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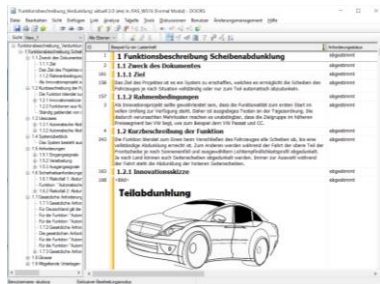
Rapid-prototyping of complex traffic functions with the help of real and simulated test fields

Prof. Dr.-Ing. Stefan Kubica, 23. Februar 2017

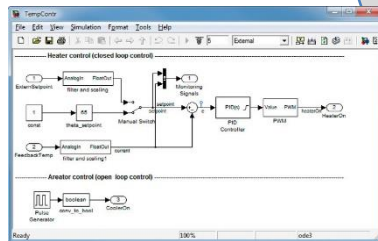
- Testing of conventional automotive functions
- New generation of cooperative functions
- Challenges of testing
- Testing with help of simulation
- Testing with help of testbed

Testing of conventional automotive functions

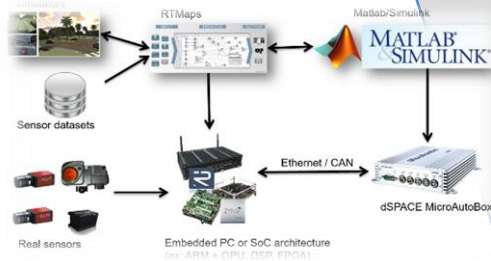
- Model-based development and testing with use of V-model



Requirements



Modeling



Rapid prototyping



Electronic control unit(s)



Test track



Test bench

Hardware in the loop(s)

```

9      * @assert (1, 1) == 2
10     * @assert (1, 2) == 4
11     */
12     public function add($a, $b) {
13         return $a + $b;
14     }
15
16     public function subtract($a, $b) {
17         return $a - $b;
18     }
19
20     ...
    
```

Code Coverage: 50.00 %

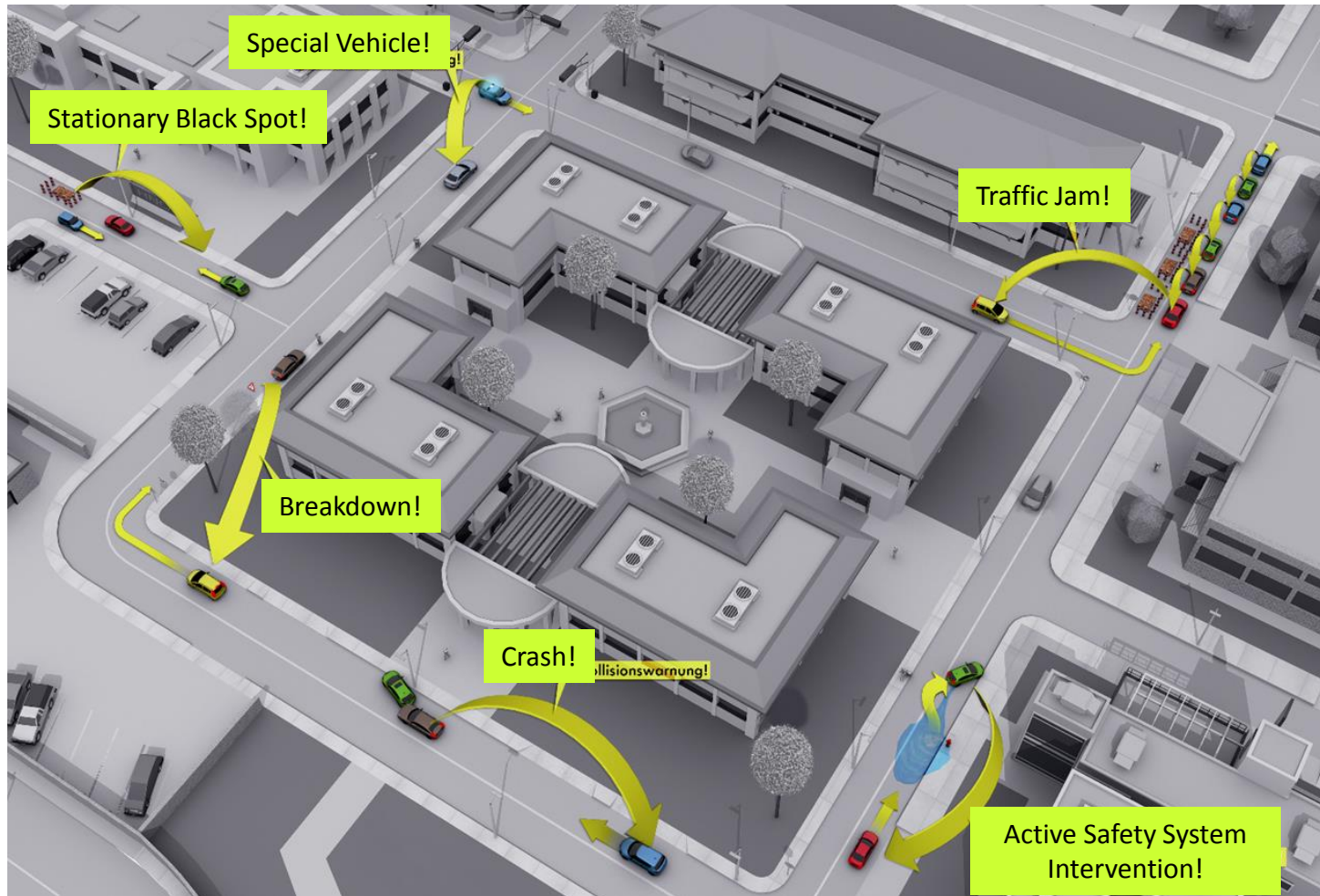
Software/Unit testing

Design

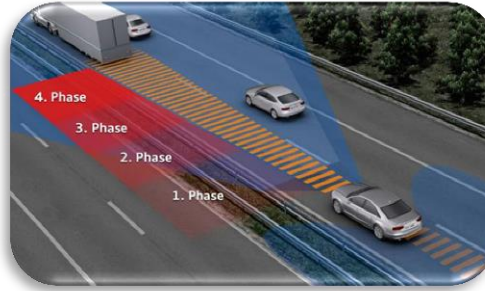
Integration

New generation of cooperative functions

- Set of „Day One“-cooperative warning functions (using WLAN 802.11p)



Challenges of „cooperative testing“



Aspects (Selection)	Conventional function	Cooperative function
(Approval) Test Drive	OEM-distinct test tracks	OEM-overall test tracks and infrastructure needed
Test cases	Execution-tasks, pre- and post-conditions are specified for the specific car and/or needed test objects	Complex test szenarios have to be specified
Reproducibility of tests	Several test facilities at the OEM, defined processes, depending on Test target	Large areas with several kind of street infrastructure needed
Monitoring and documentation of test execution	Permanently installed equipment in the area or inside the car for measurements	Server/client-architecture needed to check the participants permanently
Timeline	Car-specific development life cycle	Confidential entry timeline of cars, chicken-egg-dilemma

Challenges of „cooperative testing“

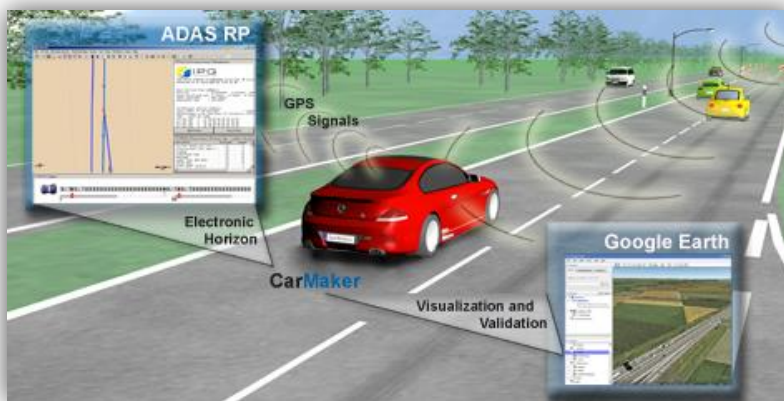
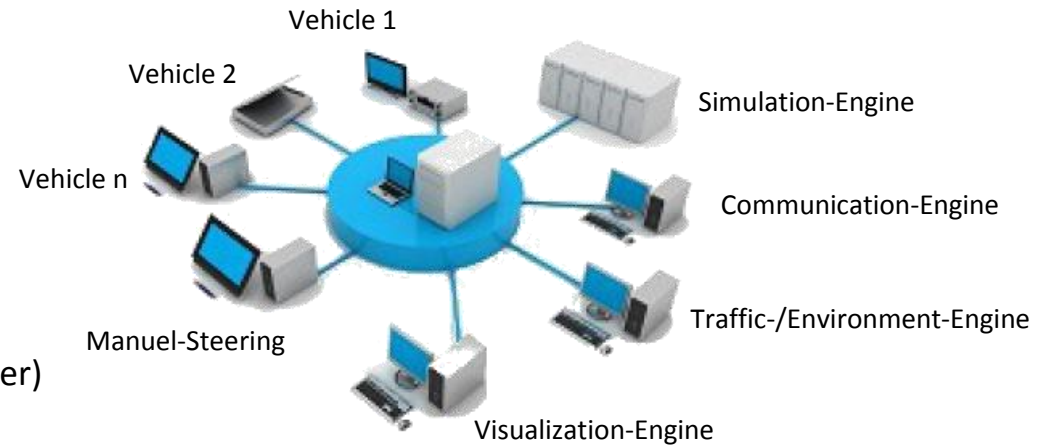
Testing with help of simulation

Simulation for first development level

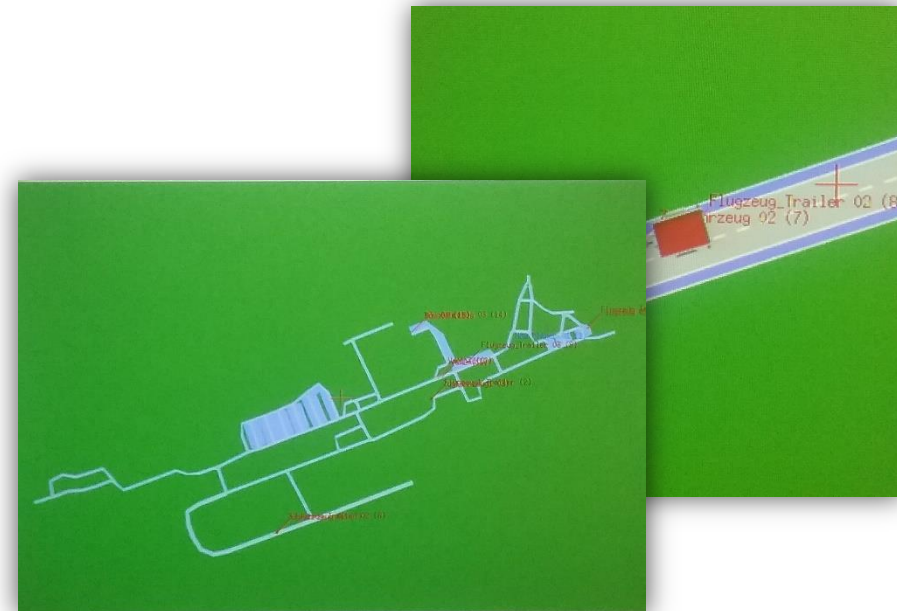
- Test of communication issues (only some)
- Test of main functionality

Limits of simulation

- Each entity has to be simulated (e.g. Weather)
- Complex computer farm needed
- Cross-cutting concerns are difficult to be included (Security & Safety, interruptions, ...)



Virtual Test Drive – Visualization example out of the automotive domain (src: CarMaker)



Virtualization of infrastructure and vehicles

Testing with help of testbed

Extension of simulation with real world aspects

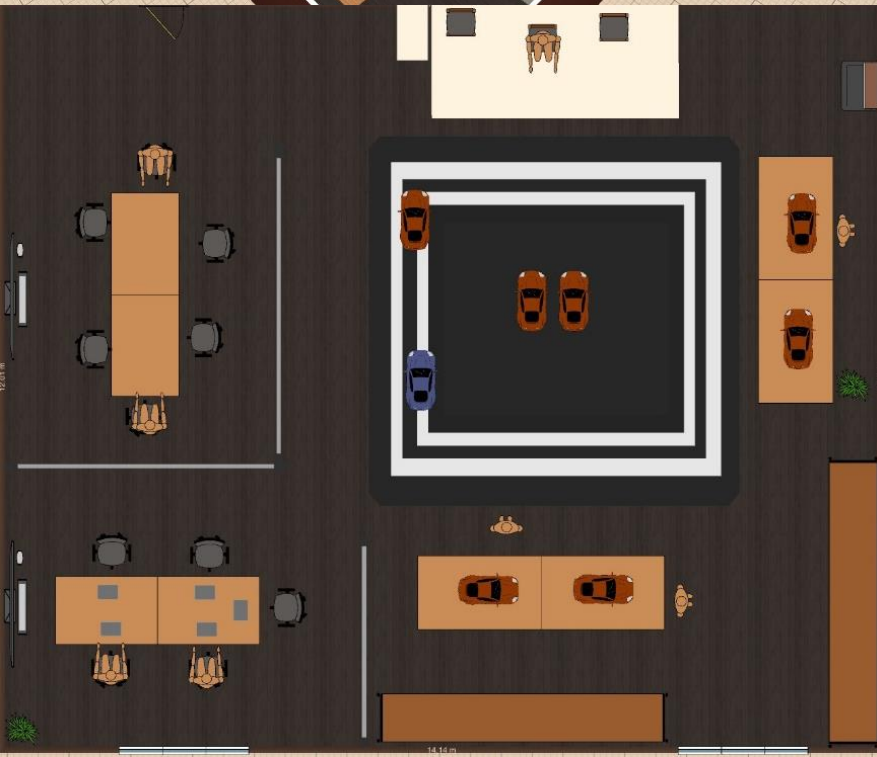


Disadvantage

- No real driver in the car → communication leads to autonomous driving

Advantage

- WYSIWYG (visualization in real life, real communication performance and aspects)
- Development environment for wide range of stakeholders (sensor-/aktor-/function-developer, public affairs, demonstration, multi-user-tests, cross-cutting concerns)

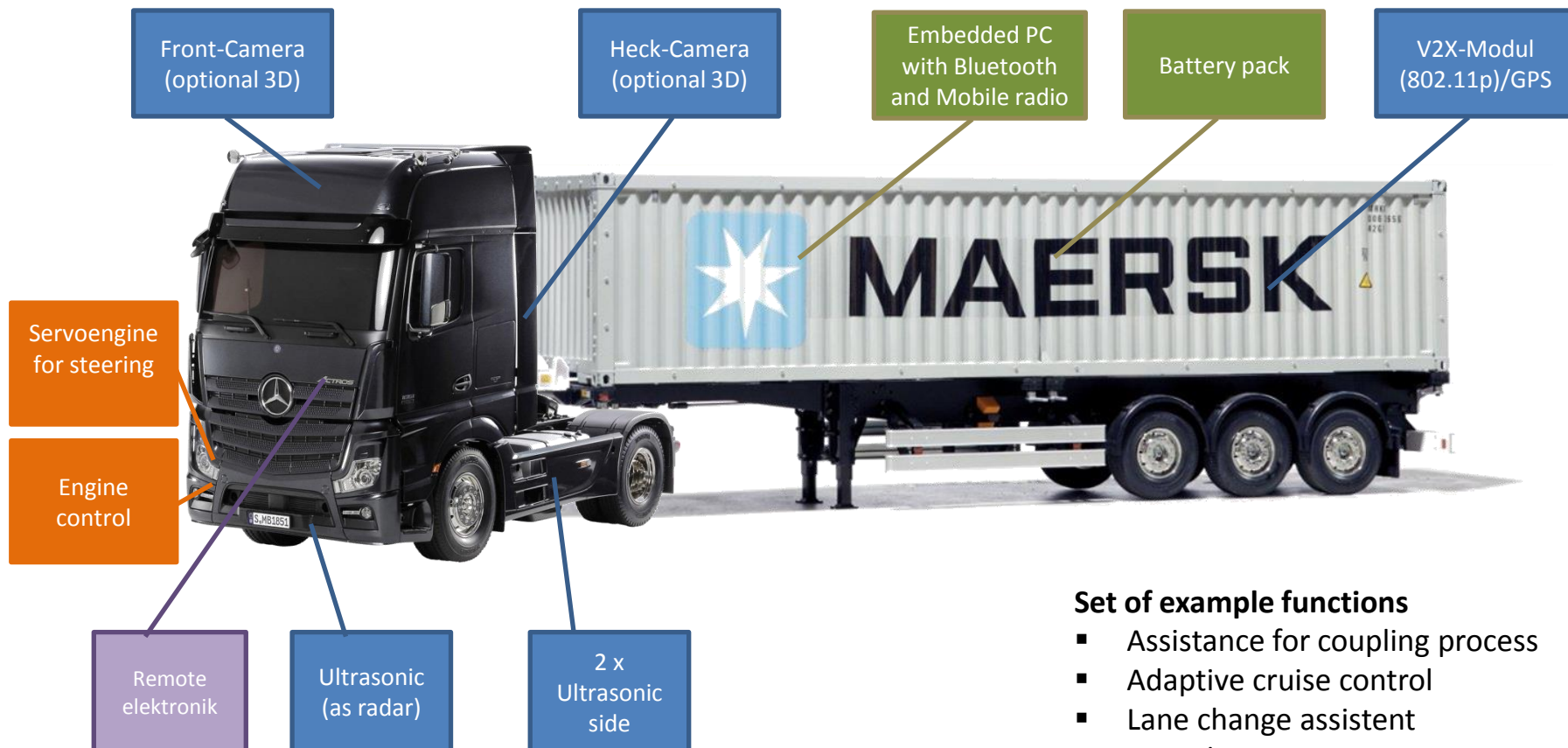


Testing with help of testbed

Model car in scale 1:14

Requirements and equipment

- Indoor operation (Outdoor use follows later)
- Prototype for fleet of cars
- Virtual Traffic Management Server



Set of example functions

- Assistance for coupling process
- Adaptive cruise control
- Lane change assistent
- Lane departure warning
- ...

Challenge for the future of testing



Src: Youtube.com