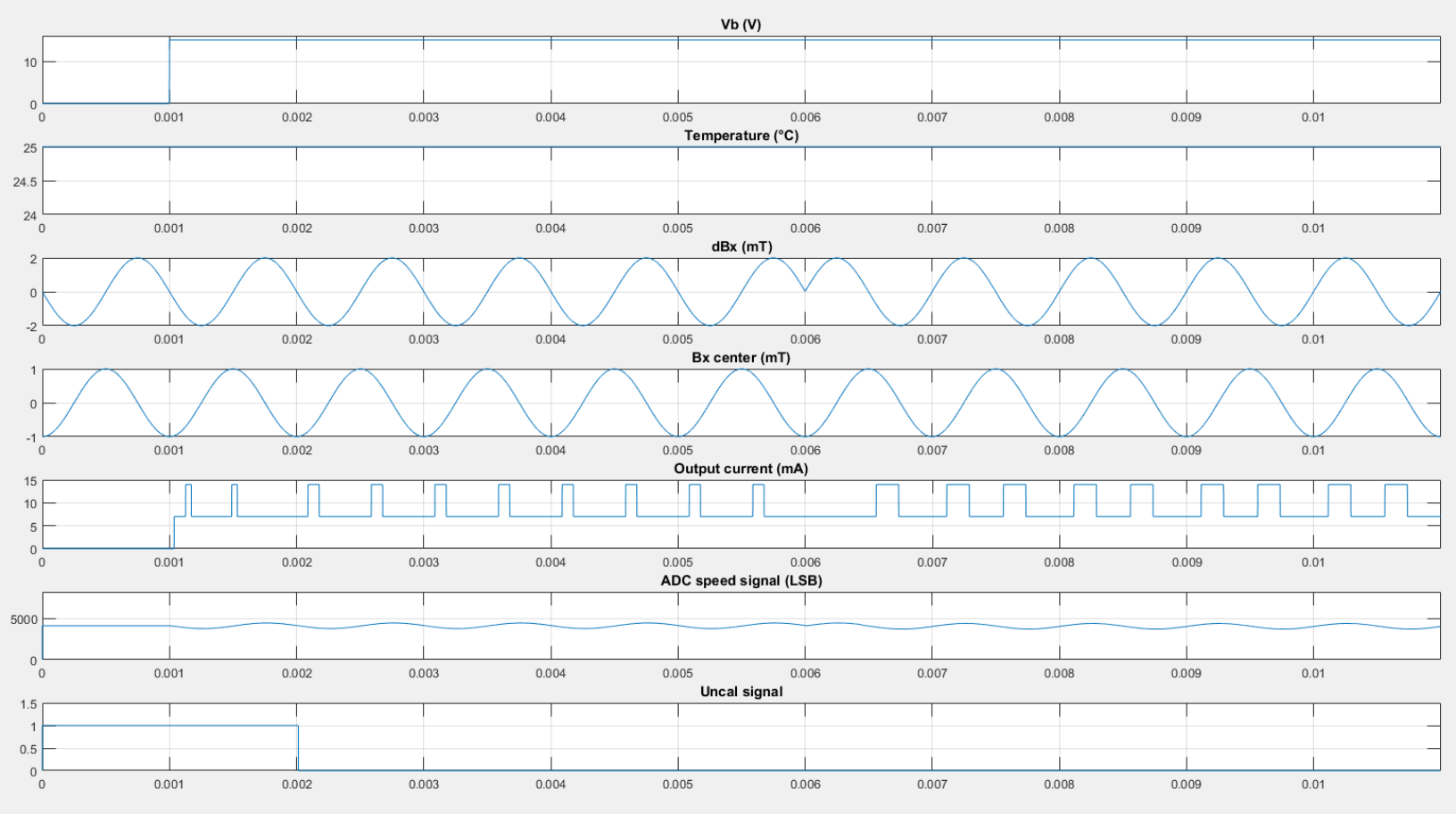
TLE5045iC/46iC models
Customer questions answered via simulations

› Ex 2: Direction change of TLE5046iC-PWME



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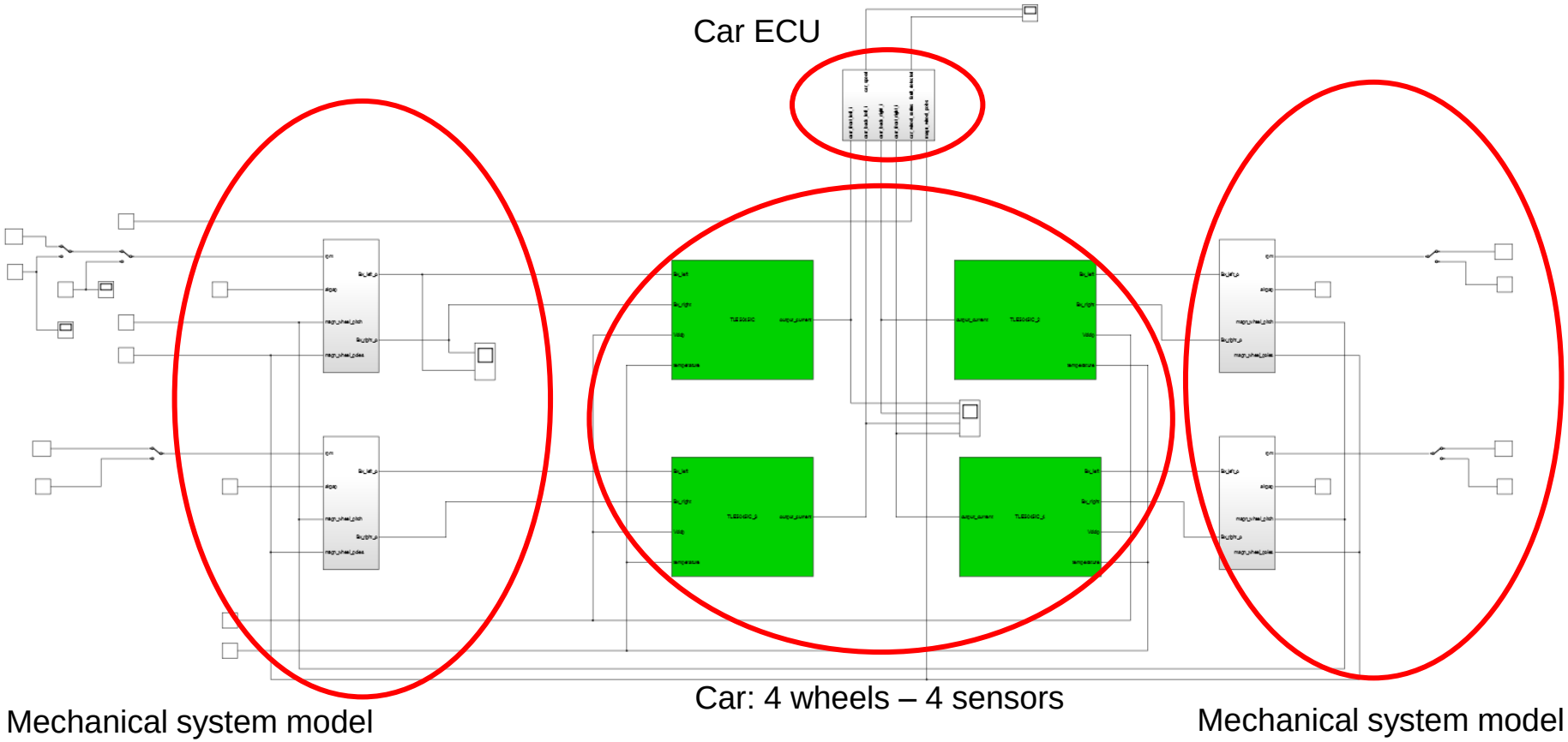
TLE5045iC/46iC models
Product 2 System - Simulink demo (1/2)



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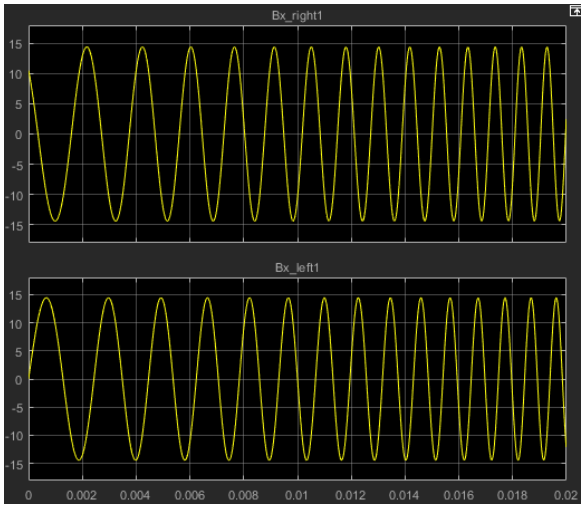
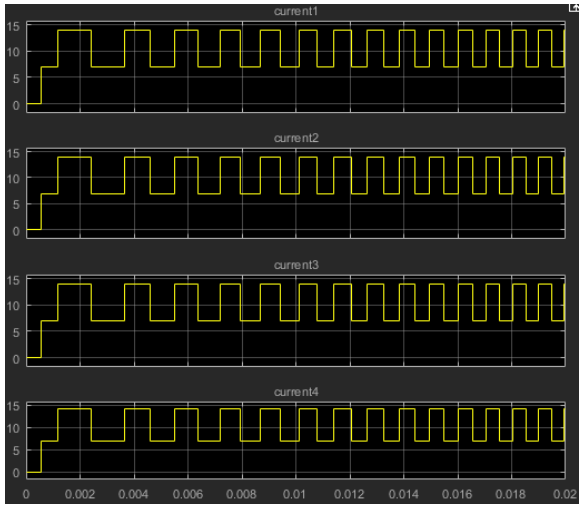
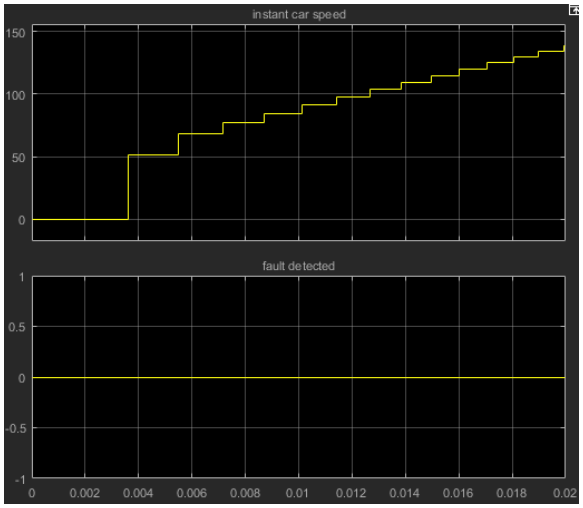
TLE5045iC/46iC models
Product 2 System - Simulink demo (2/2)

1. Define the engine RPM and mechanical system
2. Observe the output current of the sensors
3. Calculate the car speed and detect malfunctioning







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TLE5045iC/46iC models
Root cause of complex behaviors

- Accessibility to all internal signals
- Worst case analysis easily made possible
- Automatic checks via Matlab or SystemC
- Understand the problem and THEN do specific measurements to obtain more accurate information
  - Cheaper
  - Faster

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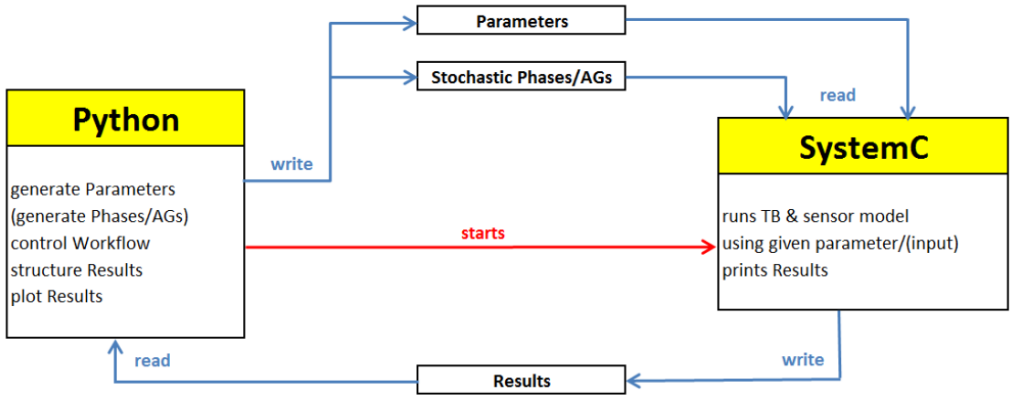
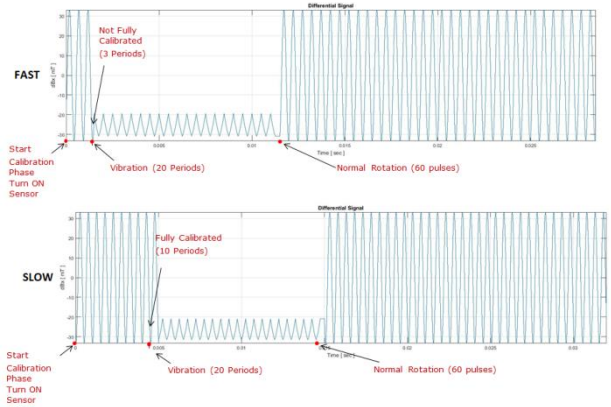
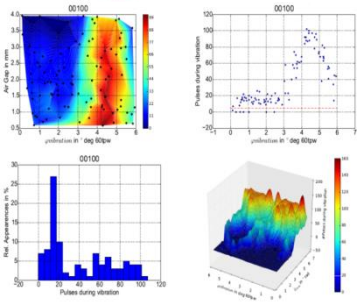
Speed sensors vibrations analysis

- Systematic analysis on phase and airgap vibration behavior
  - Airgap
  - Starting phase
- Iterative simulation and automatic post processing







C - Measurement@ag=1.7mm										
	Vibration phase Offset in deg60tw (6 is equal to one period)									
Amplitude	0	0.6	1.2	1.8	2.4	3	3.6	4.2	4.8	5.4
0.3	2	2	2	2	2	2	2	2	2	2
0.5	2	2	2	2	2	2	2	1	2	1
0.7	2	2	2	1	2	2	2	2	1	1
0.9	2	1	1	2	2	2	2	3	2	1
1.1	2	1	1	2	2	2	2	3	2	1
1.3	2	1	1	1	2	2	2	3	2	1
1.5	2	1	1	2	2	2	1	3	5	3
1.7	2	2	1	2	2	2	2	3	11	6
1.9	2	1	1	2	2	5	4	3	39	7
2.1	2	1	1	2	1	5	5	8	41	36
2.3	2	1	1	2	1	25	24	11	68	4
2.5	2	1	1	2	1	23	5	43	58	3
2.7	2	1	1	2	1	5	13	57	61	2
2.9	1	1	1	2	1	7	57	59	61	2
3.1	2	1	1	2	1	8	61	61	57	2

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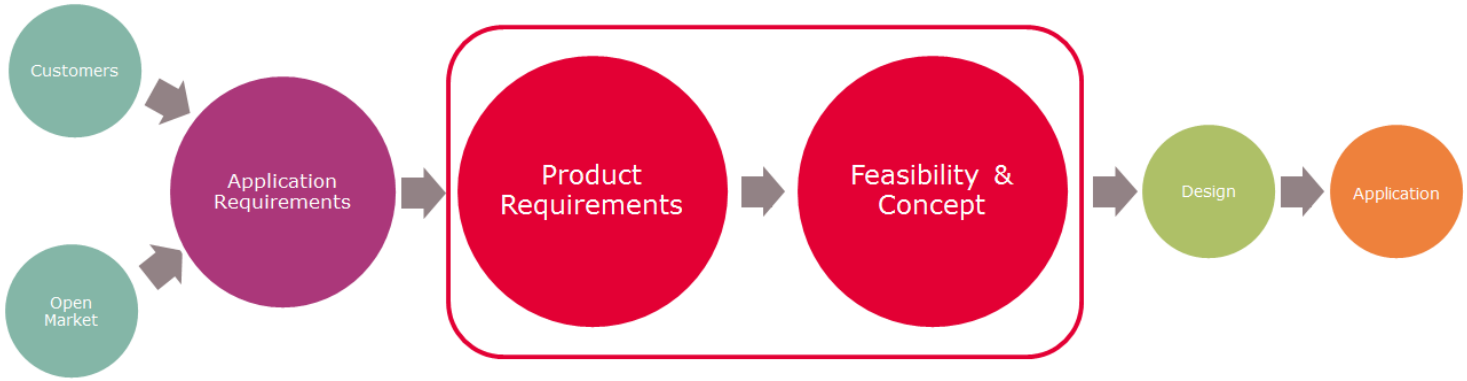
Current sensor
Product requirements & architecture definition



- Model V1.0:Product Requirement Document
- Model V2.0:Product Architecture and Safety Concept
- Model V3.0: bit true version according to VHDL implementation

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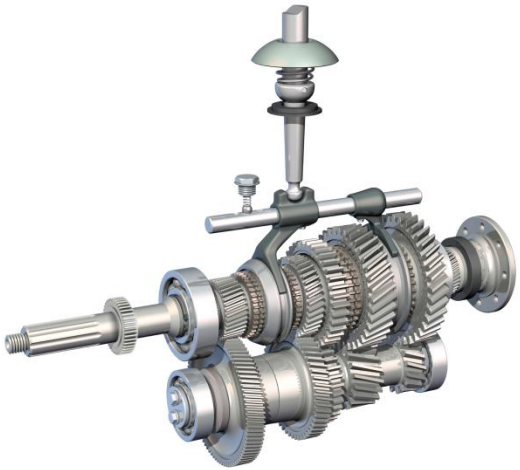
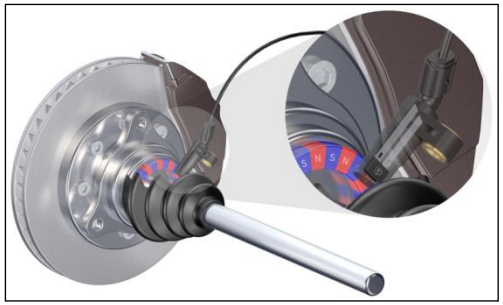
Speed sensors next generation





- Transmission
- ABS
- Early feasibility study and concept definition
- IP reuse from available product
  - Goal: LEGO like approach

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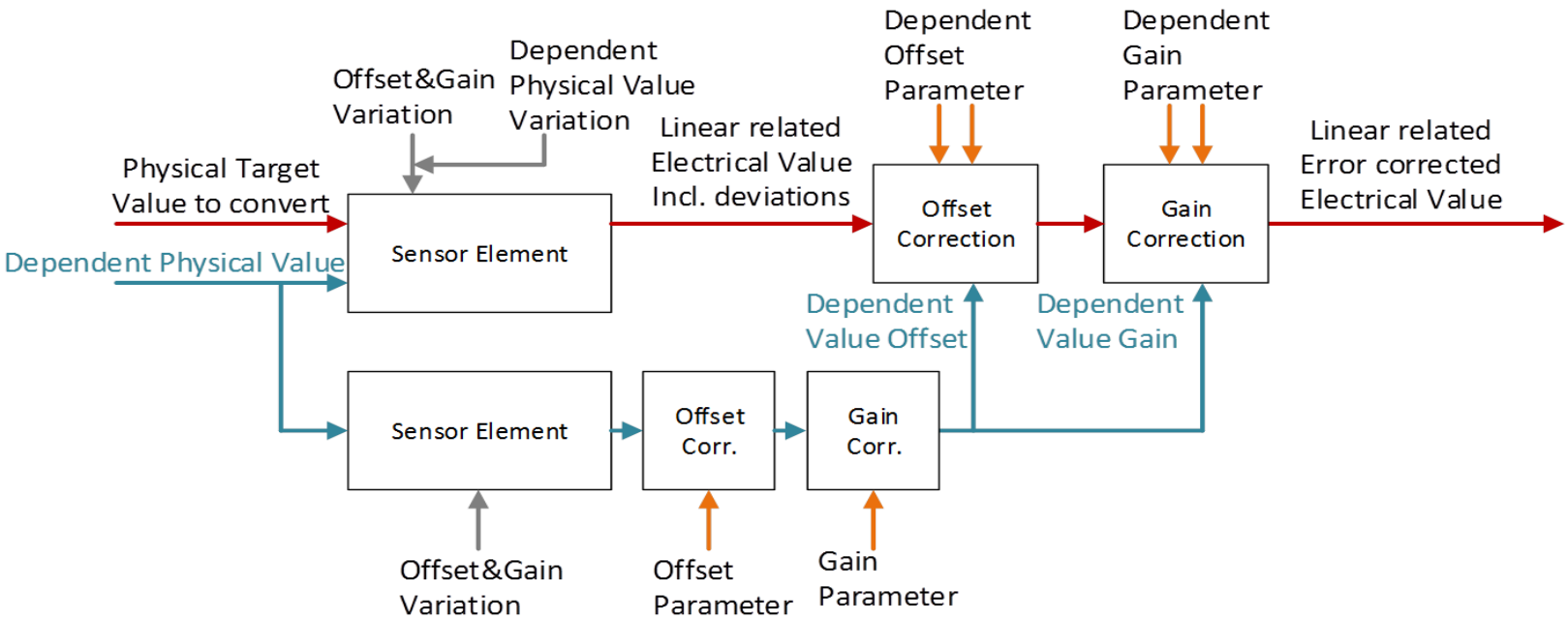
Linear hall
Data path modelling calibration



› Goals for sensor data-path modeling
  – Data-path model for calibration and accuracy (stress & temperature)
  – Derivation of module requirements
  – Executable specification for implementation

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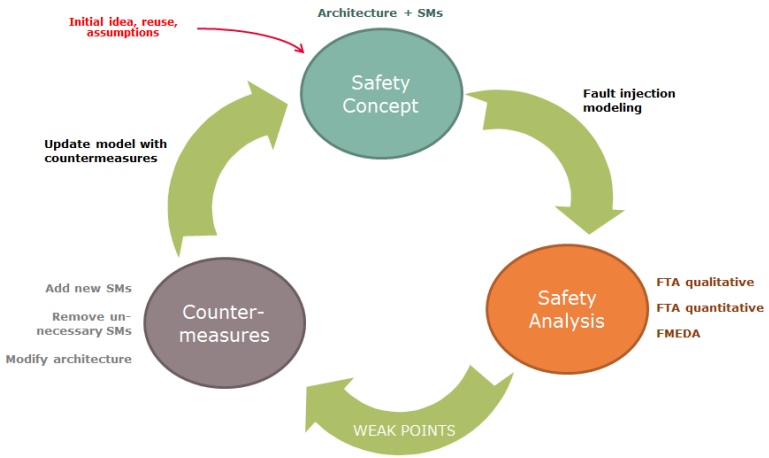
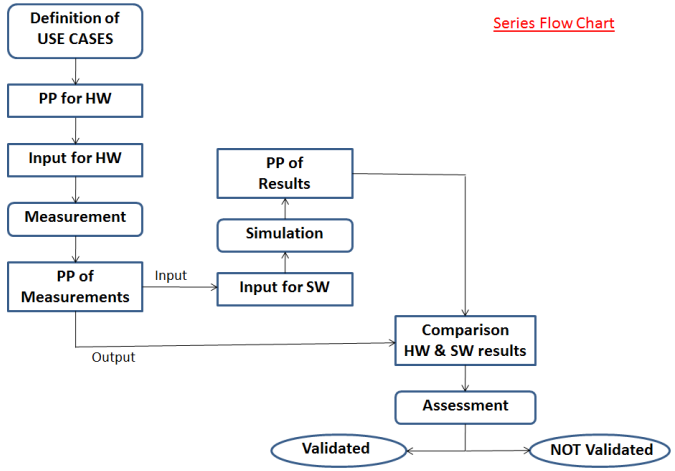
Ongoing & planned:
HW co-verification, SysC fault injection, FPGA

- Fault injection on SystemC modeling
- Co-verification with HW
- FPGA prototyping (SysC → VHDL)





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Why do we like Coside?

- Eclipse-based IDE
  - Easy to learn
  - Most of the students already used to it @ Uni
- GUI & Schematic
  - Helpful for hierarchic design & architecture definition
- XML interface to create fast .h and .cpp
  - Focus on the funnier part ☺
- Simulations utilities
  - Tb automatic generation
  - Schematic view with primitives available

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Why do we like Coseda?

- Effective and fast support, very competent and helpful people

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Conclusions

Use cases

- Customer design-in
- Executable specs
- Requirements validation
- Virtual prototyping
- Architecture exploration
- Design reference
- Integration validation

Advantages

- Early system verification and system concept development for the customers
- First PRQ validation
  - Improve PRQ quality
  - Save costs and improve time-to-market
- Early product verification dev.
  - Test-benches created for model verification can be reused for product verification

- **Behavioral modeling is a powerful tool for development and design-in activities and both the customers and Infineon can highly benefit from it.**
- **Coside plays a fundamental role in our SystemC development flow.**

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