



Iterative Design Process For The Development And Testing Of Cooperative Applications

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Short Introduction – DLR and Institute TS



Deutsches Zentrum
DLR für Luft- und Raumfahrt e.V.
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German Aerospace Center

Areas of Research

- Aeronautics
- Space
- Transport
- Energy

DLR in numbers

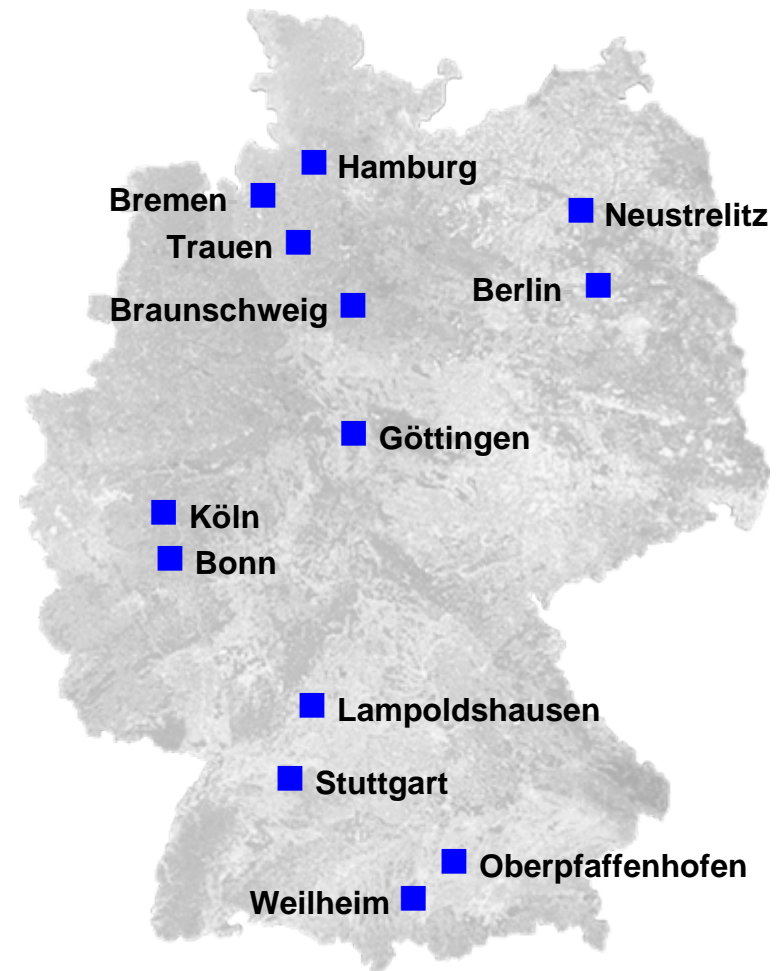
- Budget:
 - 2006 1.168 M Euro
 - 2007 1.224 M Euro



Locations and Employees

5.600 employees work at
28 research institutes and facilities
at ■ 13 locations.

Offices in Brussels,
Paris and Washington.

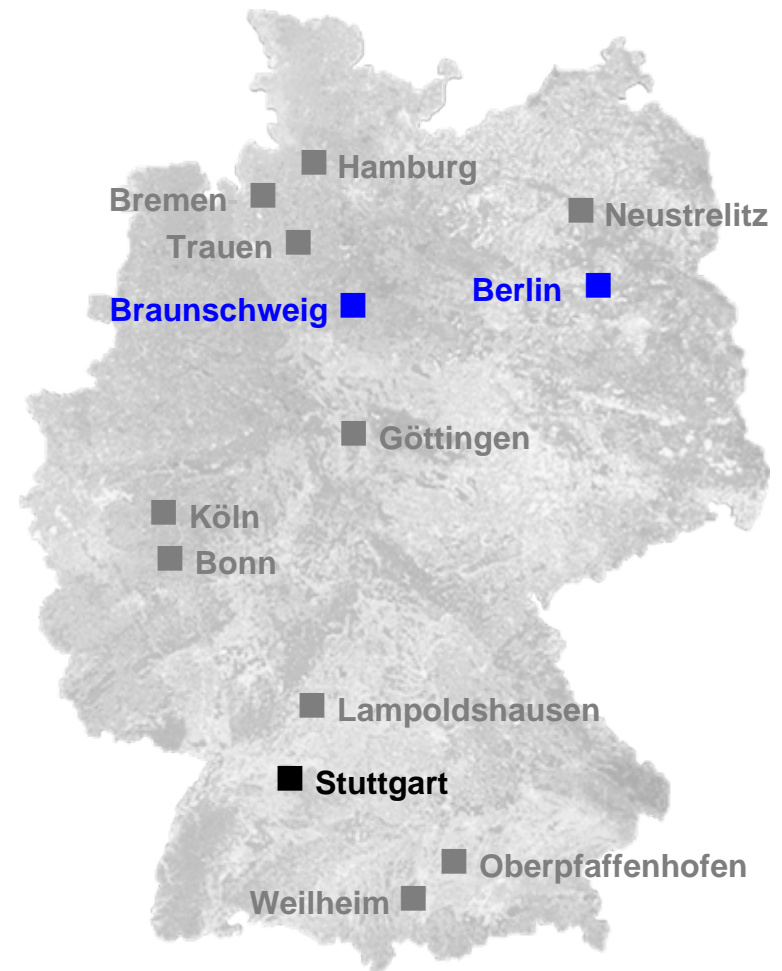




Transportation

Participating institutes

- Institute of Transport Research
- Project Transport Studies
- **Institute of Transportation Systems**
- Institute of Vehicle Concepts
- ... and 21 more institutes from aeronautics, space and energy



Institute of Transportation Systems

Residence: Braunschweig and Berlin
Since: March 2001
Director: Prof. Dr.-Ing. Karsten Lemmer
Employees: Presently 100 employees
from various scientific disciplines

Range of tasks

- Basic research
- Creating concepts and strategies
- Prototype development

Fields of Research

- Automotive
- Railway Systems
- Traffic Management





Iterative Design Process Overview

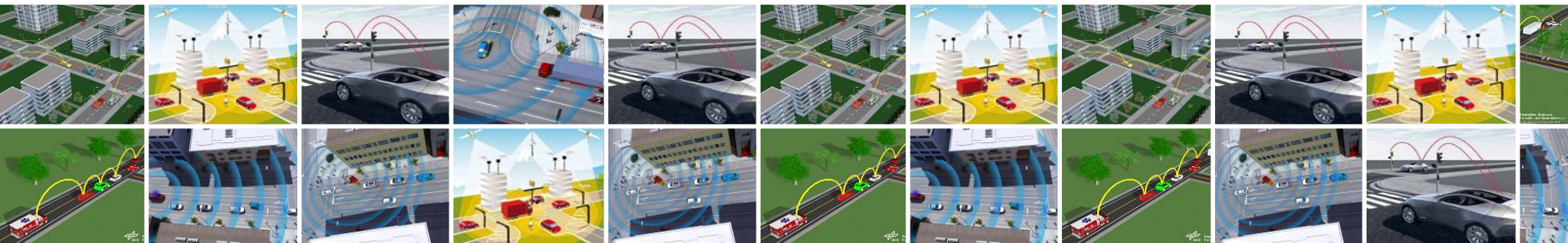


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Iterative Design Process

Introduction and Motivation

- The determination of requirements for cooperative assistance and automation based on Car-to-X technologies emphasize research questions on different levels – e.g.
 - Reliability / availability
 - Interoperability of assistance and automation systems / security
 - Different penetration rates and their influence on the function of the system, traffic safety/-efficiency, driver behavior and acceptance





Iterative Design Process

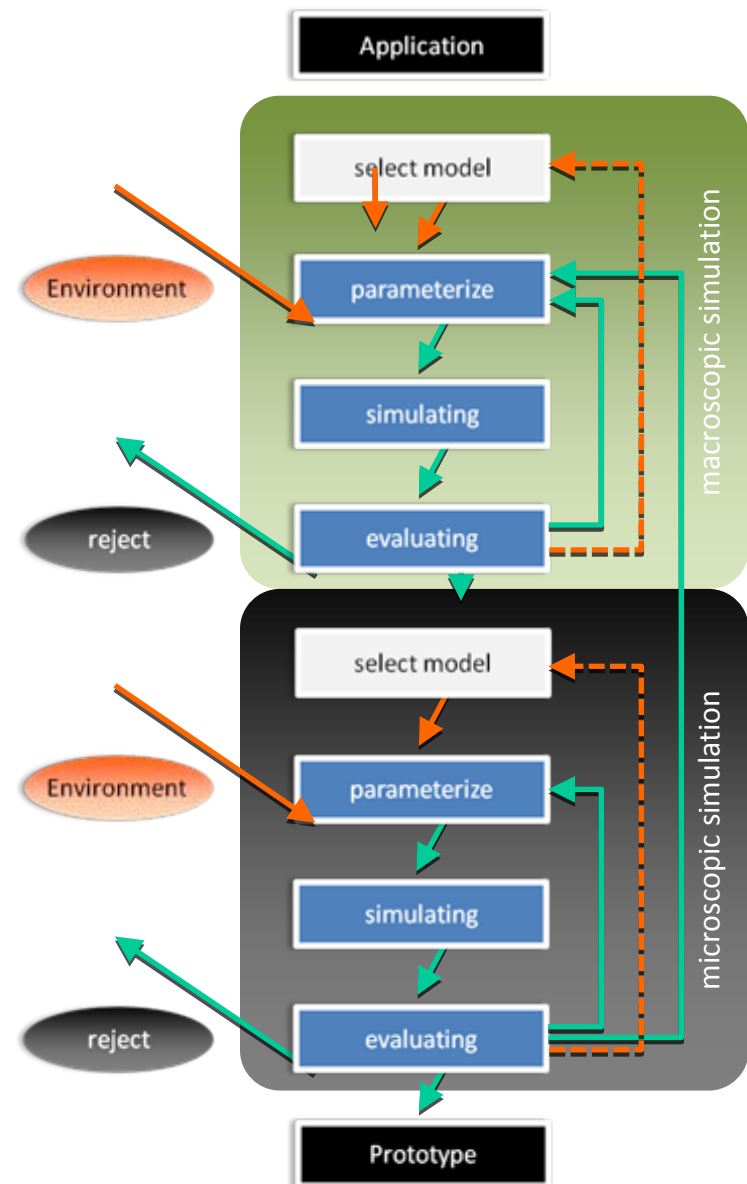
Introduction and Motivation

- Increasing importance of conducting simulation tests during the development and evaluation process because
 - Basically field operational tests (FOTs) are applicable **but**
 - Large number of equipped vehicles
 - Huge testing areas especially urban areas required
 - Immense costs
 - Influence of different penetration rates
- To run these simulation tests systematically by using the right simulators an iterative design process including guidelines and code of practice is indispensable



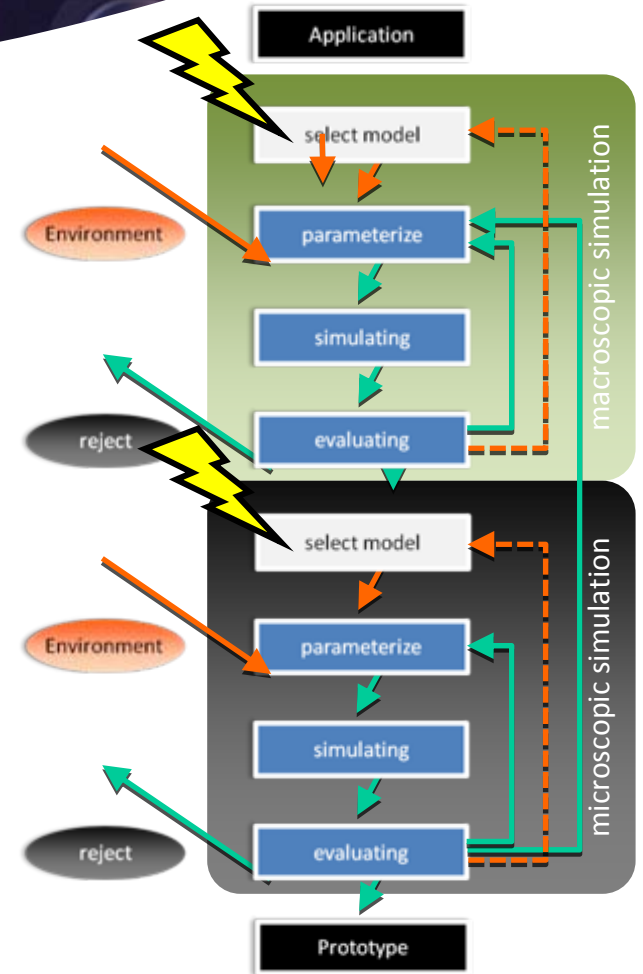
Iterative Design Process Overview

- Different steps within this process
 - Accident analysis provides an application idea
 - Study statistics on road accidents
 - Reasons for the accidents
 - Development and testing of the application within different scenario views
 - Model selection
 - Parameterization
 - Evaluation
- Prototype as final outcome



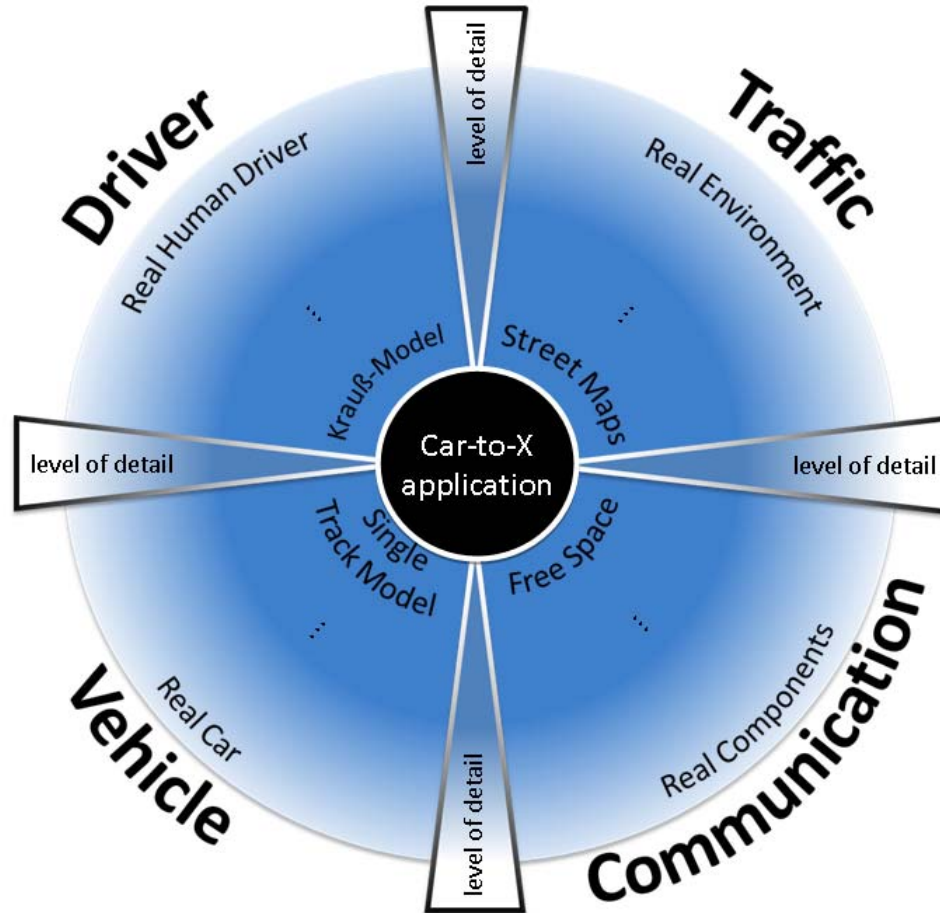


Iterative Design Process Model Selection



Iterative Design Process

Model Selection I – Overview





Iterative Design Process

Model Selection II – Background

- Often Simulators/Models are used which are not applicable for the current research question because
 - Too many unknown parameters within the model
 - Environmental influences are not considered
- **Non-transferability of the results to the real world**
- Example
 - Often NS-2 is used with non-deterministic communication model but
 - Not applicable for the investigation of safety applications in urban environments
 - Buildings and other cars are not considered for the communication



Iterative Design Process

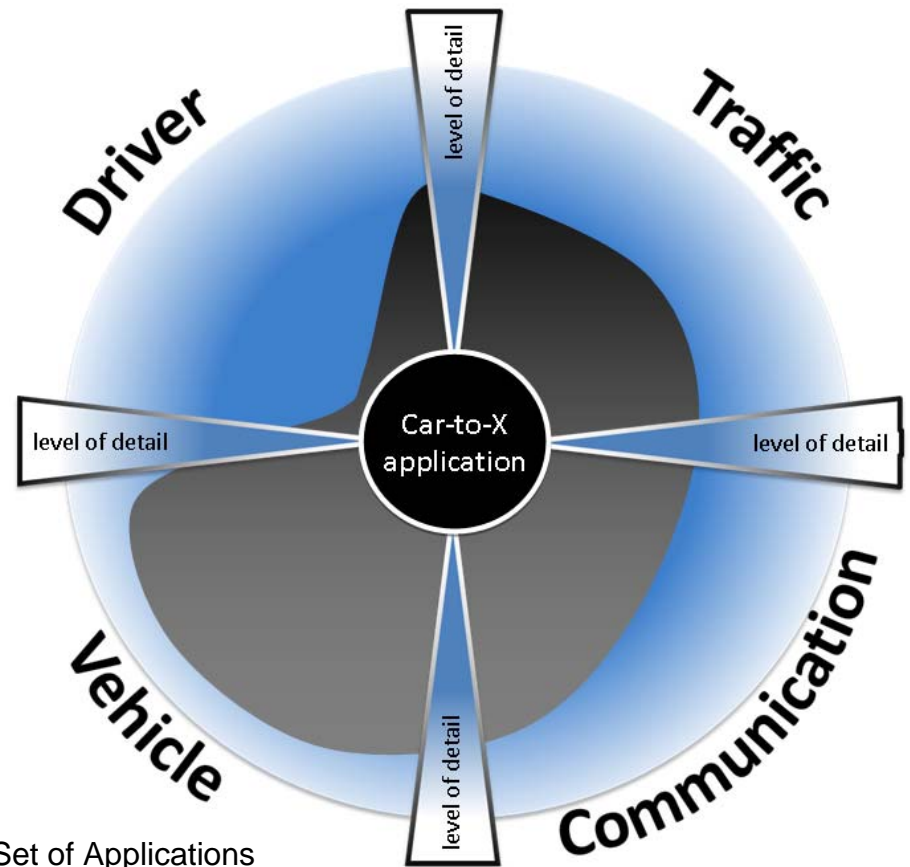
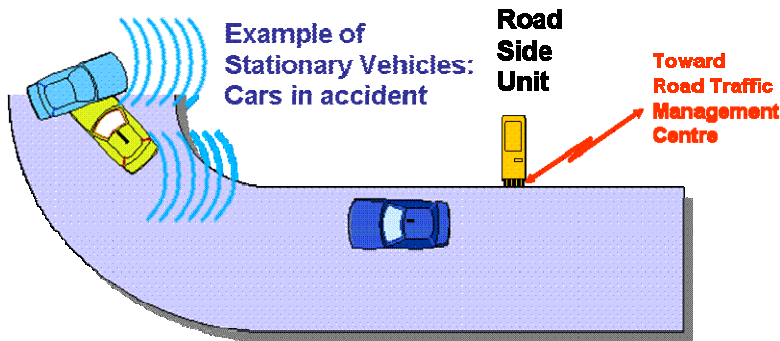
Model Selection III – Key Parameters

- Two main key parameters for model selection
 - **Scenario scale**
 - Macroscopic
 - Traffic flows in huge areas
 - Traffic Management
 - Microscopic
 - Certain parts of the traffic flow
 - Safety critical applications
 - Communication aspects (e.g. message propagation)
 - **The description of the Car-to-X application**
 - Requirements
 - Intended Effect
 - Performance Indicators
 - ...

Iterative Design Process

Model Selection IV – “Stationary Vehicle Warning”

- Example – “Stationary Vehicle Warning” (ETSI BSA¹)
 - Informs the driver about a stationary vehicle
 - Safety application
 - Microscopic view only



¹ European Telecommunications Standards Institute Basic Set of Applications



Iterative Design Process

Model Selection V – “Stationary Vehicle Warning“

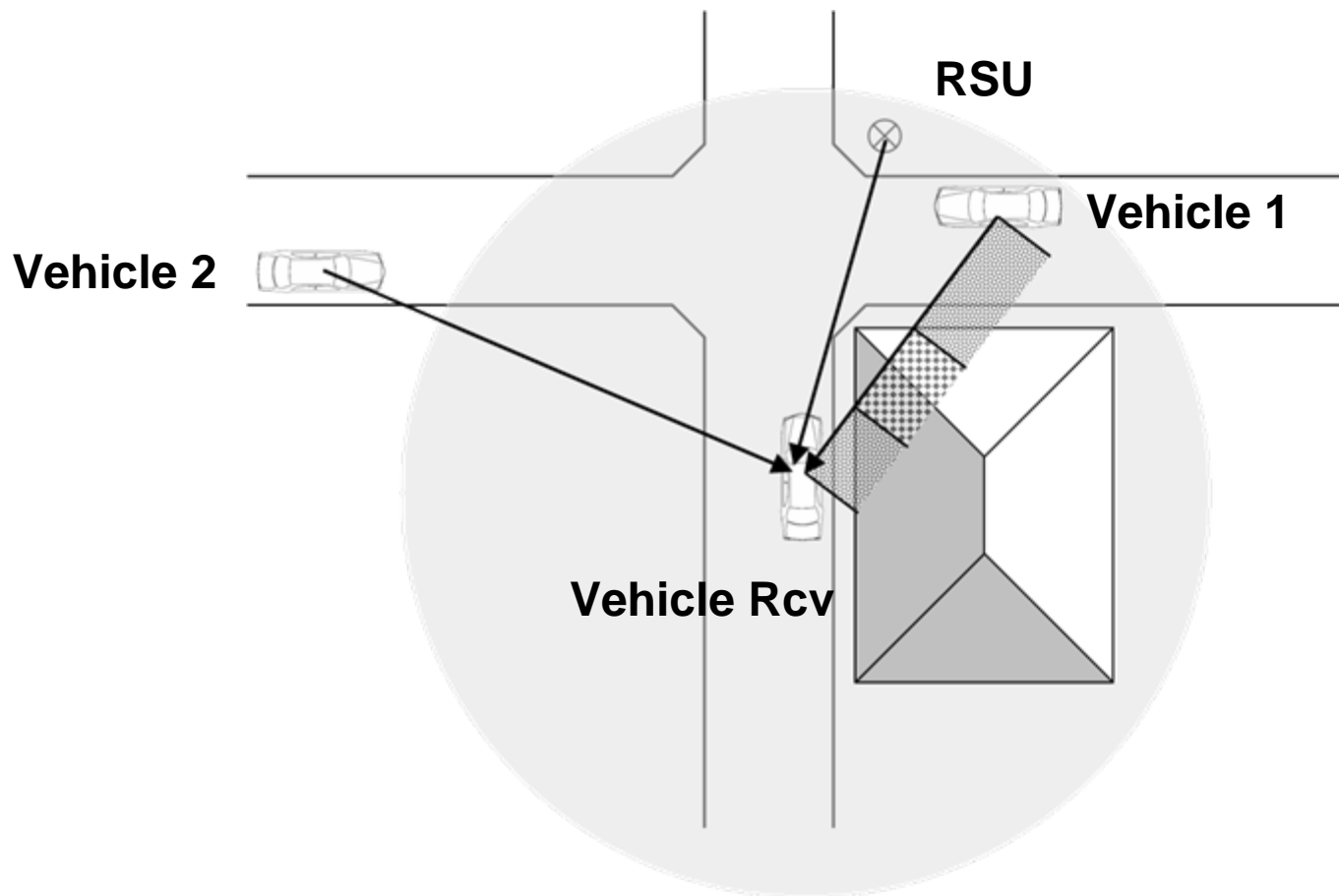
- **Communication Model**
 - **Environmental influences**
 - **Deterministic message propagation**
 - **No simulation of ISO/OSI layers like MAC/NET/TRA**
 - **Latency times, Sample frequency**
 - **Signal Damping**
 - **Communication range**
- **Driver Model of surrounding traffic**
 - e.g. Krauß model
- **Vehicle Model of ego vehicle**
 - Non-linear two track model
- **Traffic**
 - e.g. VISSIM, SUMO, ...





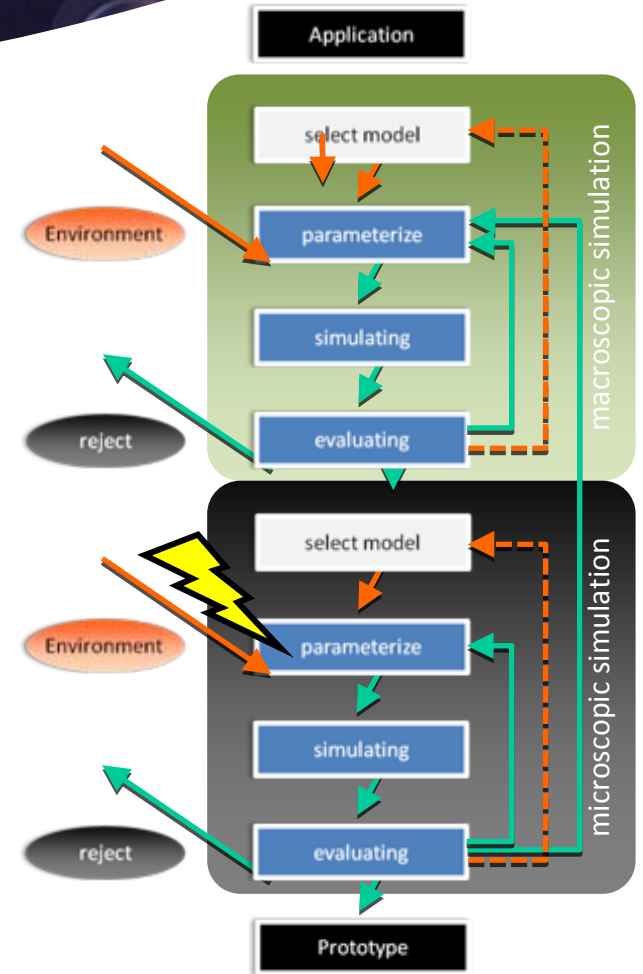
Iterative Design Process

Model Selection VI – Communication Simulator





Iterative Design Process Model Parameterization





Iterative Design Process

Model Parameterization I – Overview

- Different models provide different influencing parameters
- Some of the parameters have to be varied and some are fixed within the simulation
 - Static parameters
 - Variable parameters
- Variable parameters are varied until the intended effect of the application can be verified
 - Traffic management
 - Macroscopic scenario view
 - e.g. identification of penetration rate and needed communication range to achieve the intended effect
 - Microscopic scenario view
 - Validation of the identified parameters by considering environmental influences, too



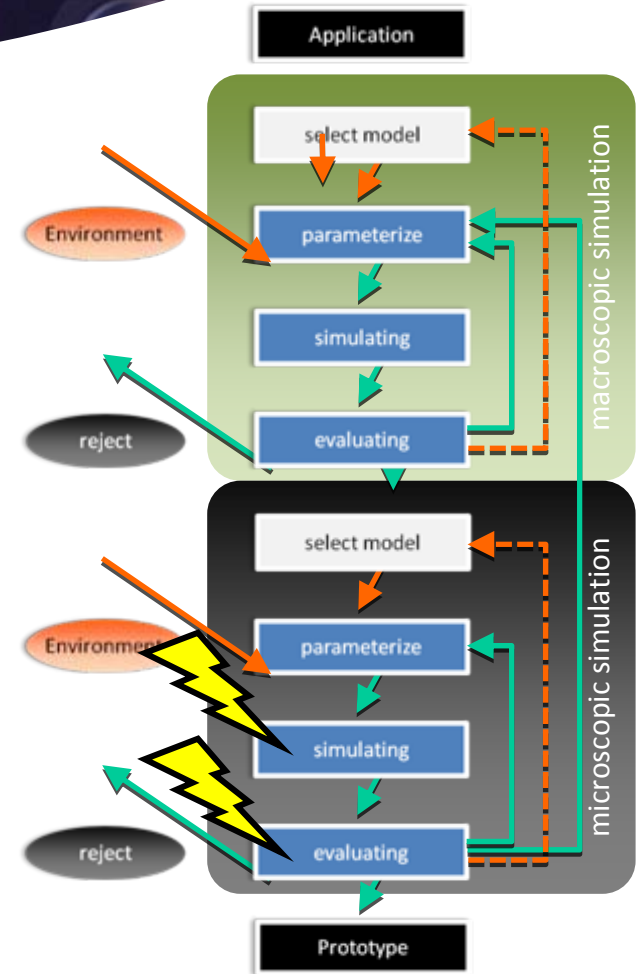
Iterative Design Process

Model Parameterization II – “Stationary Vehicle Warning“

- Stationary Vehicle Warning – Safety application
 - One aim could be the investigation of communication aspects and their influence on driver behavior
 - Intended effect
 - e.g. warn driver 300 m before traffic obstruction
 - Static parameters
 - Properties of environmental surroundings
 - Communication frequency 5.9 GHz
 - Variable Parameters
 - Transmitting power
 - Antenna position



Iterative Design Process Simulation / Evaluation





Iterative Design Process

Simulation/Evaluation – “Stationary Vehicle Warning“

- For the simulation trials
 - The static parameters are fixed
 - The variable parameters will be varied
 - Iterative process
 - Fix all variable parameters but one
 - Vary the one left
 - If the intended effect is not verifiable change one or more of the fixed parameters and restart process
 - Example
 - Fix antenna position
 - Vary the transmitting power



Iterative Design Process Conclusion



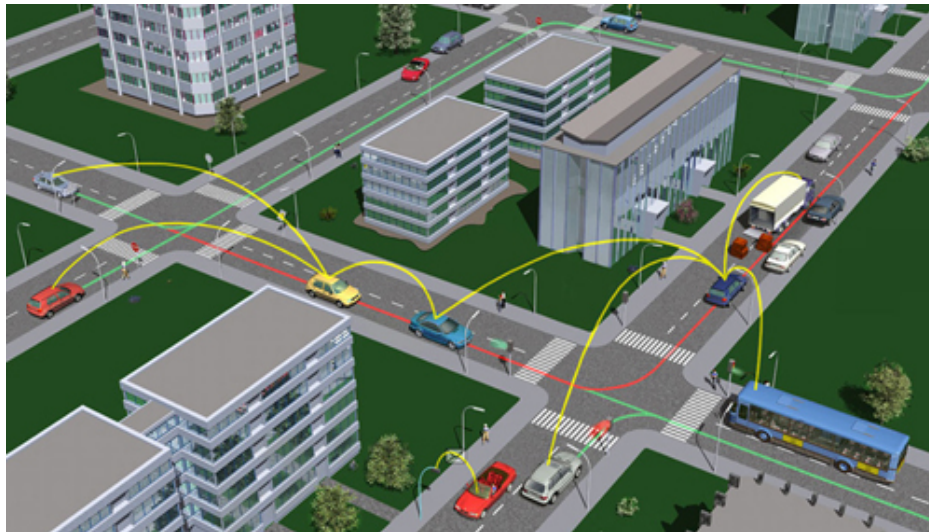


Iterative Design Process

Conclusion

- The iterative design process emphasize the importance of simulation in the area of Car-to-X systems
- Selection of the right simulator models is indispensable
 - For Car-to-X the focus is on communication simulation
- Choice of the right model parameters is important
- When running the iterative design process successfully for simulation it can be adapted to FOT
 - There the model selection process is omitted





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