

# 基于模型的设计在汽车功能安全项目中的应用

## The application of MBD in automotive functional safety projects

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KOSTAL ASIA  
2015.06.18



1.

**MBD status in KOSTAL ASIA**  
科世达亚洲MBD现状

2.

**KOSTAL ASIA software develop process(MBD)**  
科世达亚洲软件开发流程

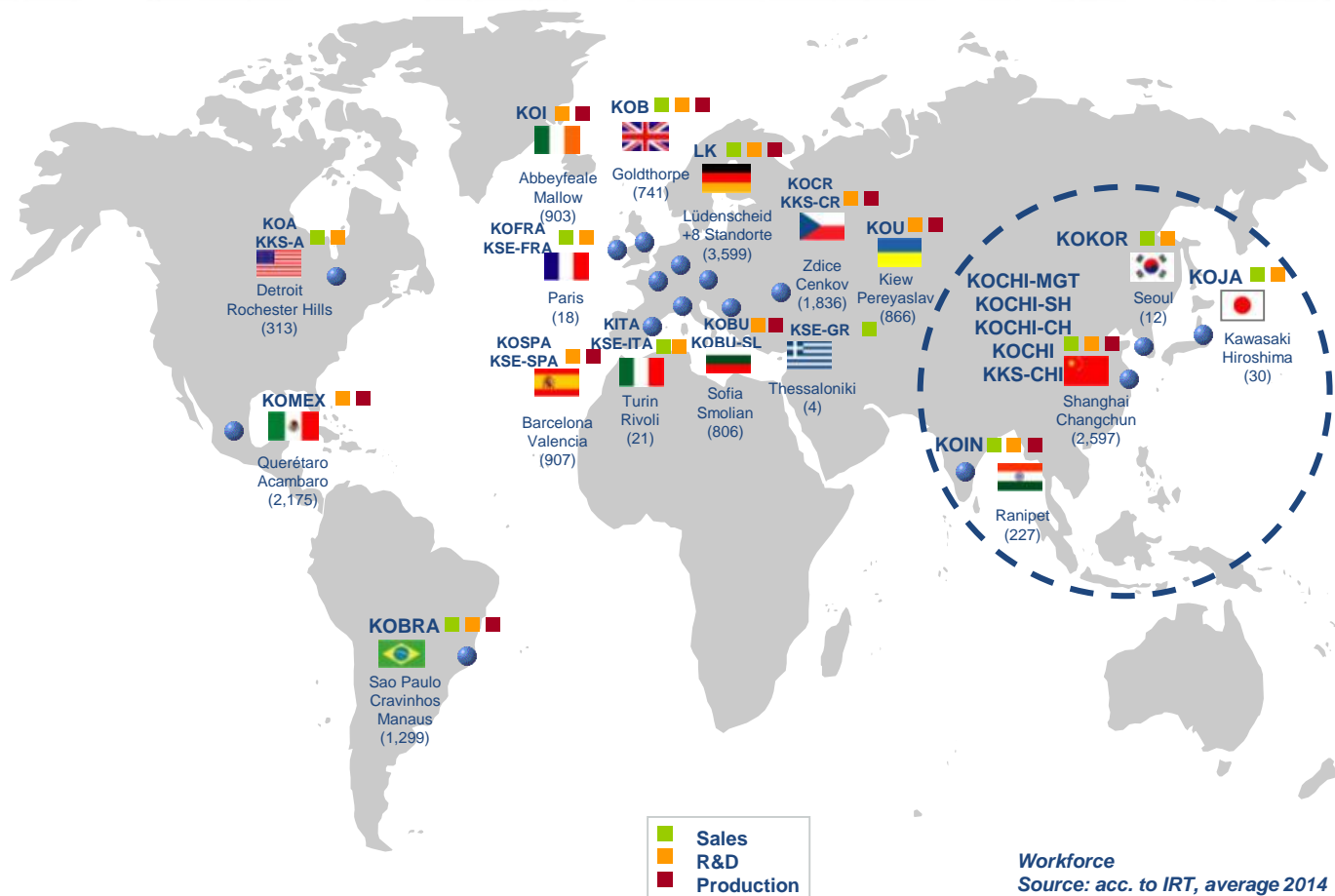
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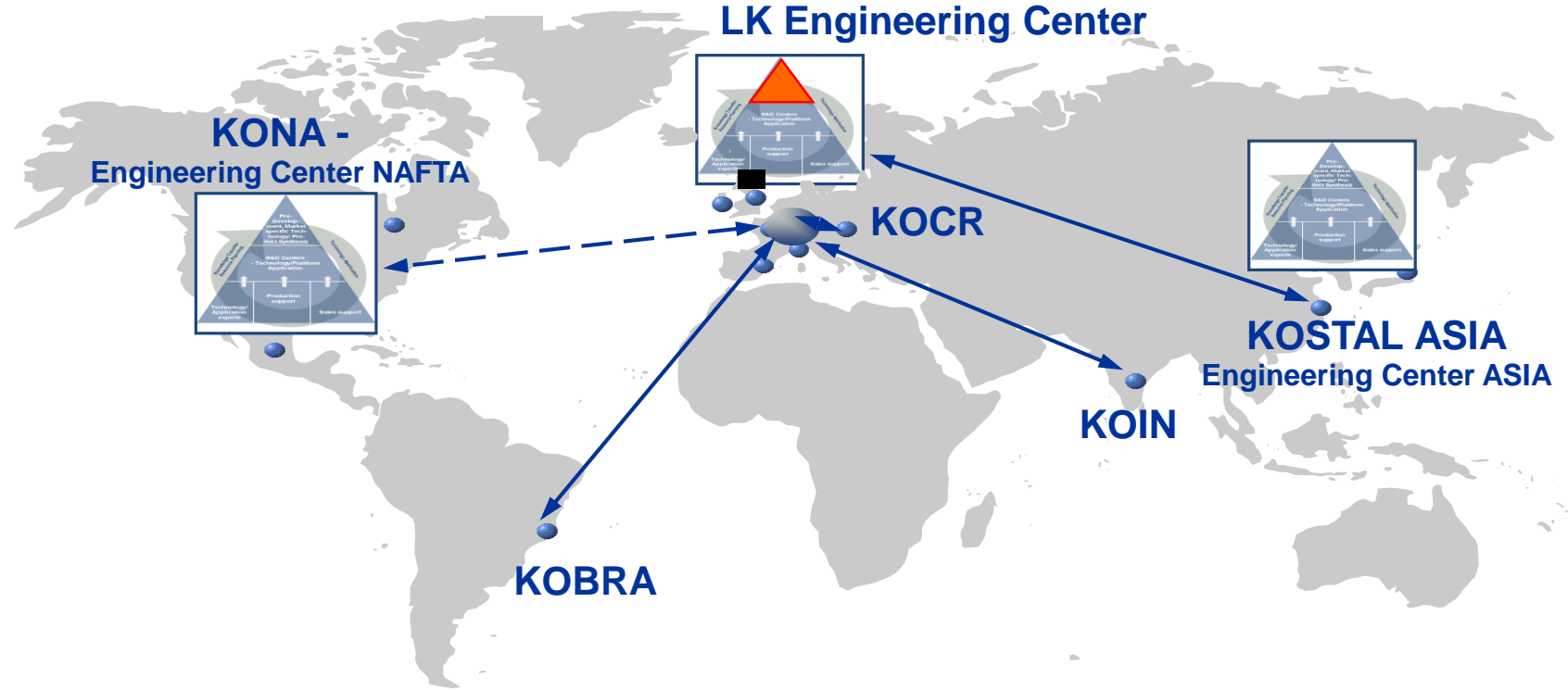
**The application of MBD in functional safety projects**  
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1.

## MBD status in KOSTAL ASIA 科世达亚洲MBD现状





## *Mechatronics*



*Steering Column Modules*

*DAC / RLS*



*Roof Module*



*E-Shifter*

## *Electronics*

*Body*



*Seat*

*Door*



*Access Electronics*



*On-Board Charger (OBC)*

## *Operating Elements & Switches*



*Seat sw. / Module*

*Door sw. / Module*



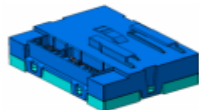
*Faceplate*



*Steering Wheel sw.*

## BFM

**SOP**



Light and wiper controller

Sop: 2013.12

## PEPS

**SOP**

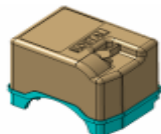


First Sop: 2014.05

Next Sop: 2015.08

## ESCL

**Ongoing**



ASIL-D required

Sop: 2016

## SCM

**Ongoing**



Steering switch with LIN

Sop: 2016

**KOSTAL**  
**ASIA**

Training/ Technical Supporting



**KOSTAL**  
**ASIA**

Workshop/ Alignment for  
Process, Tools, Methods

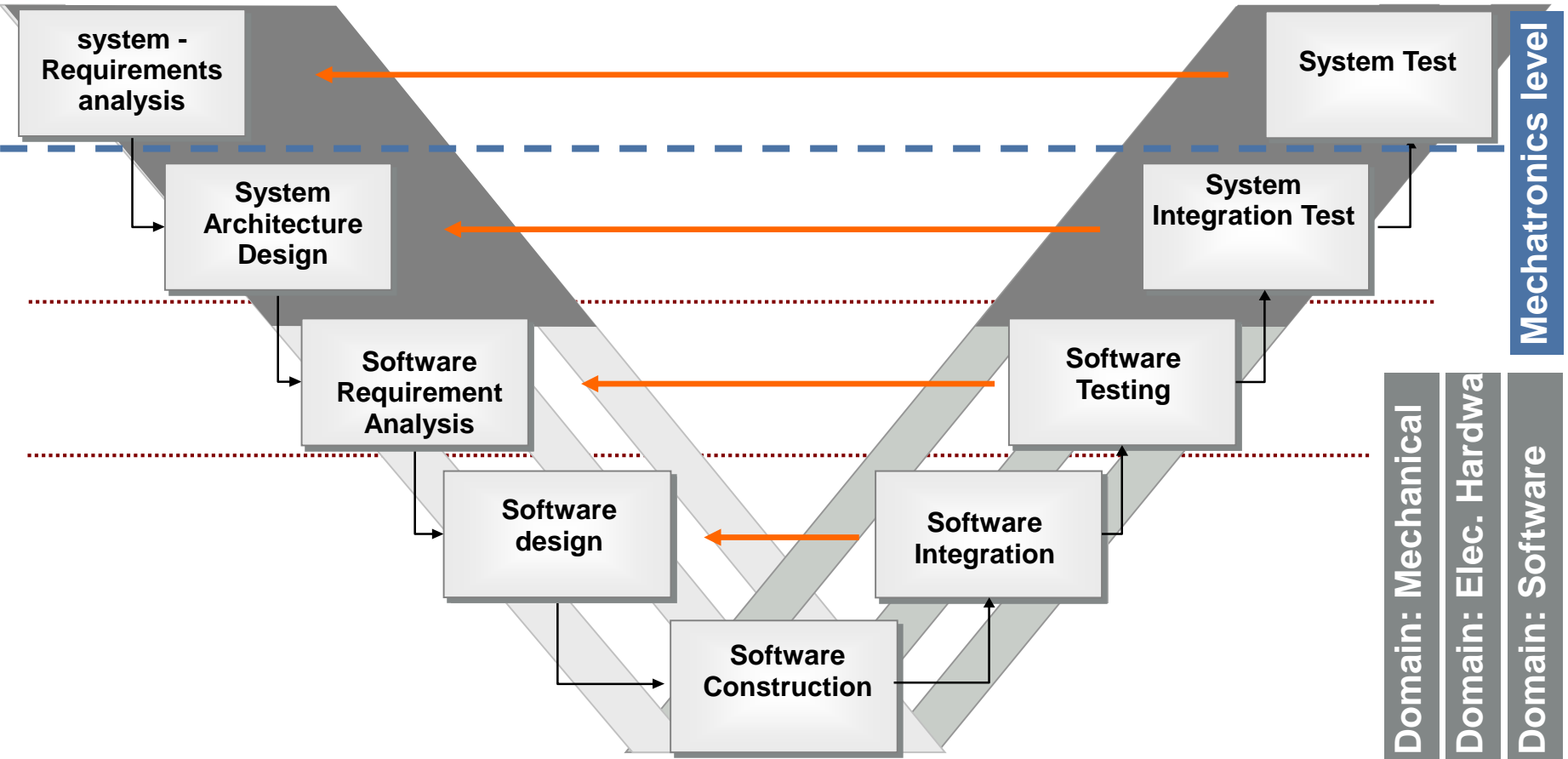
**KOSTAL**  
**Germany**

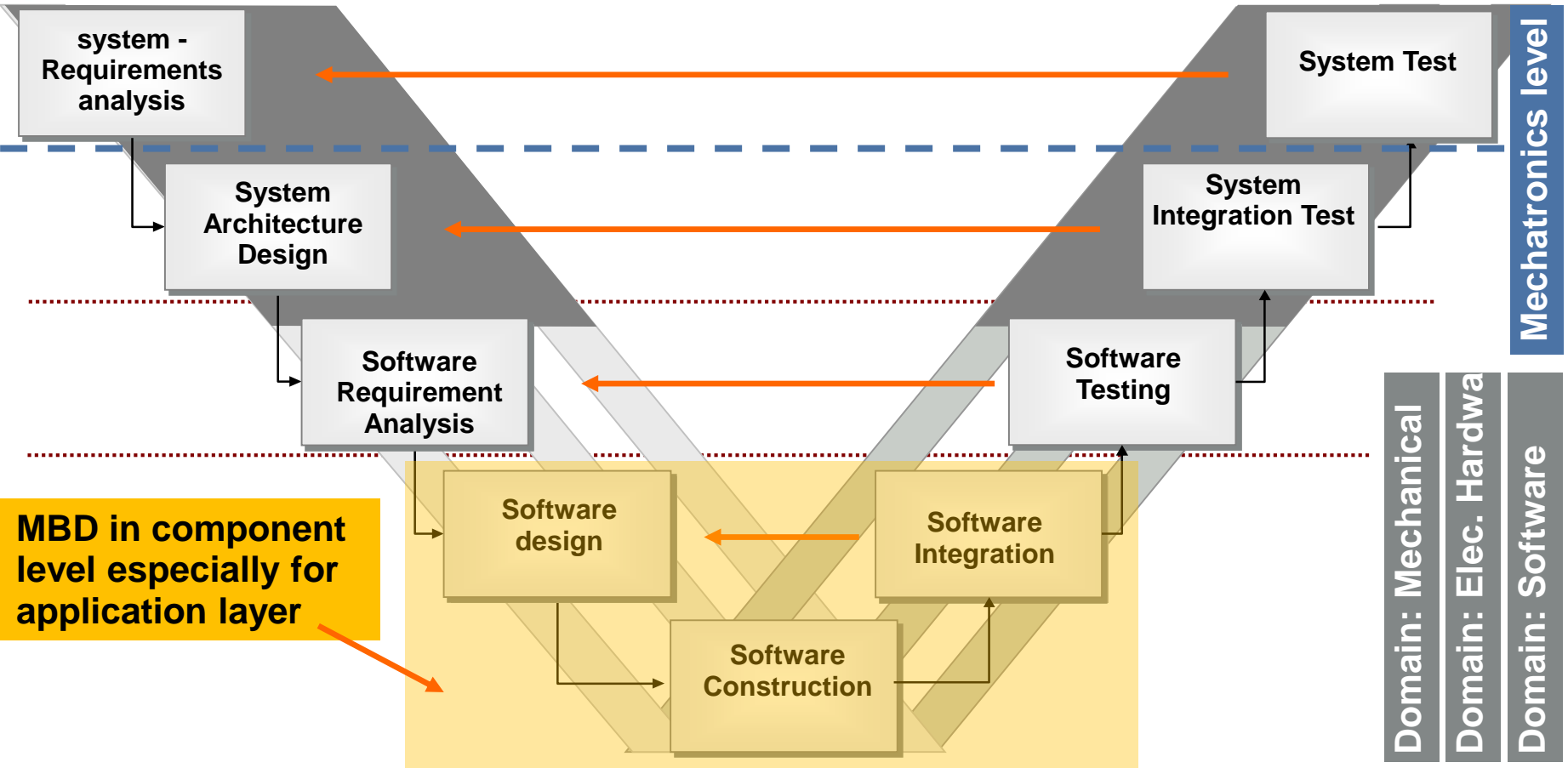




2.

## KOSTAL ASIA software develop process(MBD) 科世达亚洲软件开发流程

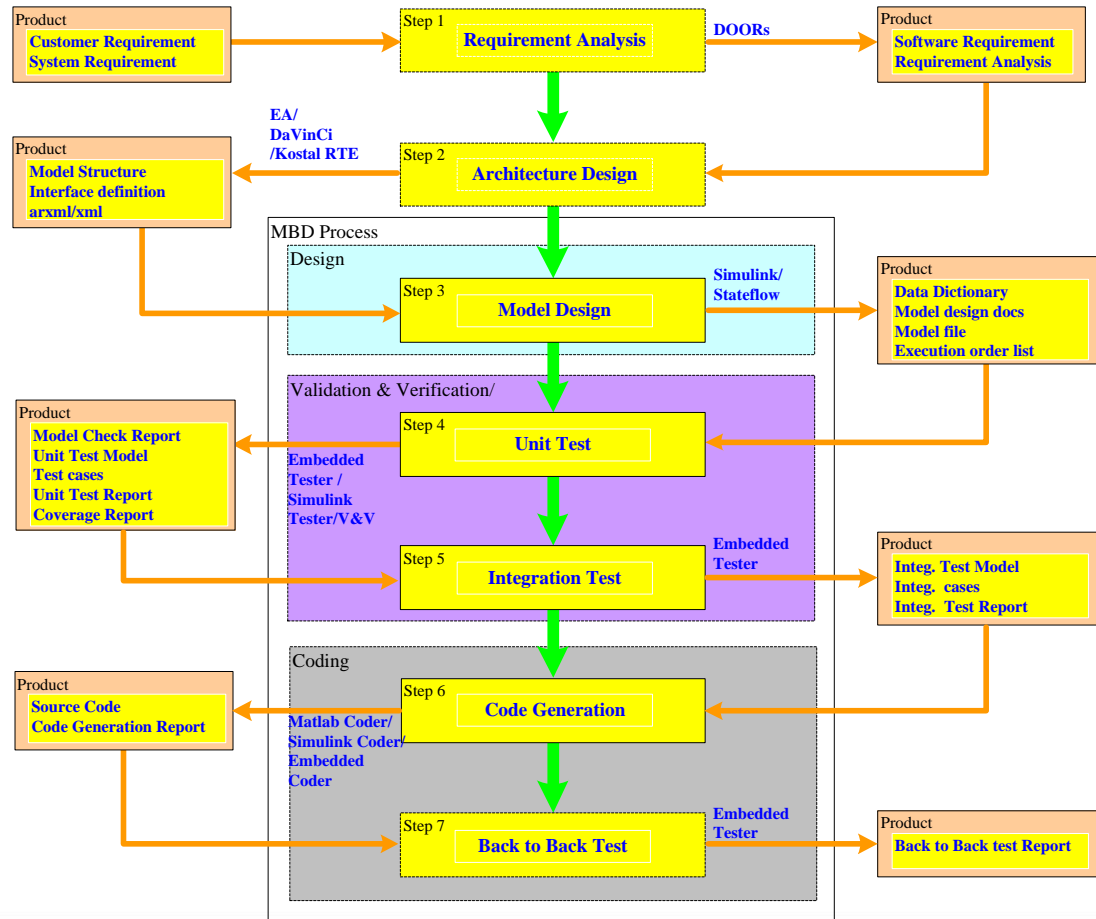




**MBD in component level especially for application layer**

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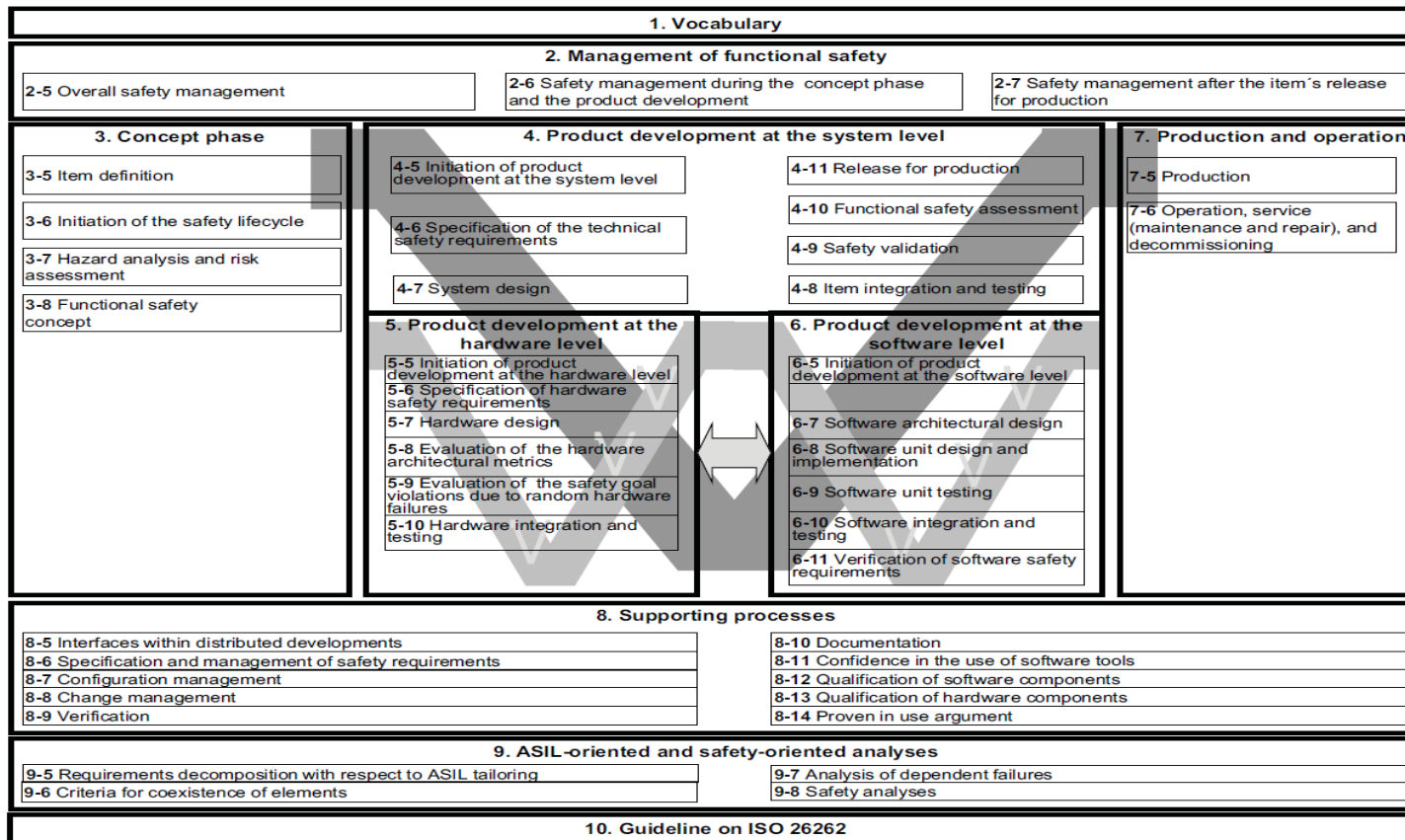
# Flowchart of Model Based Design





3.

## The application of MBD in functional safety projects MBD在功能安全项目中的应用



# Safety relevant functionalities

KOSTAL has many years of experience in safety management, starting with IEC61508 projects in 2003 (SIL3)

ISO26262 is managed by KOSTAL since 2010

There are 18 engineers have AFSP(Automotive Functional Safety Professional) certificate

## ISO 26262 references (assessed projects)

### ASIL-C/D:

- VW PQ25 Steering Angle Sensor (ASIL-D)
- SGM Electric Steering Column Lock(ASIL-D)
- Daimler BR222 Steering Angle Sensor (ASIL-D)

### ASIL-B:

• • • • •



**Assessmentbericht für das sicherheitsgerichtete Mantelrohrschaltermodul MRSM BR222/205**

**Versions-Nr.:** 1.0  
**Erstellungsdatum:** 2013-07-31  
**Prüfberichts-Nr.:** SEBS-A.072706/13TB  
**Produkt:** Mantelrohrschaltermodul MRSM BR222/205  
**Auftraggeber:** Leopold Kostal GmbH & Co. KG  
 An der Bellmerlei 10  
 58513 Lüdenscheid

**Auftragsnummer:** G.SEB.BS.03.001.08.031  
**Prüfstelle:** TÜV NORD Systems GmbH & Co. KG  
 Functional Safety  
 Halderstr. 27  
 86150 Augsburg  
 Germany  
**Verfasser:** Josef Neumann

**Review:** Bianca Pfluff

*Neumann*  
*B. Pfluff*

Dieser Technische Bericht darf nur in vollständigem Wortlaut wiedergegeben werden.

**Standards**  
 ISO 26262: 2011  
 • Lenkwinkelsensor, ASIL-D  
 Straßenfahrzeuge - Funktionale Sicherheit









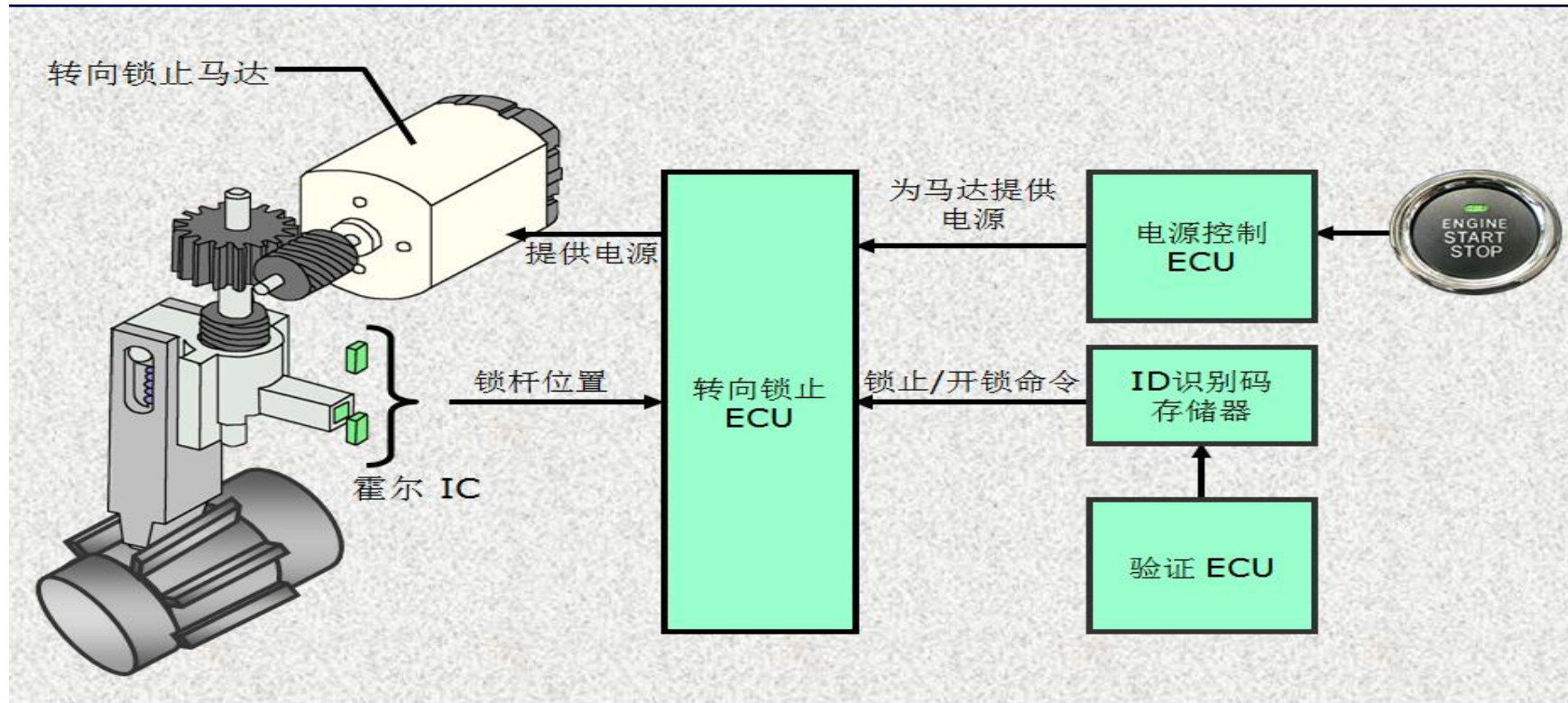
## Example

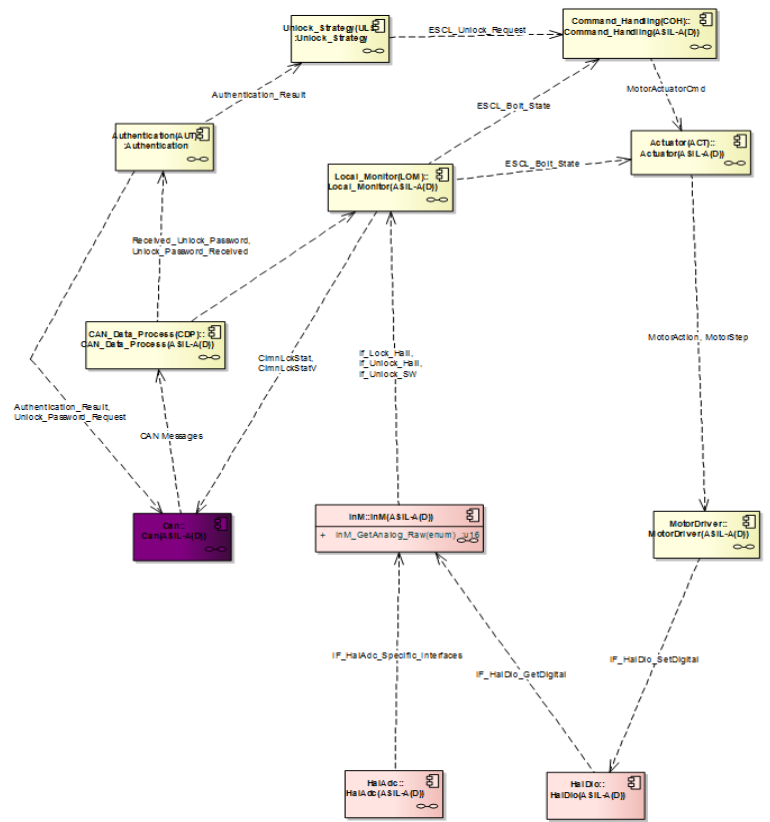
转向锁止作动器 (带转向锁止ECU)





## Example





## Software unit testing

| Methods |  | ASIL |    |    |    |
|---------|--|------|----|----|----|
|         |  | A    | B  | C  | D  |
| 1a      | Requirements-based test (a)  | ++   | ++ | ++ | ++ |
| 1b      | Interface test   | ++   | ++ | ++ | ++ |
| 1c      | Fault injection test (b)   | +    | +  | +  | ++ |
| 1d      | Resource usage test (c)  | +    | +  | +  | ++ |
| 1e      | Back-to-back comparison test between model and code, if applicable (d) | +    | +  | ++ | ++ |

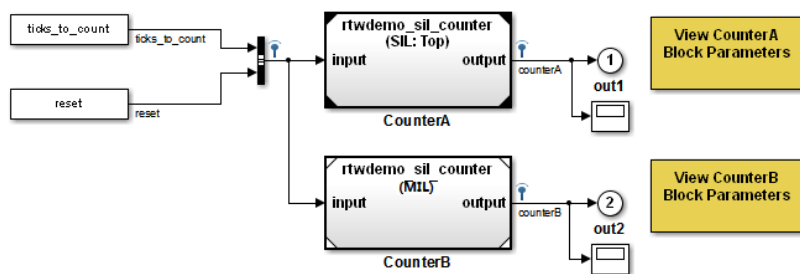
## Methods for deriving test cases for Software unit testing

| Methods |  | ASIL |    |    |    |
|---------|--|------|----|----|----|
|         |  | A    | B  | C  | D  |
| 1a      | Analysis of requirements                           | ++   | ++ | ++ | ++ |
| 1b      | Generation and analysis of equivalence classes (a) | +    | ++ | ++ | ++ |
| 1c      | Analysis of boundary values (b)                    | +    | ++ | ++ | ++ |
| 1d      | Error guessing (c)                                 | +    | +  | +  | +  |

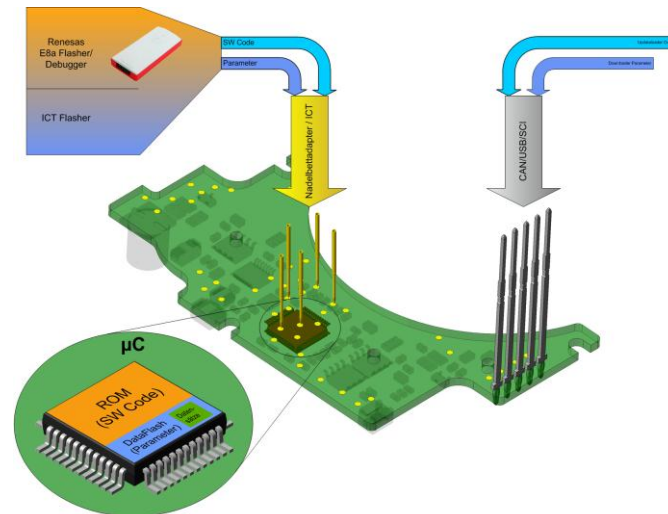
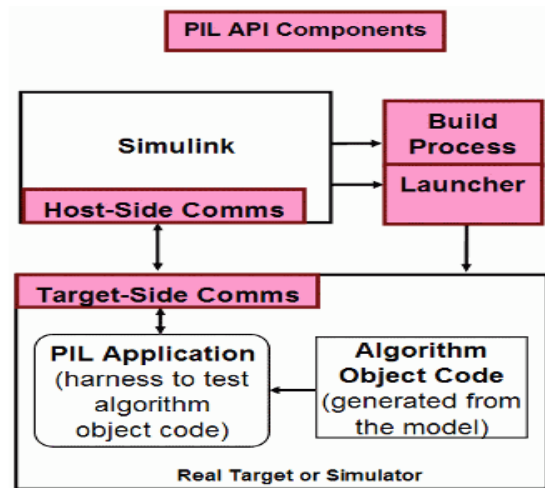
## Structural coverage metrics at the software unite level

| Methods |  | ASIL |    |    |    |
|---------|--|------|----|----|----|
|         |  | A    | B  | C  | D  |
| 1a      | Statement coverage                           | ++   | ++ | +  | +  |
| 1b      | Branch coverage                              | +    | ++ | ++ | ++ |
| 1c      | MC/DC (Modified Condition/Decision Coverage) | +    | +  | +  | ++ |

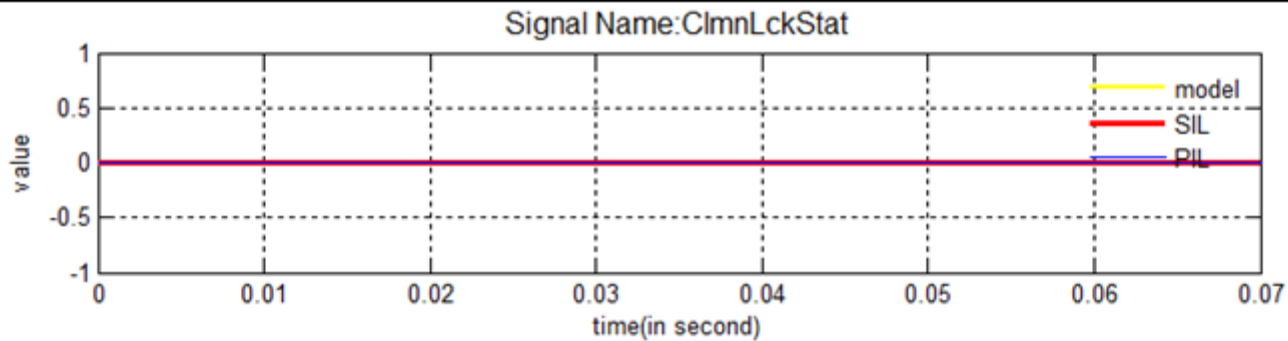
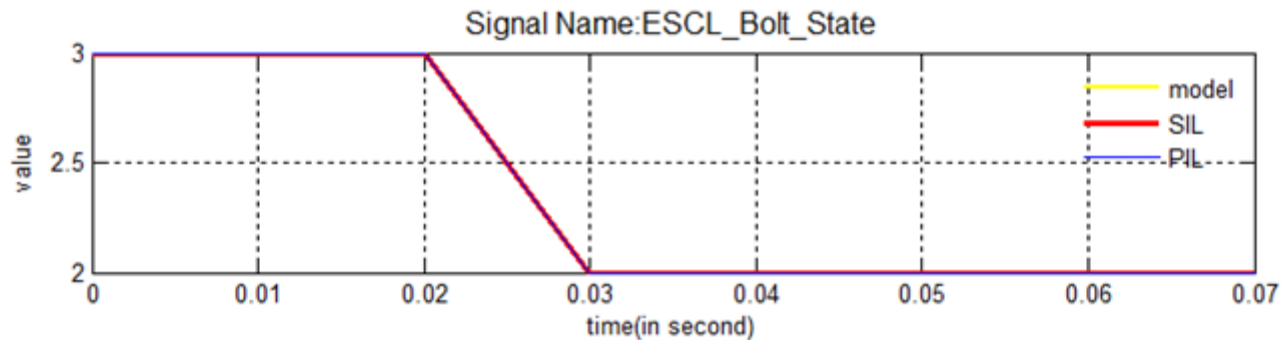
## SIL TEST



## PIL TEST



## This is test case1



## Manual code

- Long test time
- Multi Test Tools
- More Test Cases

## Model

- More effective when executive test
- Test case reuse saves time
- Test result visualization

## Advantages of Model-Based Design

