



# Dynamic Route Switching in CarMaker for Charge Stop Planning

Joint Project with KS Engineers & IPG Automotive



# Agenda

- **Motivation**
- **Basic Idea and Implementation**
- **Workflow in CarMaker**
- **Execution Example**
- **Functions and Limitation**
- **Conclusions**



# Motivation

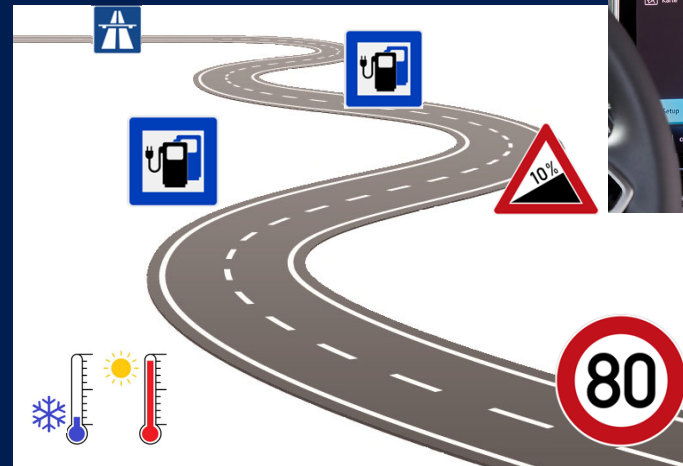
## – Specific functions in electric cars

- Precise range estimation
- Route planning with charging stops



## – Car Integration tests

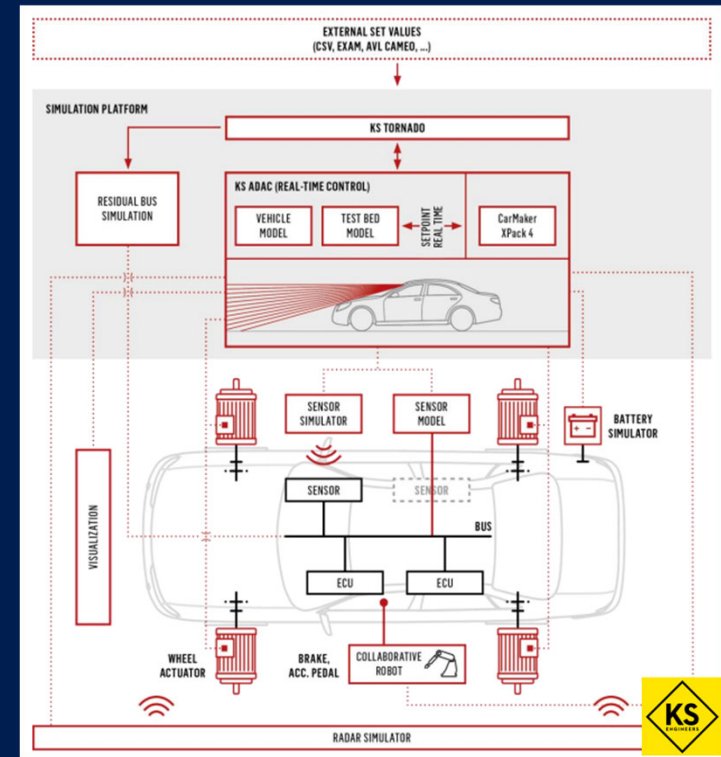
- Realistic road conditions
- Temperature conditions
- Charging characteristics
- Repeatable driving behavior



## ➤ Special test rig for reproducible tests needed

# Motivation

- Tests for electric cars on the Functional Integration Test rig (FIT)
    - Road load from route topology
    - GPS-positioning from simulation
    - Sensor stimulation
    - Climatical influences
    - Actuation in car by driving robot
    - Charging point
  - Environment simulation: CarMaker
- **Test rig setup covers all base requirements**



# Motivation

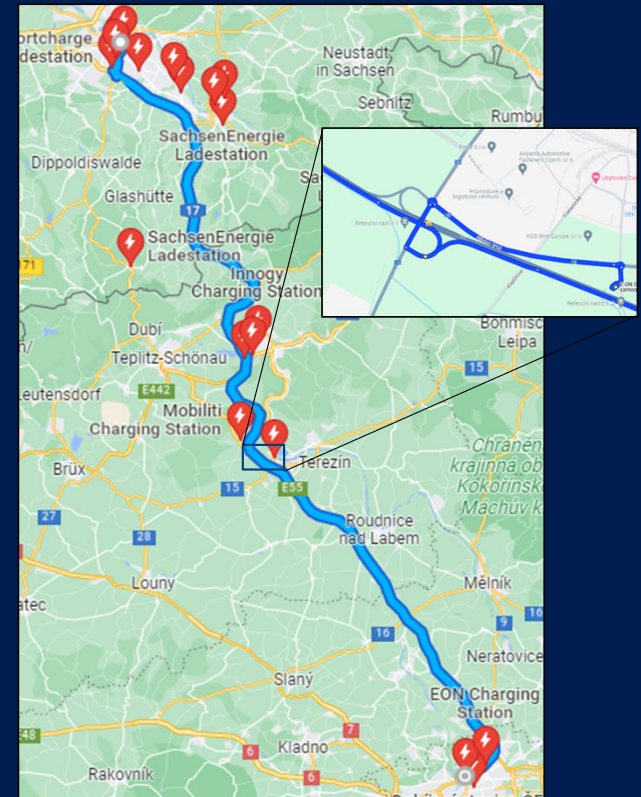
- First evaluation:
  - ✓ Range estimation
  - ✗ Charging strategy (Multi-Stop-Route-Planning)
- Problem:
  - Dynamic selection of charging points on the route needed
  - CarMaker requires static route definition at simulation start



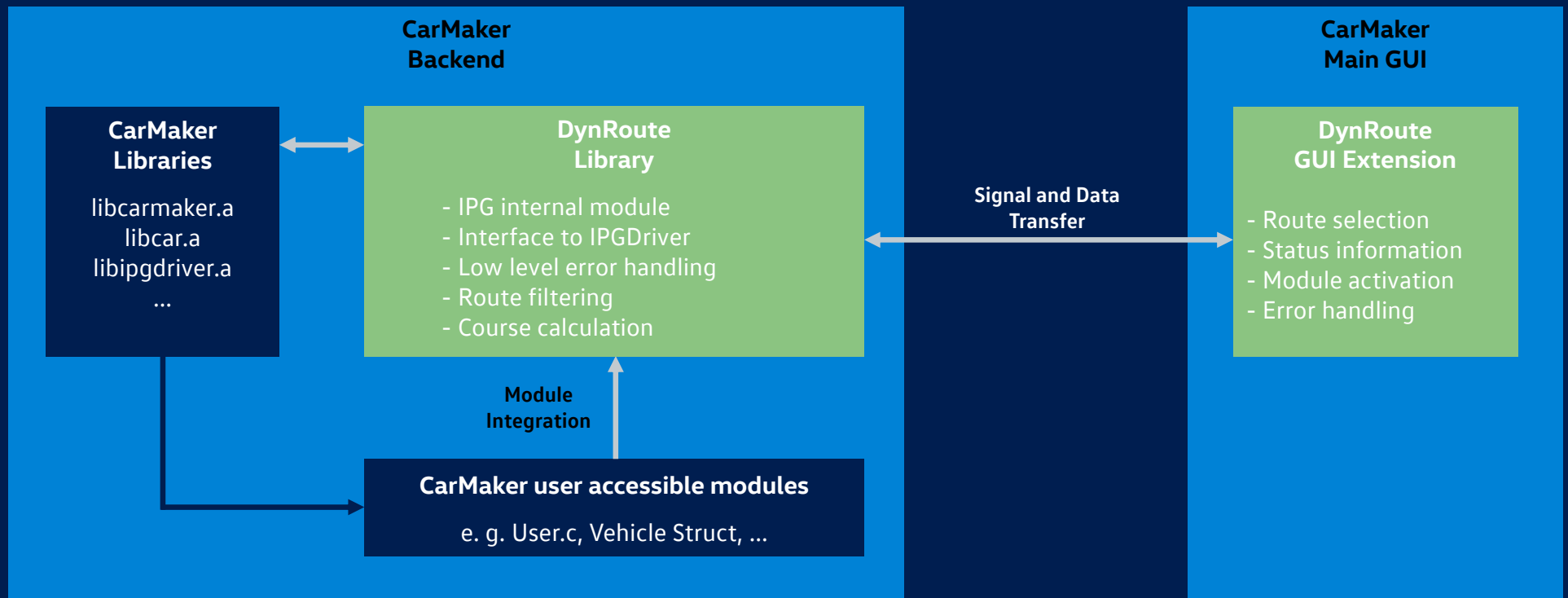
➤ **Insufficient for realistic tests of the charging strategy**

## Basic Idea

- Base requirements:
  - Predefined main route
  - Additional routes to the charging points
  - Optional switch to diverting routes during the simulation
- Requirements for CarMaker:
  - Change to the alternative route after user request
  - Control the car on the alternative route
  - Stop the car at the charging point
  - Return the car to the main route after the charging process

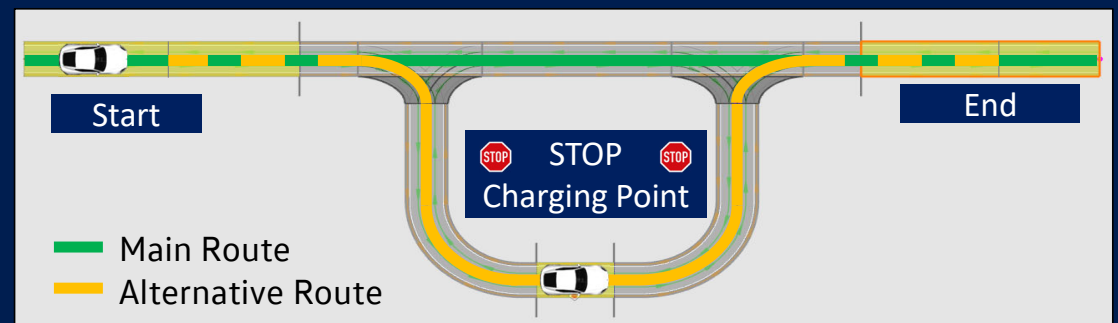
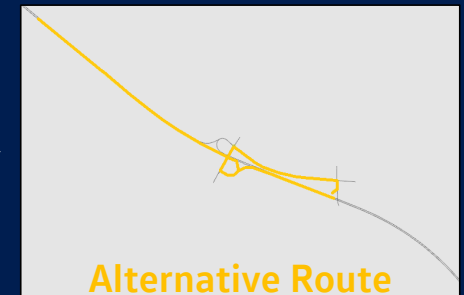
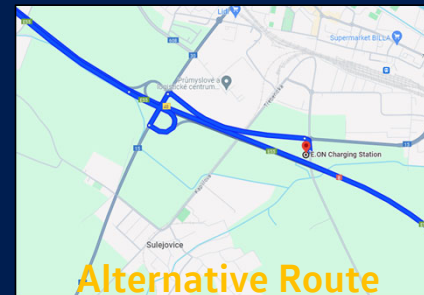
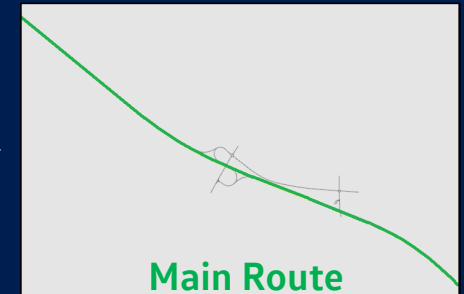
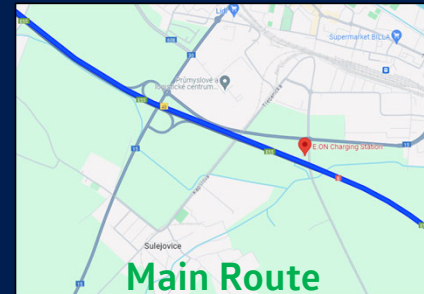


# Implementation in CarMaker



## Workflow in CarMaker Route Preparation

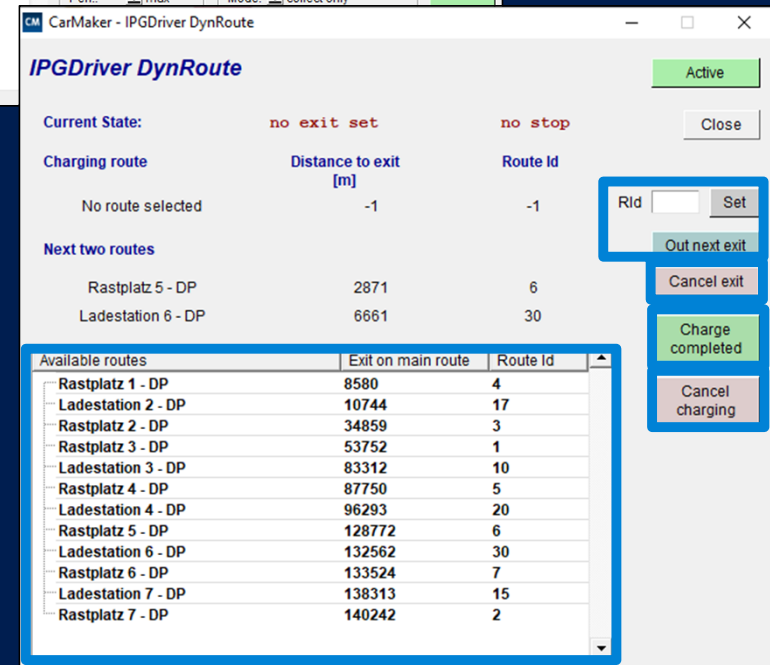
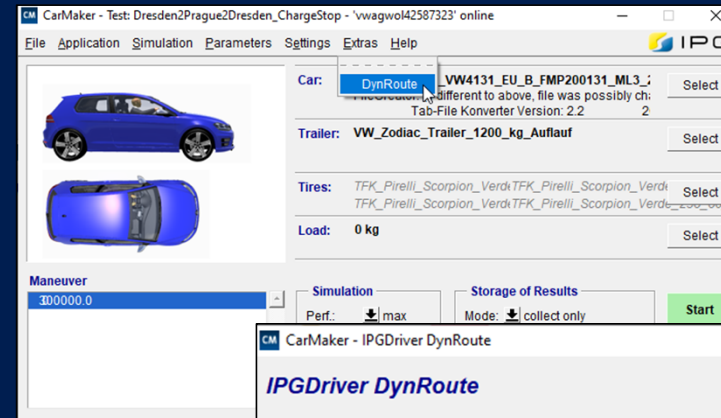
- Definition of the **main route**
- Definition of **alternative routes** to the charging points:
  - Start on the main route
  - End on the main route
  - Overlap with the main route
  - Stop Marker at the charging point





# Workflow in CarMaker Simulation Execution

- Activate the IPGDriver DynRoute
- Start simulation as usual
- List of alternative routes is generated
- Set alternative route by Route ID or „Out next exit“-button
- Cancel Exit is possible until the diverting route is entered
- Charge completed terminates the stop at the charging point
- Cancel charging skips the charging stop



# Execution Example in CarMaker

Stop at 1<sup>st</sup> charging point



CarMaker - IPGDriver DynRoute

**IPGDriver DynRoute** Active Close

Current State: no exit set no stop Close

Charging route	Distance to exit [m]	Route Id
No route selected	-1	-1

Next two routes

Ladestation 3 - DP	1559	10
Rastplatz 4 - DP	5995	5

Available routes

	Exit on main route	Route Id
- Rastplatz 1 - DP	8580	4
- Ladestation 2 - DP	10744	17
- Rastplatz 2 - DP	34859	3
- Rastplatz 3 - DP	53752	1
- Ladestation 3 - DP	83312	10
- Rastplatz 4 - DP	87750	5
- Ladestation 4 - DP	96293	20
- Rastplatz 5 - DP	128772	6
- Ladestation 6 - DP	132562	30
- Rastplatz 6 - DP	133524	7
- Ladestation 7 - DP	138313	15
- Rastplatz 7 - DP	140242	2

Buttons: Out next exit, Cancel exit, Charge completed, Cancel charging

Stop at 2<sup>nd</sup> charging point



CarMaker - IPGDriver DynRoute

**IPGDriver DynRoute** Active Close

Current State: no exit set no stop Close

Charging route	Distance to exit [m]	Route Id
No route selected	-1	-1

Next two routes

Ladestation 3 - DP	-1	10
Rastplatz 4 - DP	-1	5

Available routes

	Exit on main route	Route Id
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Buttons: Out next exit, Cancel exit, Charge completed, Cancel charging



## Functions and Limitations

- Automated alternative route detection:
  - Start and end on the selected main route
  - Shorter than the main route
- Robustness:
  - Check for incomplete alternative routes
  - No change of routes after entering alternative route
- Limitations:
  - No cancellation of a started route
  - No traffic on alternative route
  - No distinction between normal and charging stops
  - Alternative route is not displayed in route viewing



## Summary and Outlook

- Enhanced functionality to enable route switching in running simulations
- Enabler for the application on the FIT-test rig for new test case
- Base function planned for release with CarMaker 14



**Thank you.**

