



dSPACE – Empowering Safe Autonomous Driving

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Chattanooga TN.

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Agenda

1. Who we are
2. How dSPACE helps the Engineering Community
3. Connectivity
4. Simulation Environment needs
5. Examples

dSPACE: Digital Signal Processing And Control Engineering

Distributors in

8
countries

More than

30

years of experience

family-owned company;
visionary founder

Project centers in

4

german cities

Local dSPACE
companies in

7

countries around
the globe

> 2.000

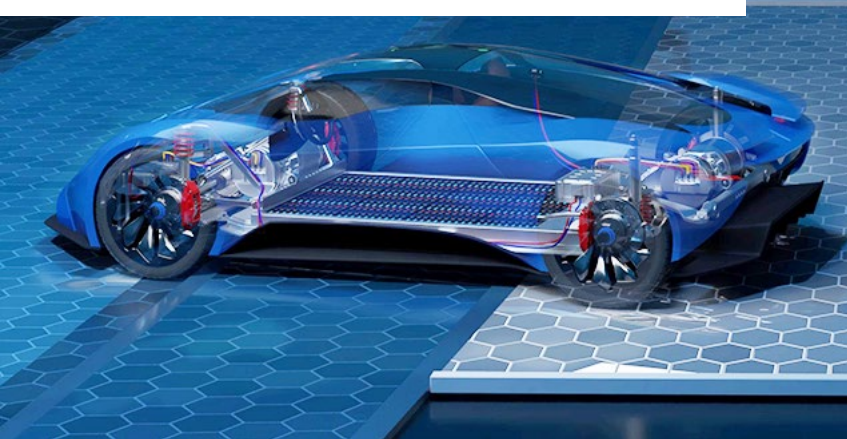
global employees

Continuously growing R&D and engineering
capacities and capabilities, investing in state-of-the-art technology

~ 1.600

engineers and software scientists

Primary Segments:



Automotive, Aerospace, Commercial and Off-Highway, Electrification, Academics/Research, Medical Engineering, Industrial Automation

Solutions for Electromobility

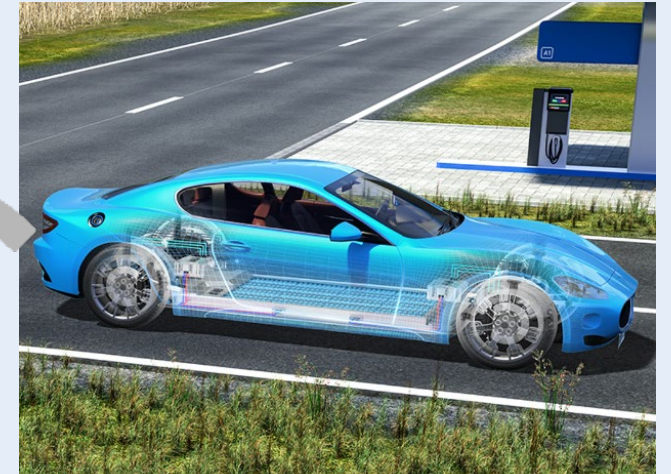
Combining **electric vehicles** and **renewable energy** sources are mega trends for modern mobility.



GRID



CHARGING/ESS

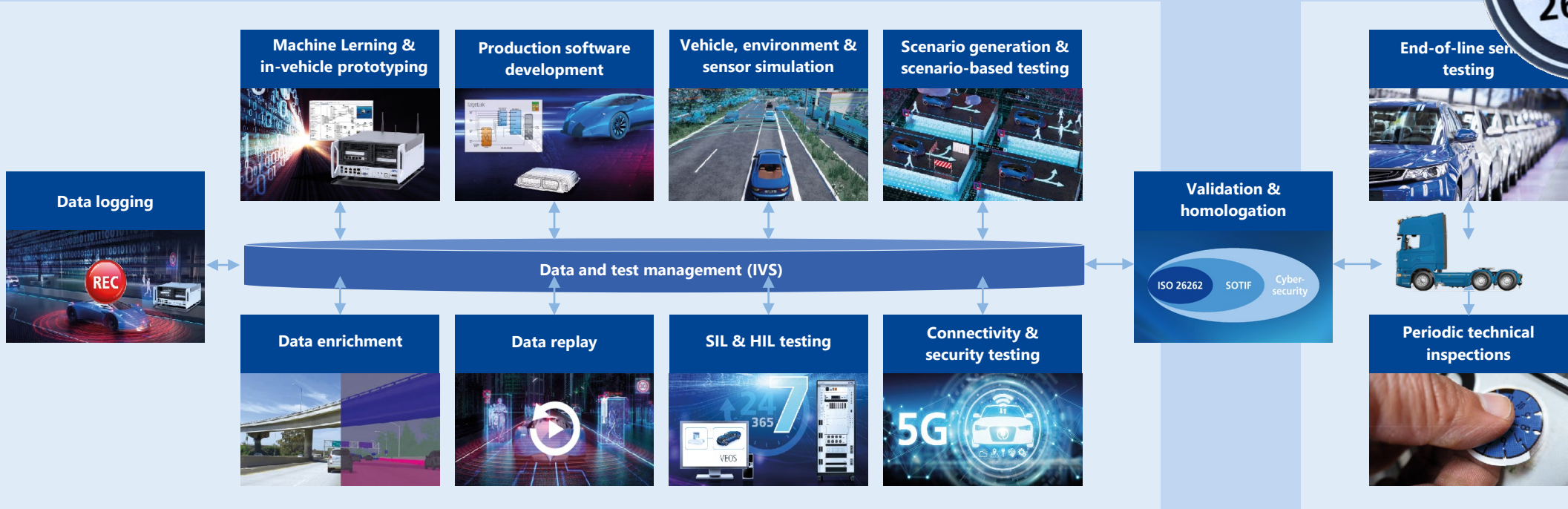


VEHICLE

CONNECTIVITY

Smart Grids, Charging, Energy Storage, Power Electronics, Electric Drives, PLC, 4G, 5G, WiFi, GNSS

Solutions for Connected & Automated Vehicles



dSPACE Consulting

dSPACE Engineering Services and Partner Eco System

Connectivity in Ground Vehicles

Application type	Use Case	Communication type
Infotainment	In-car entertainment & internet access	4G/5G
Infotainment	In-car voice assistant (Alexa, Siri, Google Assistant...)	4G/5G
Smart Mobility	Community/Smart Parking, Carsharing, MaaS	4G/5G
Safety	eCall/NG eCall	2G/4G
Safety/Efficiency	Remote diagnostics	4G/WLAN
Efficiency	Predictive driving (eHorizon, Live HD maps...)	4G/5G
Comfort	Keyless Entry	4G/BT/UWB
Safety	V2X Day One (safety applications)	V2X (V2V, V2I)
Comfort	Automated Valet Parking/Remote Parking	WLAN/BT
Safety/Comfort/Efficiency	OTA Update for Software-defined Vehicle	4G/WLAN
Comfort/Efficiency	Traffic Light Information, GLOSA	4G/V2I
Comfort/Efficiency	Cooperative ACC	V2X
Safety/Efficiency	Platooning	V2X
Safety	Sensor Sharing	V2X/5G
Safety	VRU Protection	V2X/5G
Safety/Efficiency	Cooperative Maneuvering/Driving	V2X/5G
Safety/Comfort/Efficiency	L4/L5 self-driving cars	V2X/5G

Increasing demand
for advanced
simulation & testing

V2N: Vehicle-to-Network (V2Cloud)
V2V: Vehicle-to-Vehicle
V2I: Vehicle-to-Infrastructure

V2P: Vehicle-to-Pedestrian
BT: Bluetooth
MaaS: Mobility-as-a-Service

UWB: Ultra-wideband
GLOSA: Green Light Optimized Speed Advisory

Roadmap towards CAV

Semi-automated Driving

V2X Day 2

V2X Day 3+

Fully-automated Driving

Connected Automated Vehicle

Driver Assistance

V2X Day 1

Awareness Driving
Collision Warning

Sharing status data

Simple use cases for driver information



Collective Perception
VRU protection

Sharing object list

Sharing sensor raw data

Integration with functions for perception and data fusion

Need for Sensor Simulation
Need for Infrastructure Simulation

Cooperative Driving
Merging on highways

Sharing intention

Maneuver coordination

Integration with functions for maneuver planning and decision making

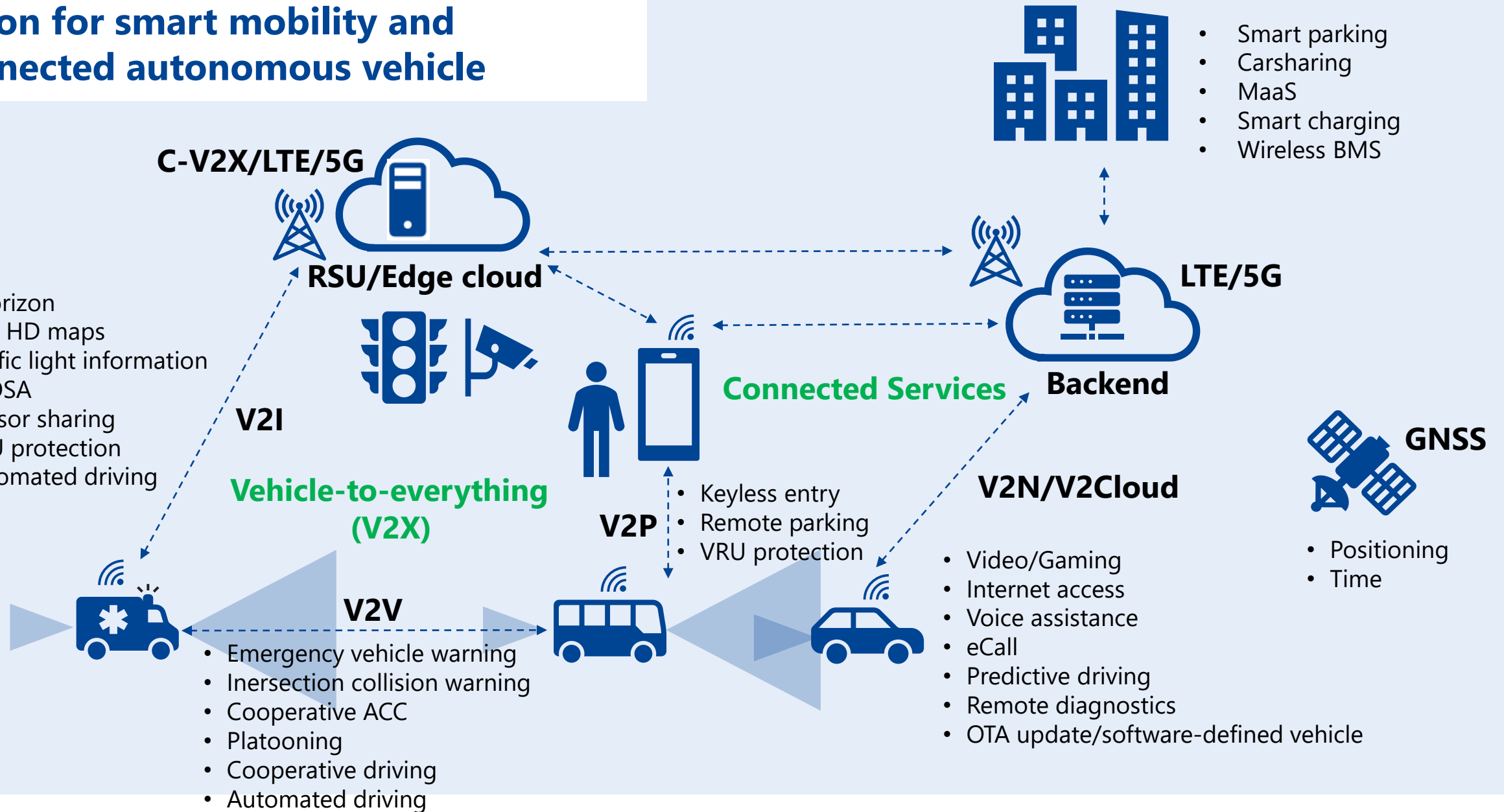
Need for Scenario-based Testing
Need for Large Scale Simulation

Increasing number and complexity of scenarios
Increasing demand for simulation and validation

Vision for smart mobility and connected autonomous vehicle

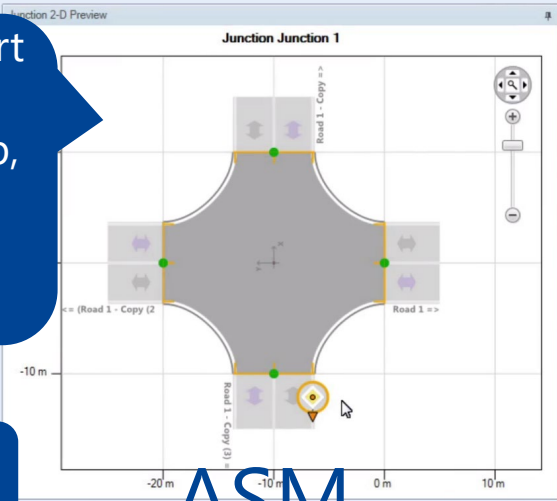
- eHorizon
- Live HD maps
- Traffic light information
- GLOSA
- Sensor sharing
- VRU protection
- Automated driving

- Smart parking
- Carsharing
- MaaS
- Smart charging
- Wireless BMS



V2X Day1: Infrastructure Simulation

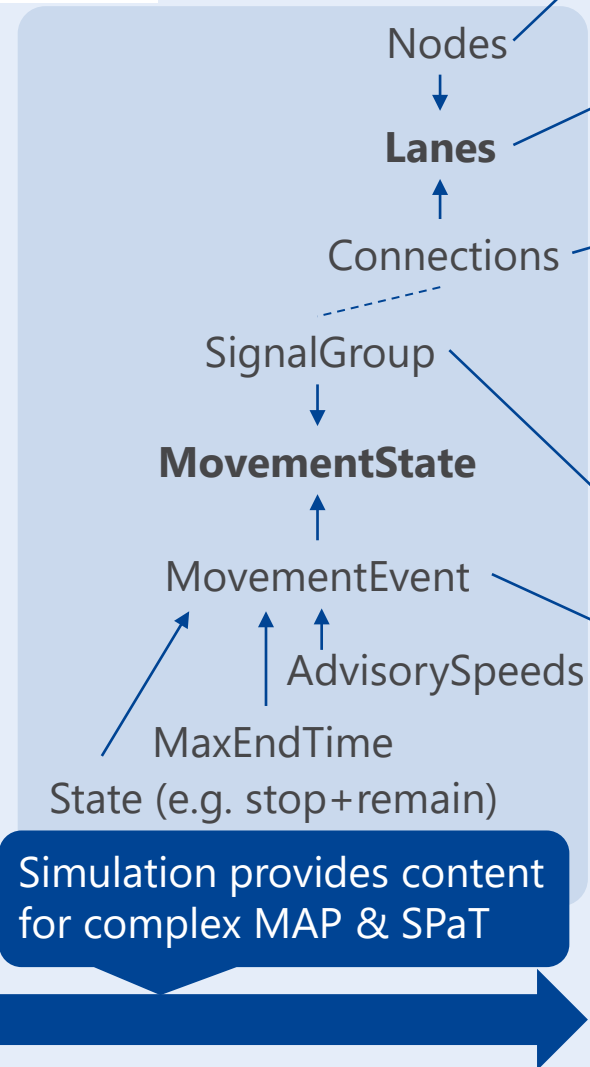
Create or import roads from OpenStreetMap, OpenDrive, TomTom, HERE, ...



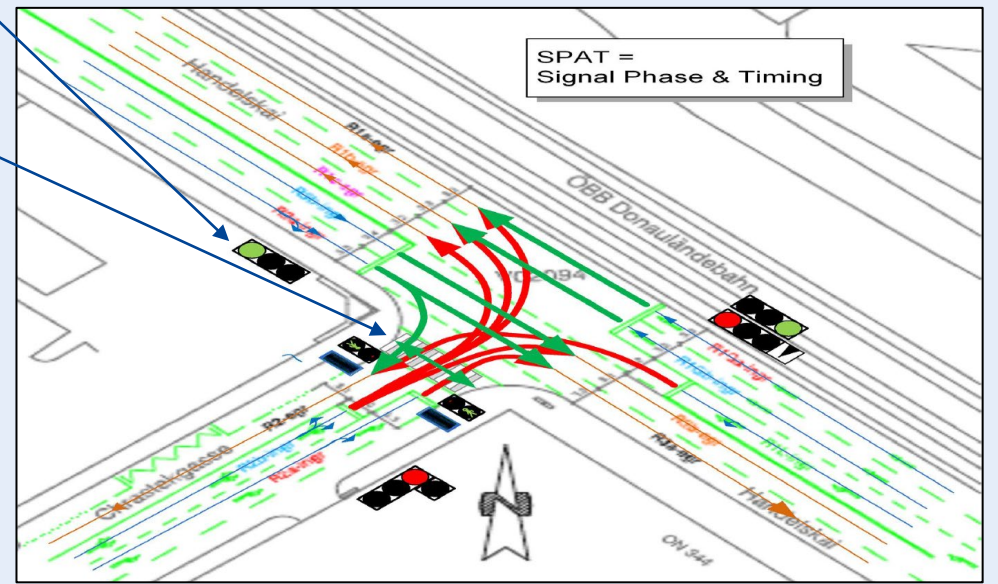
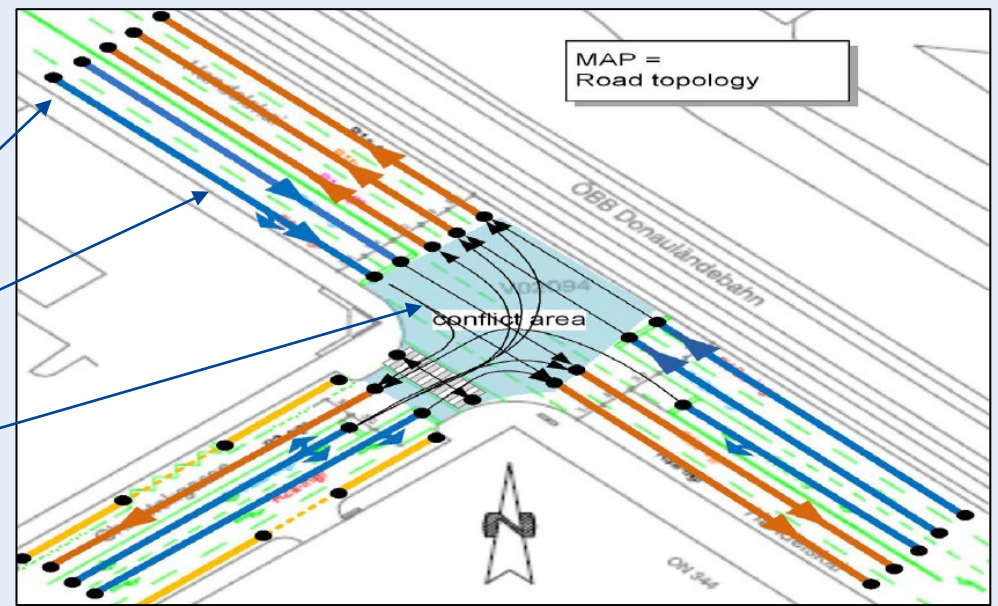
Define signal timing plan



- Use Case:
- Traffic Light Information
 - GLOSA...



Simulation provides content for complex MAP & SPaT



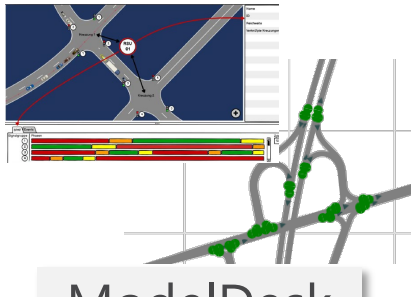
V2X – MAP and SPaT

Parameterization and simulation of map data and signal phases

Key takeaways

Preparation

Scenario Editor & Parameterization

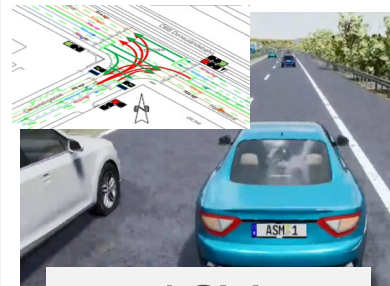


ModelDesk

Definition of signal phases and timing

Simulation & Interfacing

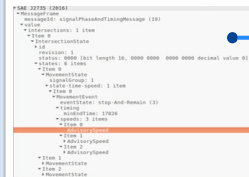
Vehicle & Environment Models



ASM

Simulation of signal phases

V2X-Blockset



Message signal generation

Network Simulator



System-under-Test



Hardware-in-the-Loop

SCALEXIO

Platforms

V2X signal definition in ModelDesk

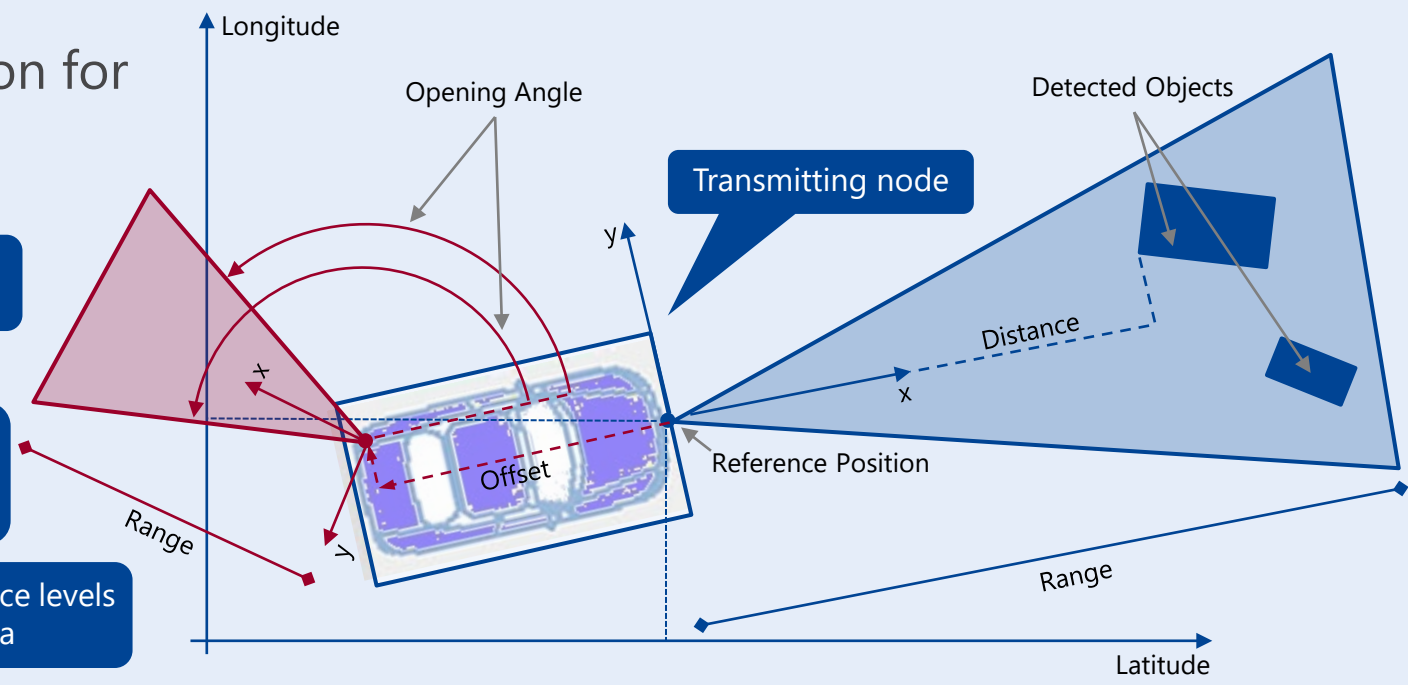
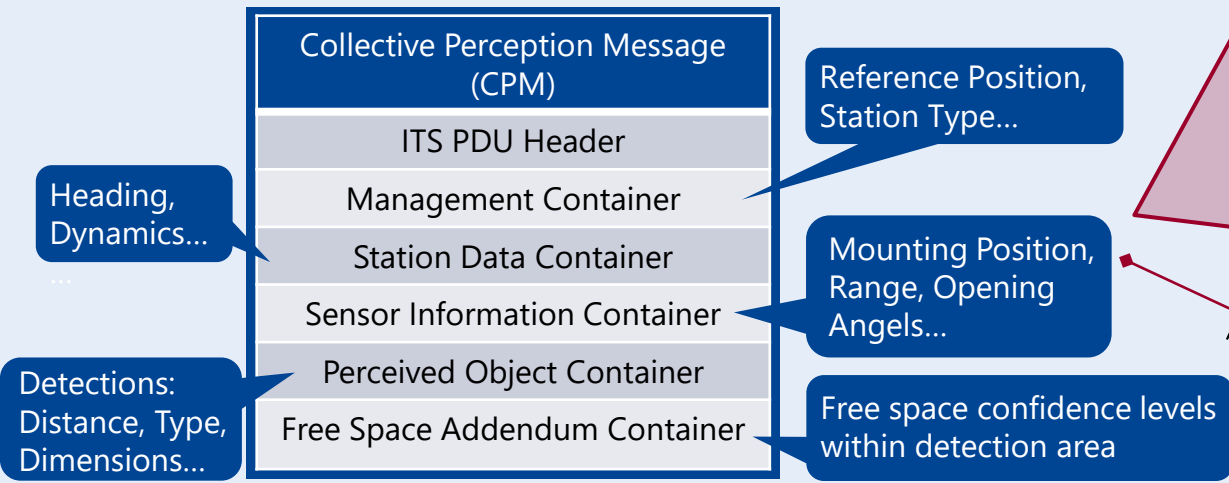
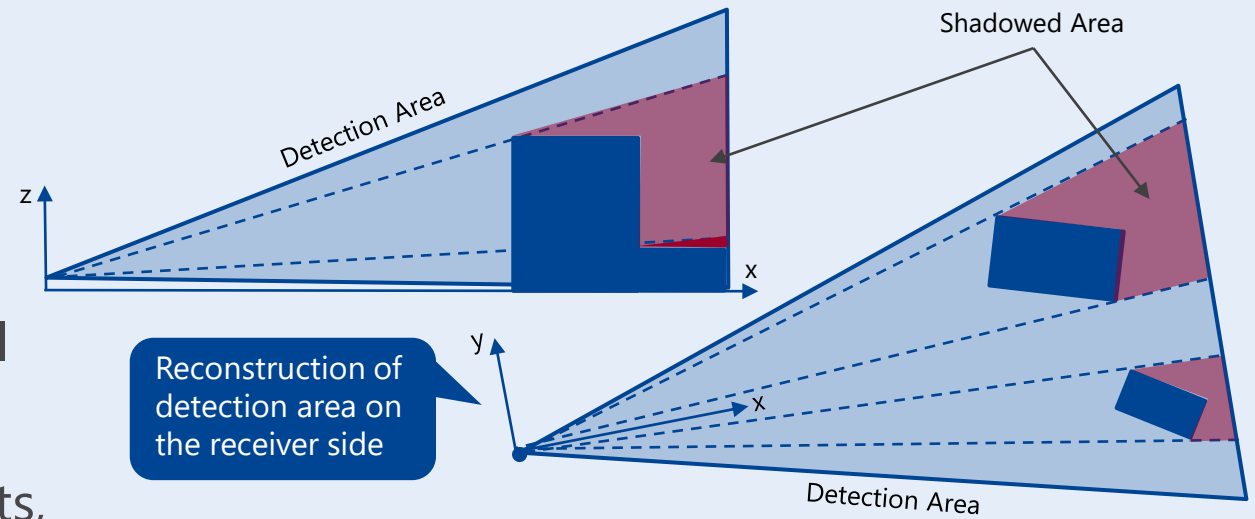
V2X MAP and SPaT (Signal phase and timing) **simulation** in ASM

V2X MAP and SPaT message **generation** with V2X-blockset

V2X Day 2: Collective Perception

Challenges for Testing

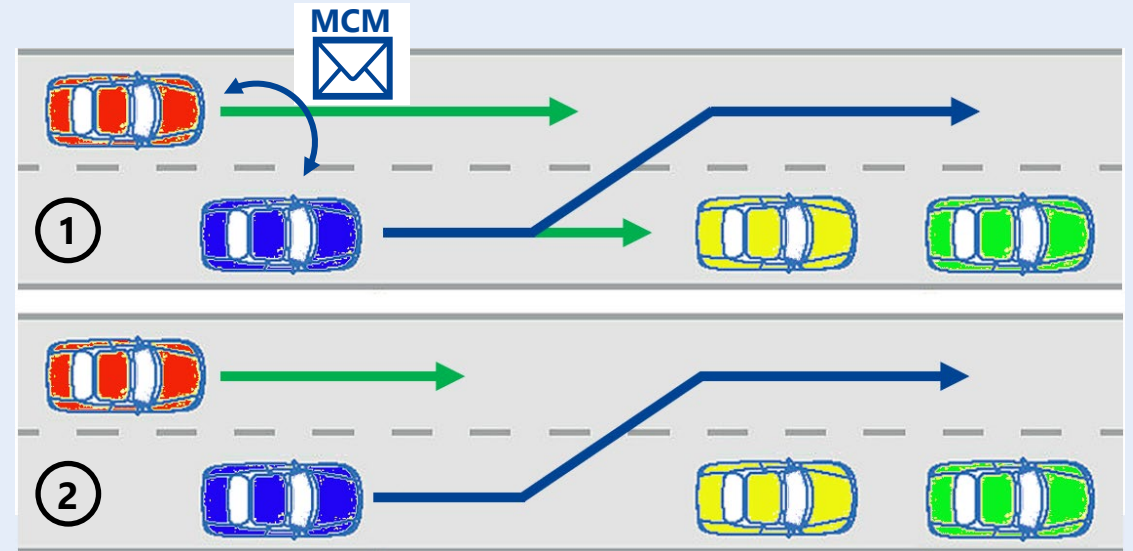
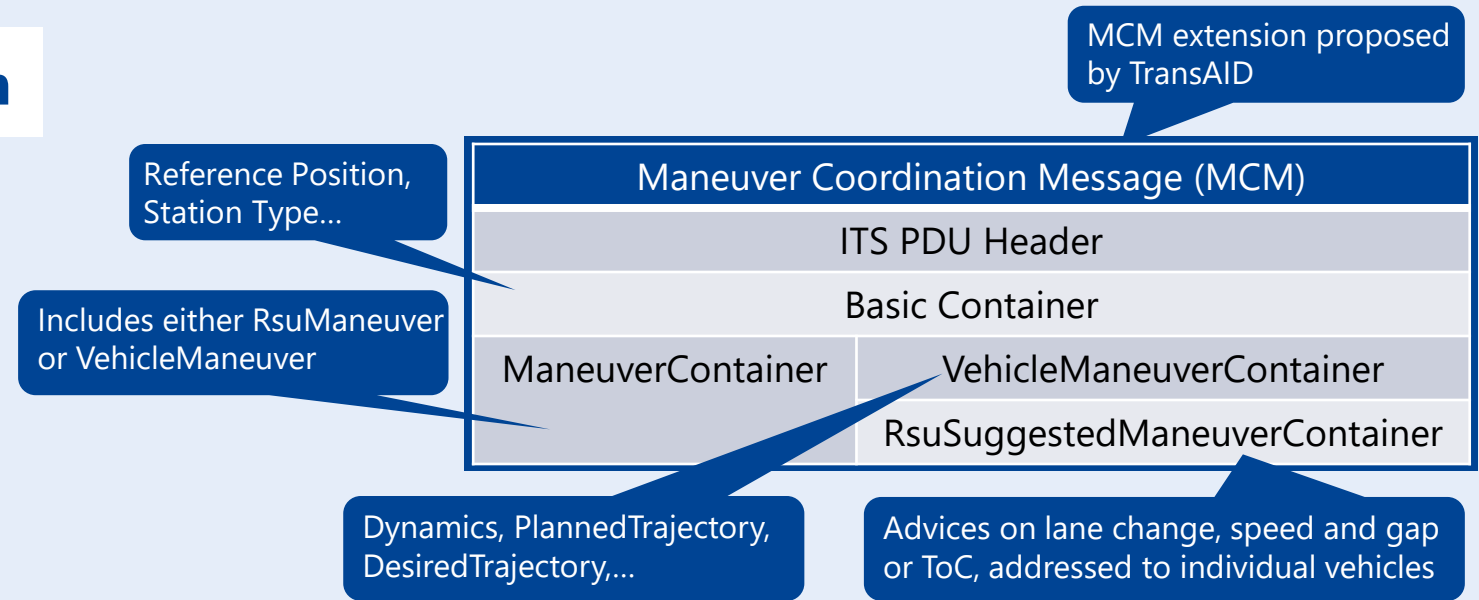
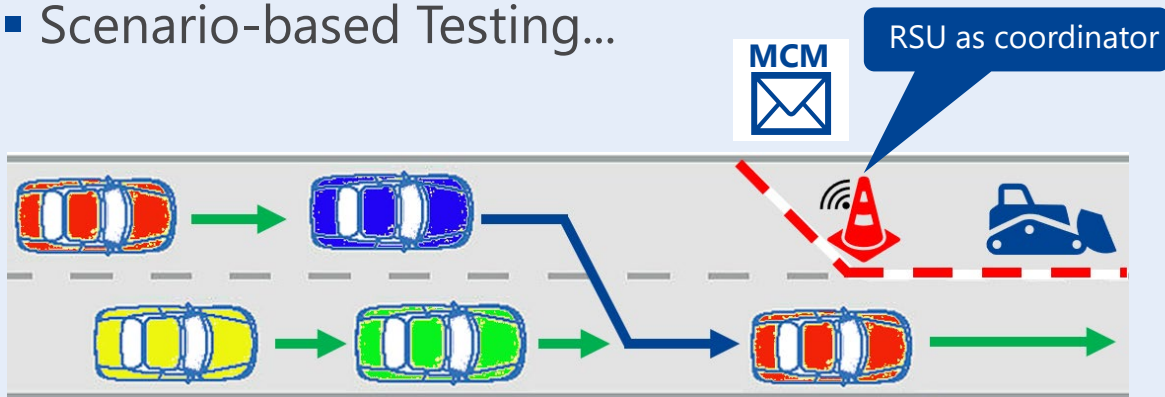
- Sensors simulation with different levels of detail
- Multiple, different sensors and sensor fusion
- Environment simulation with pedestrians, cyclists, construction zones, etc.
- Sensor-realistic Simulation and 5G emulation for HD Sensor Sharing...



V2X Day 3: Maneuver Coordination

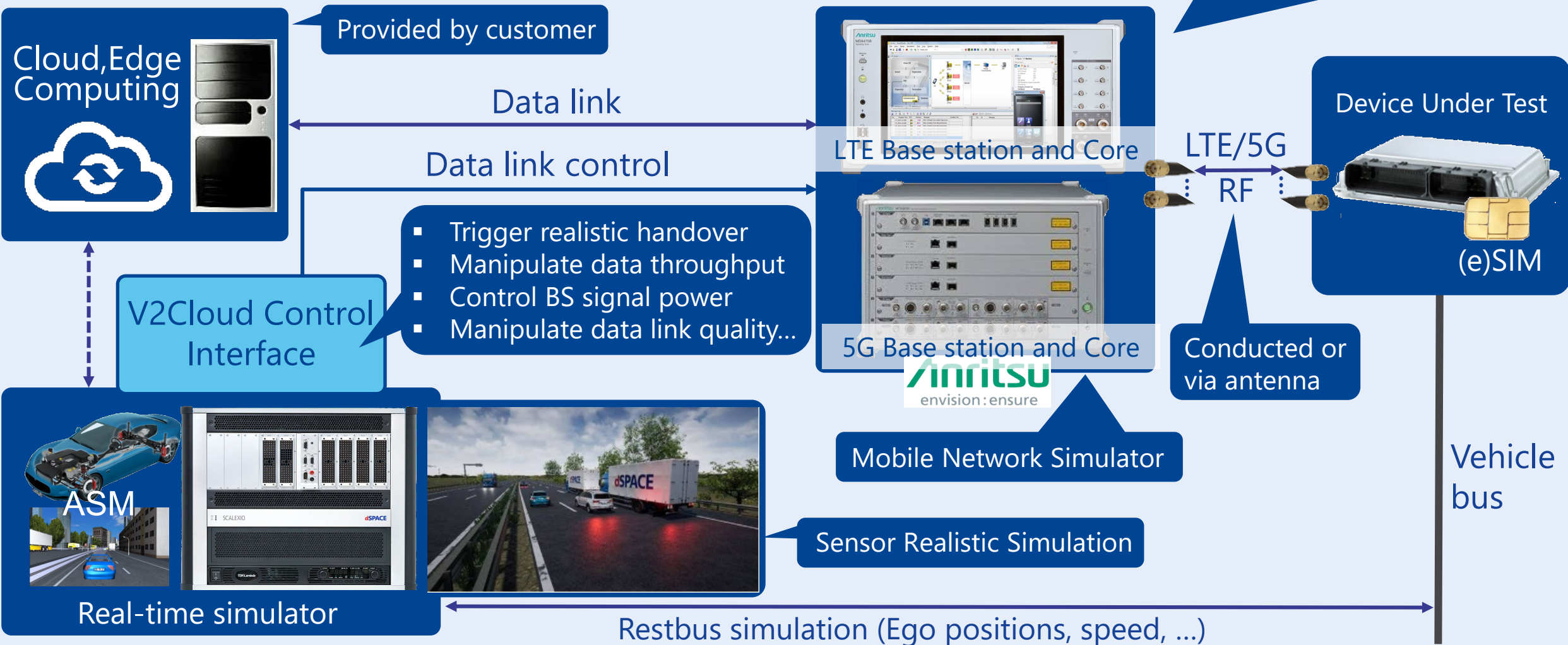
Challenges for Testing

- Lots of different scenarios
- Varying number of vehicles
- Trajectory simulation
- Infrastructure simulation with support of maneuver coordination
- Scenario-based Testing...



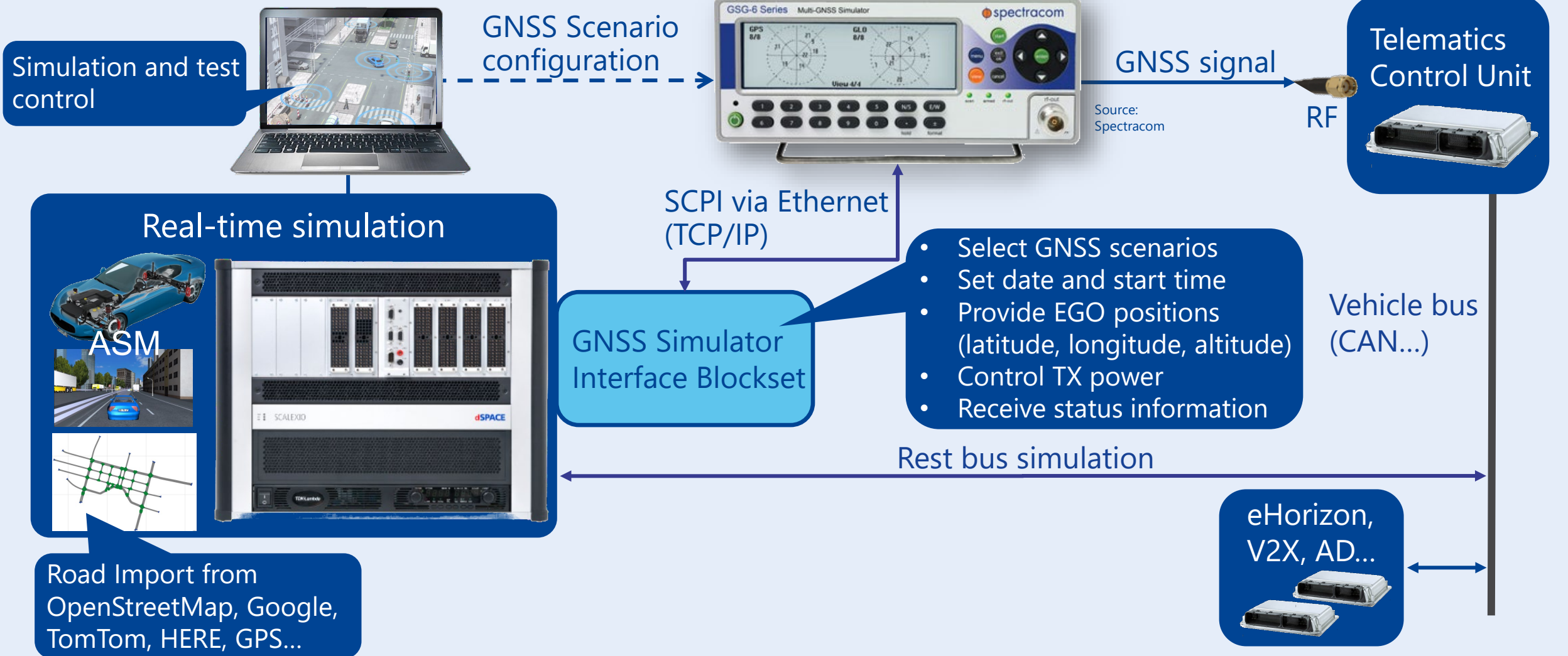
Testing 4/5G-enabled services & Handover

- 5G/4G Radio Access Network Simulation
- Core Network Simulation
- TCU Testing
- Access to Edge Computing/Cloud



TCU: Telematics Control Unit (Connectivity device)
 BS: Base Station
 (e)SIM: (embedded) Subscriber Identity Module
 ASM: dSPACE Automotive Simulation Models

GNSS integration with HIL

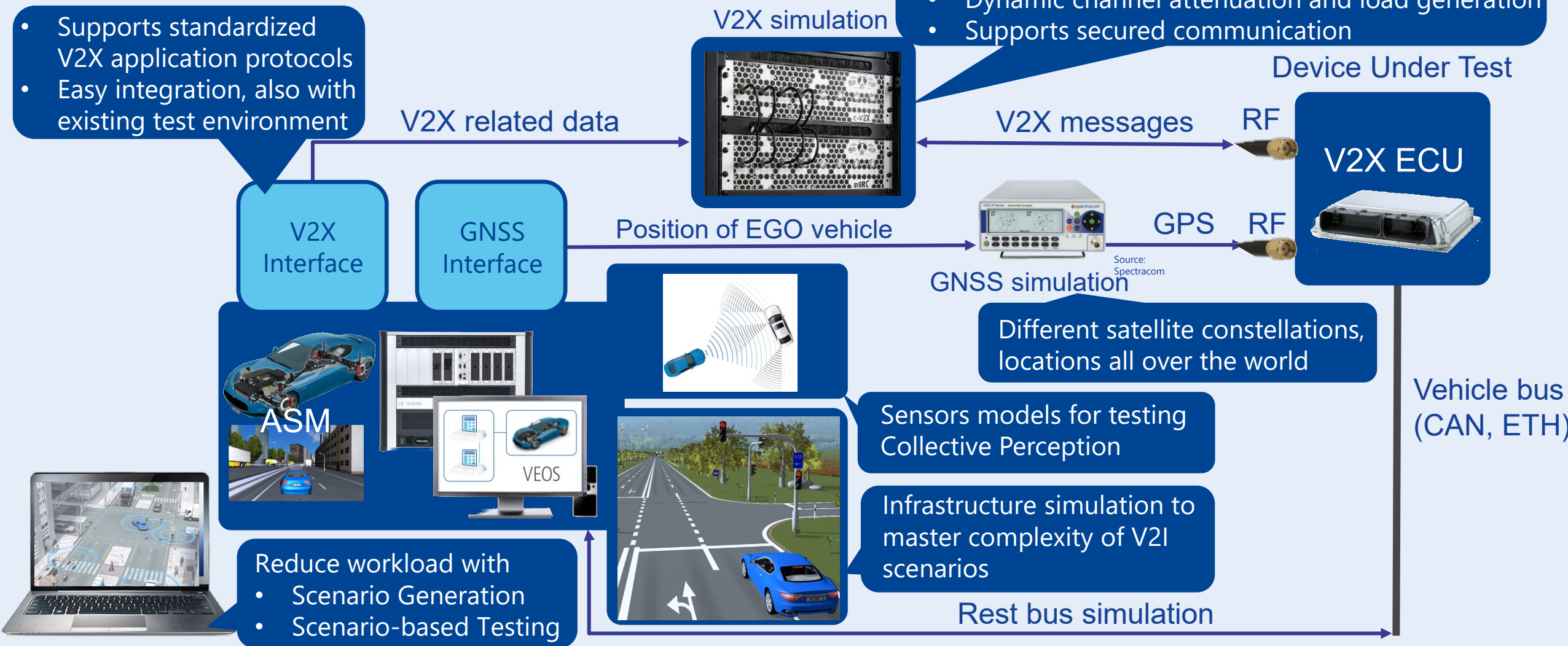


SCPI: Standard Commands for Programmable Instruments
 GNSS: Global Navigation Satellite System
 ASM: dSPACE Automotive Simulation Models
 RF: Radio Frequency

One for all: Testing a wider range of V2X applications

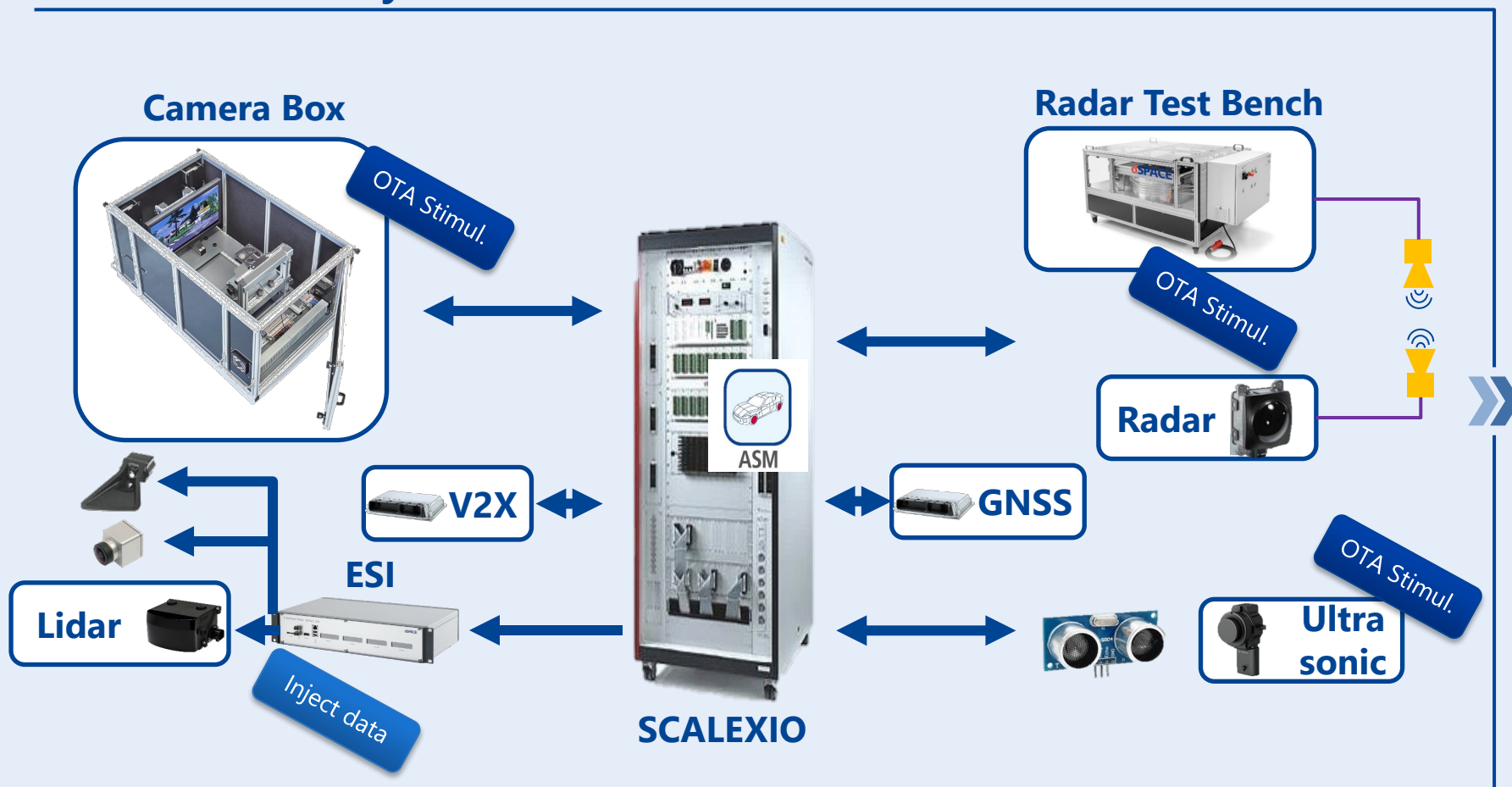
- All standards: EU, US, CN
- All technologies: 802.11p, C-V2X (PC5)
- V2X Multi-Stack, high number of simulated nodes
- Dynamic channel attenuation and load generation
- Supports secured communication

- Supports standardized V2X application protocols
- Easy integration, also with existing test environment



Integrated ADAS/AD Sensor Testing

“Virtual vehicle” system for SW verification in labs



Key takeaways

Comprehensive portfolio

Over-The-Air stimulation and data injection of

- Radar
- Lidar
- Camera
- Ultrasonic

automotive sensors plus

- GNSS
- V2X

Traffic model by dSPACE ASM.

dSPACE offers complete, integrated ADAS testing systems from one source!

VIL for AD – Vehicle OTA Testing

Integrated Vehicle-in-the-loop test setup

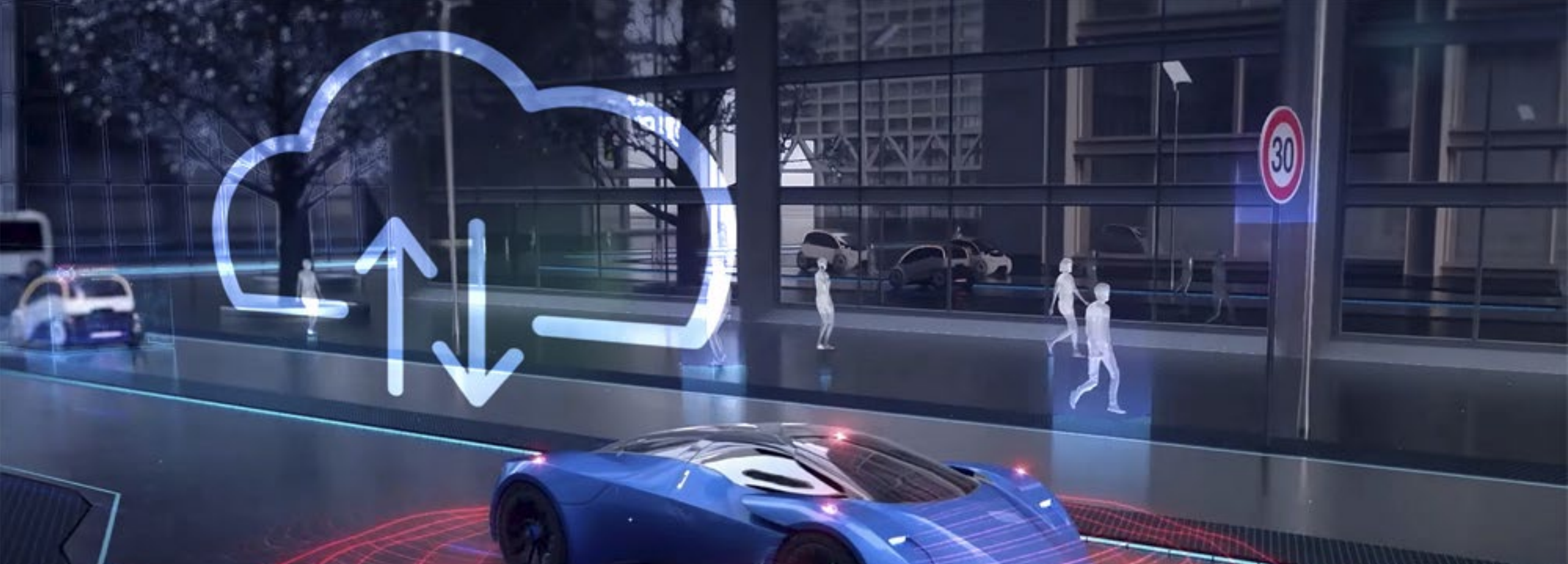


Key takeaways

Combine Over-The-Air stimulation of

- Radar
- Camera
- Ultrasonic
- GNSS
- V2X

» **Synchronous stimulation of all sensors!**



Thank you for listening!

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