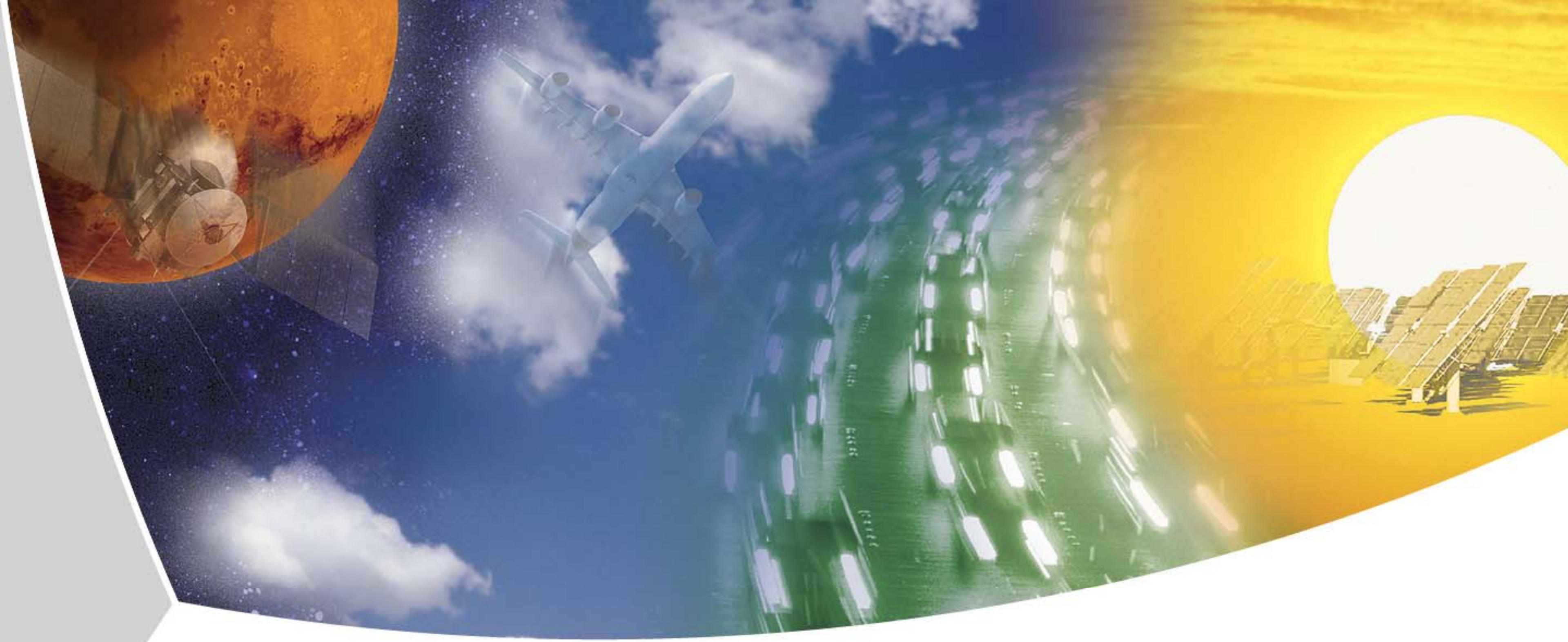

DLR Simulation Environment m^3

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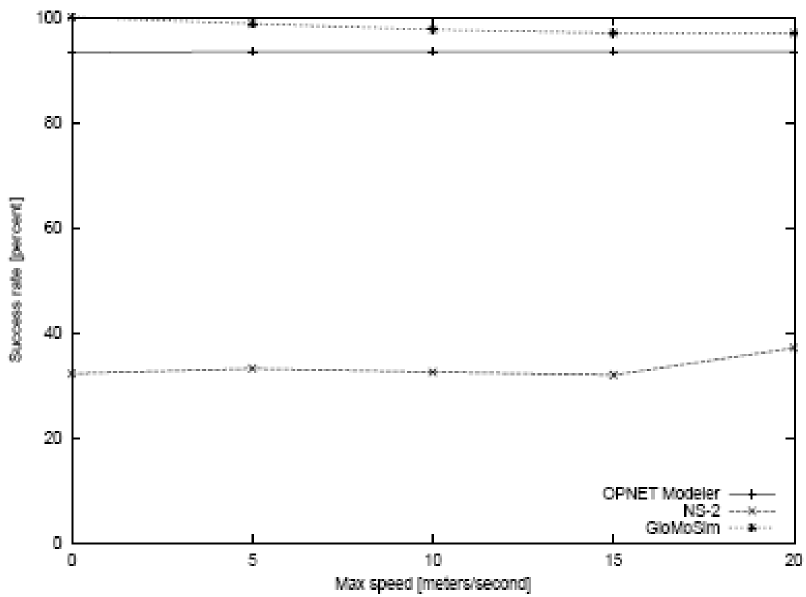
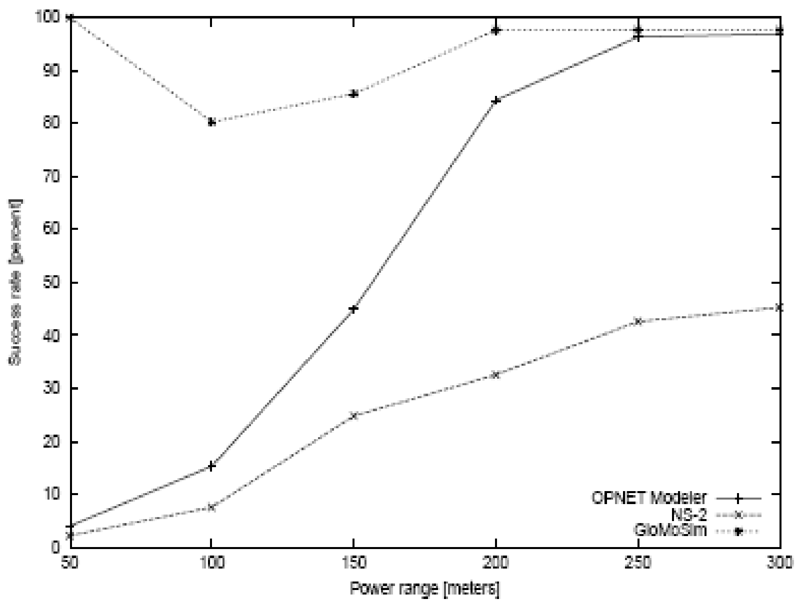
Motivation

Contradicting simulation results





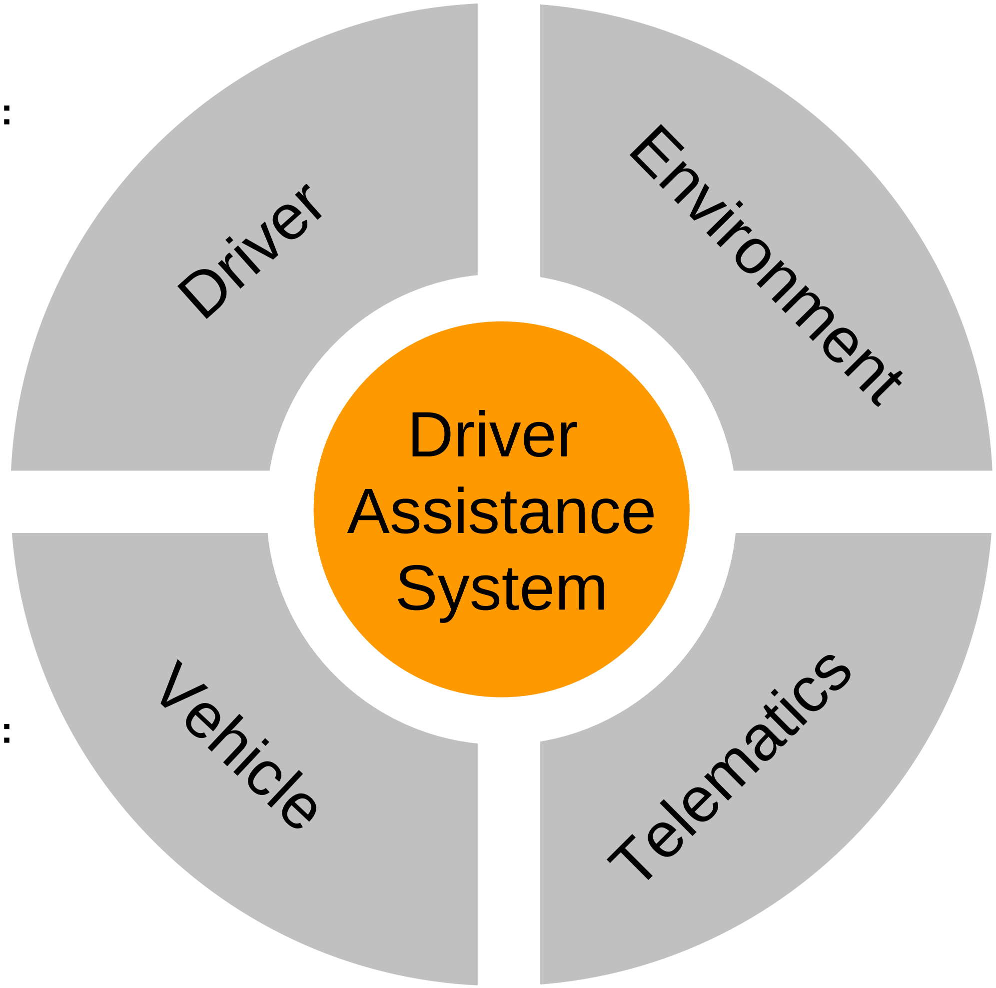
Source: Cavin et.al.: On the accuracy of MANET Simulators

Problem today: Different simulation environments use different models which generate different results

Simulation Environment

Alternative Models:
- Car Following
- Lane Changing
- Gap Acceptance

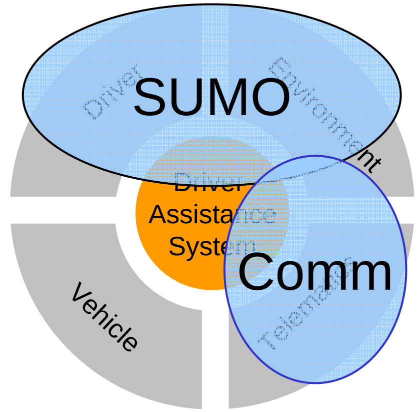
Alternative Models:
- GDF
- ESRI Shapefile
- OpenDrive



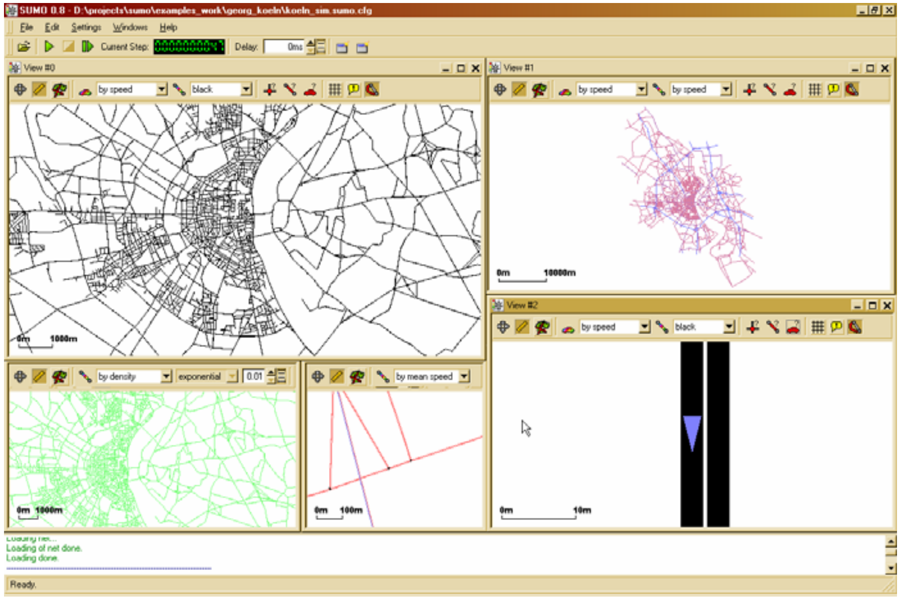
Alternative Models:
- CarSim
- VeDyna
- CarMaker

Alternative Models:
- Free Space
- Rayleigh Fading
- Rice Fading

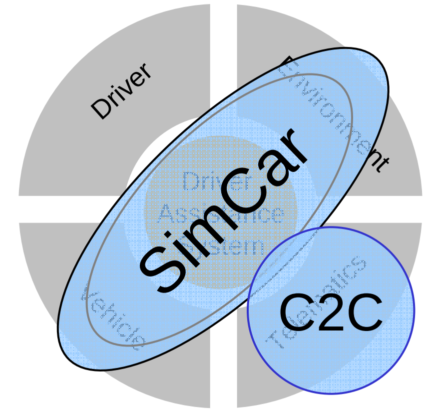
DLR Simulation Environment
SUMO



- **S**imulation of **U**rban **MO**bility (SUMO)
- C++ based, open-source simulation environment
- Microscopic, space continuous, time-discrete traffic simulation
- Multi-modality (cars, busses, trains, pedestrians, etc.)
- Output: visualization, file
- *Driver*: Krauß-Model
- *Environment*: various road network formats
- *Telematics*: Extension to support Inter-Vehicle-Communication



DLR Simulation Environment
Driving Simulator



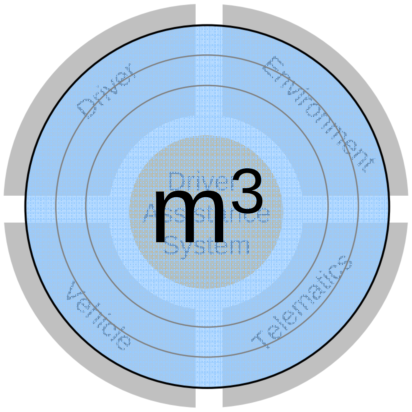
- Comprehensive research infrastructure for the development of future driver assistance functions
- Functional characteristics:
  - Analysis of driver behavior and requirements
  - Conception, design and test of assistance functions
  - Validation and verification of concepts
- Incremental support from virtuality to reality

Extending Simulation Environments

- Extending existing simulation environments by new components often causes incompatibilities of models because of:
  - Missing information
  - Incomplete information
  - Inaccurate information
- Examples:
  - Lane Change *Driver*-Model with ESRI Shapefile *Environment*-Model
    - Lane information is missing
  - Multi-path *Telematics*-Model with GDF *Environment*-Model
    - Information about buildings, vegetation, elevation, etc. is missing
- Modules of the simulation environment have to be aligned and fully integrated into the simulation environment

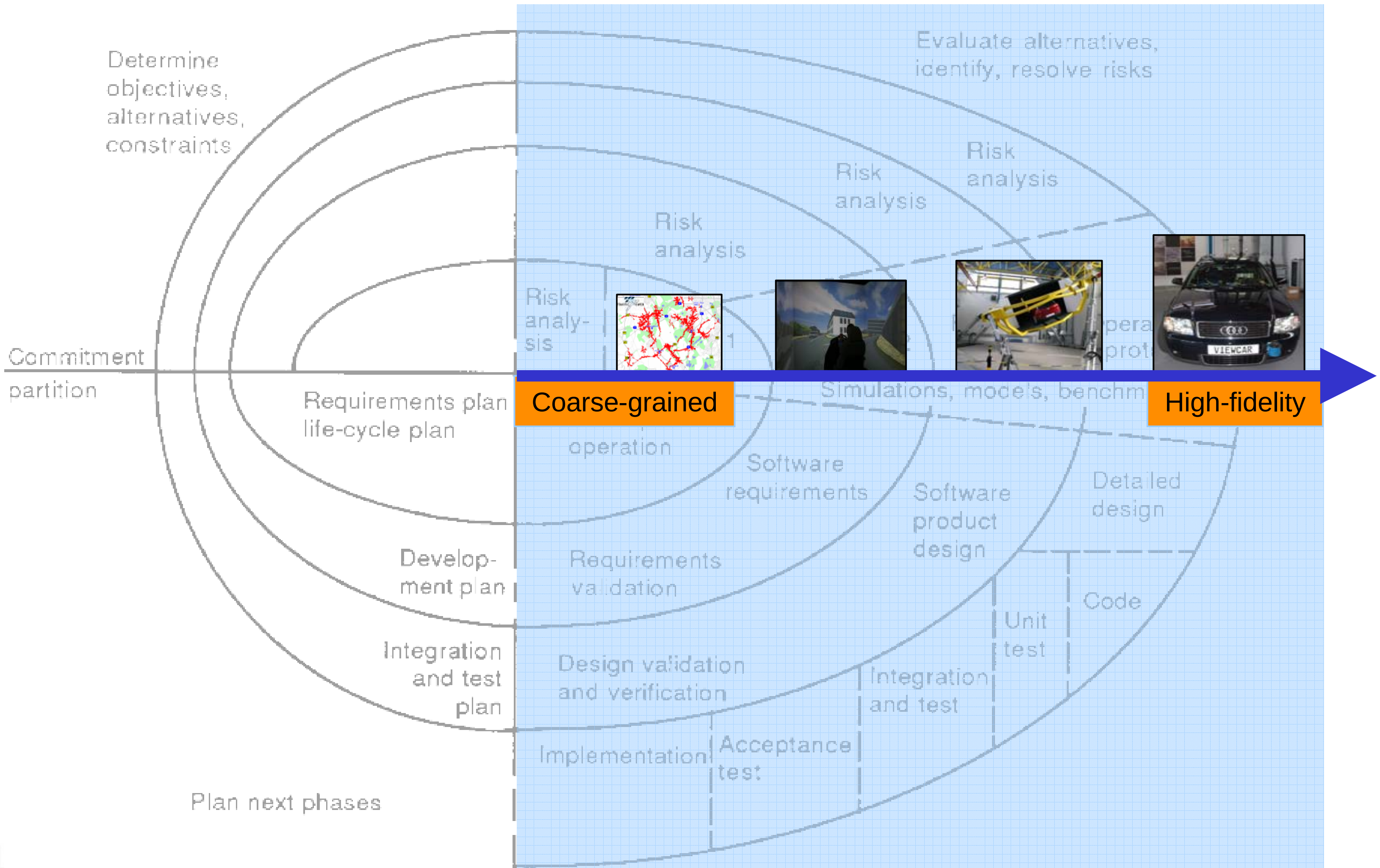
DLR Simulation Environment

m³ **m**ulti-modal **m**ulti-vehicle **m**obility simulation



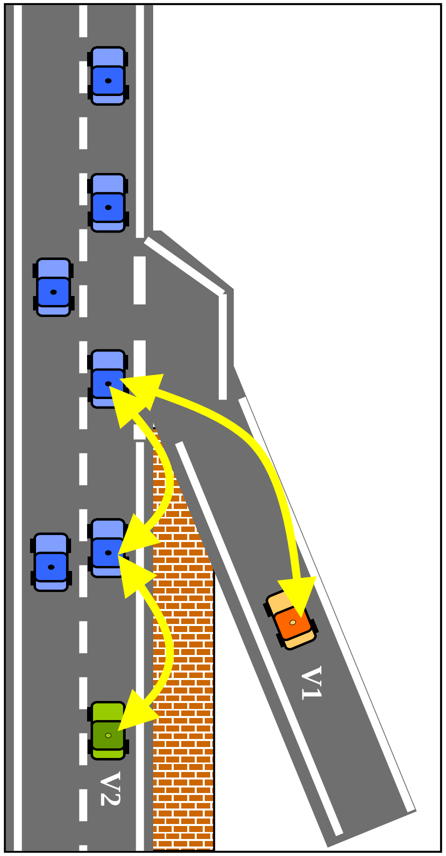
- Integrated tailorable simulation environment
- From course-grained to high-fidelity model selection
  - *Driver*: changeable behavior models
  - *Vehicle*: macroscopic to (sub)microscopic models
  - *Environment*: simplified to realistic models
    - Detailed mapping of real environments
    - 3D (buildings, vegetation, elevation, etc.)
    - Automatic generation with driving, satellite, overflight data
  - *Telematics*: simple information flow to detailed signal propagation models
- Incremental support: e.g. Driver(s)-in-the-Loop

m³ Support in Use-Case Development



C2C-CC Use-Cases

- C2C-CC has a list of more than 120 promising use-cases, e.g.:
  - V2V Merging Assistant
  - Pre-crash Sensing
  - Traffic Jam Ahead Warning
  - Traffic Signal Violation Warning
  - Remote Diagnostics
  - Map Downloads
- Too many use-cases for near-term demonstration, but not for simulation



Conclusions

- ITS Society requires a standardized, but highly adaptable simulation environment for a **reliable comparison** of novel algorithms and to show the **benefit** in safety, efficiency and/or comfort of novel use-cases
- Necessity of various defined models (from course-grained to high-fidelity) and inter-model dependencies for *Driver*, *Vehicle*, *Environment* and *Telematics*
- Independent modular test and certification environment is inevitable

Thank you for your attention!

Questions?

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