

Simulation Tool Suite ASM (Automotive Simulation Models)

ASM Traffic

- Environment simulation for ADAS and autonomous driving
- Road networks
- Traffic scenarios
- Traffic signs, buildings, pedestrians, objects
- Convenient graphical definition in ModelDesk

The vehicle graphics used in this brochure are by courtesy of Maserati, Scania, and Volkswagen.

Content

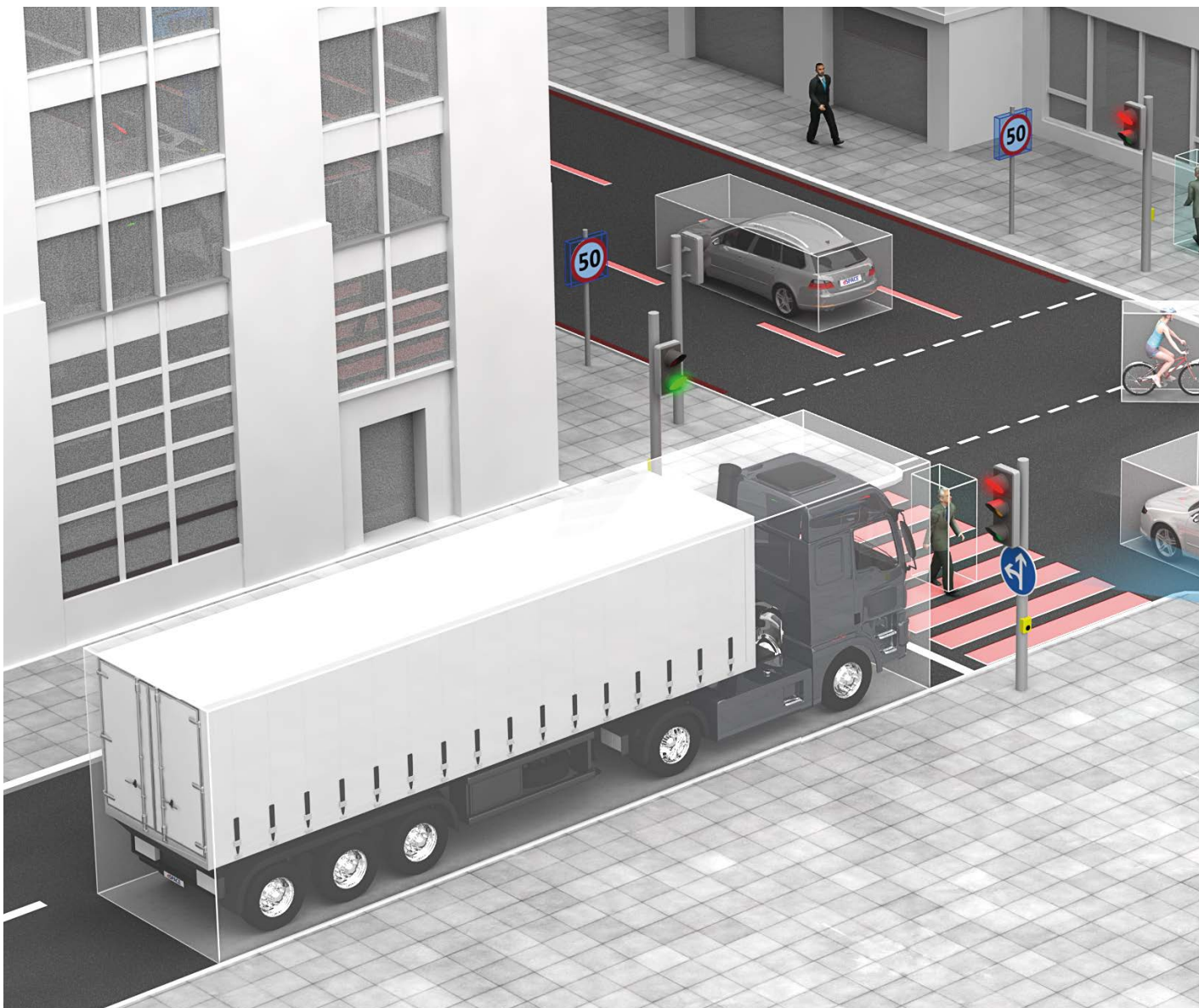
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Virtual Road Traffic

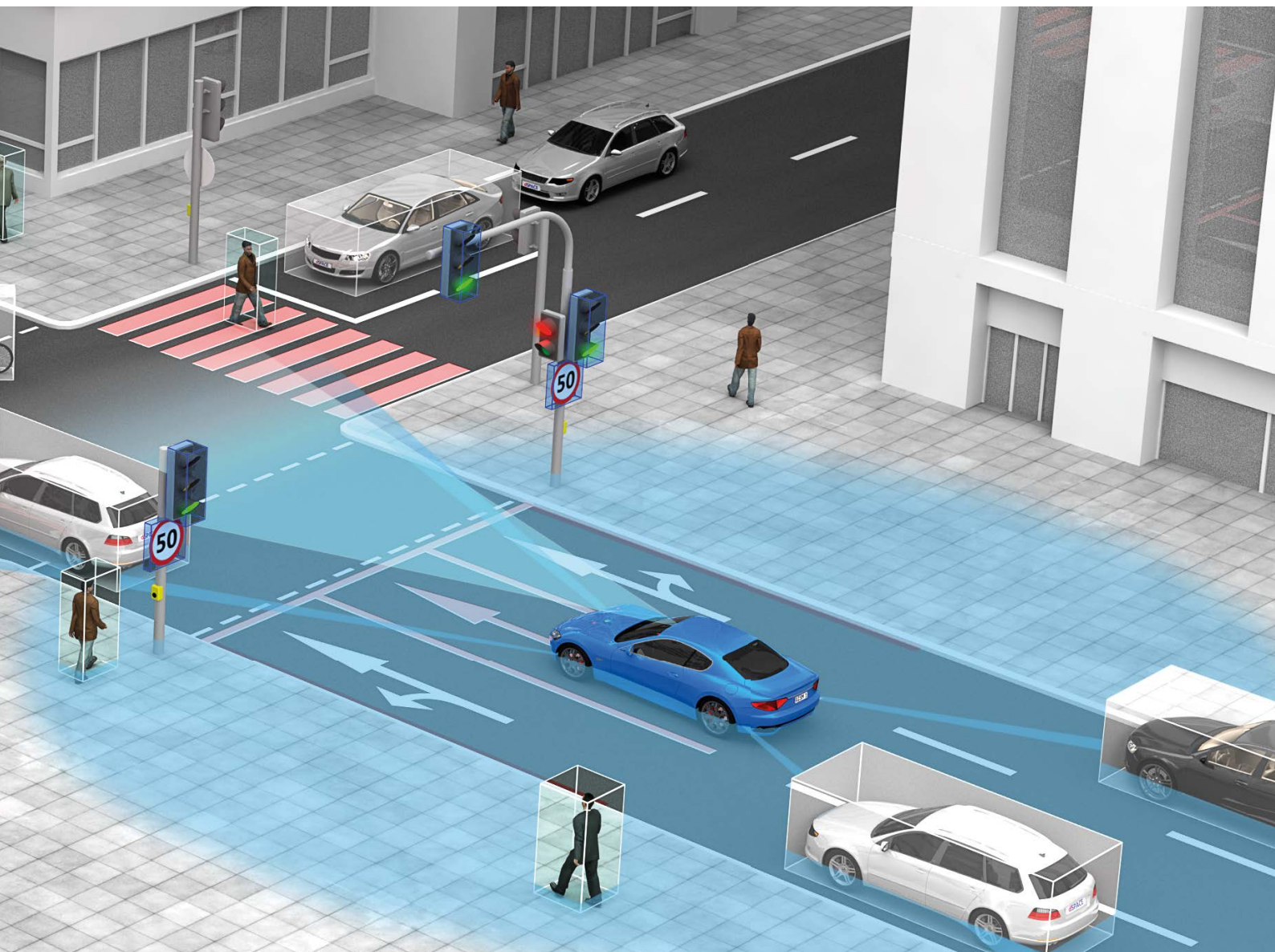
Efficient Controller Development

How can you test new control software for advanced driver assistance systems (ADAS) and autonomous driving features long before the vehicle and environment sensors are even ready? How can you prove that new concepts fulfill your requirements? And how do you speed up the development of the ever more complex electronic systems? The answer

is simulation: virtual test drives in road traffic made easy by off-the-shelf simulation models and ready-to-use roads and maneuvers. In a car, on a road, with surrounding traffic, an urban environment, traffic signs, intersections, GPS – all virtual. At your desk. Visualized testing is quick and convenient and there is no better way to handle complexity.



The ego-vehicle (blue) operates from a camera/sensor perspective. Ego means 'I', the first person singular. In the context of this brochure, the term is identical with 'vehicle under test'.

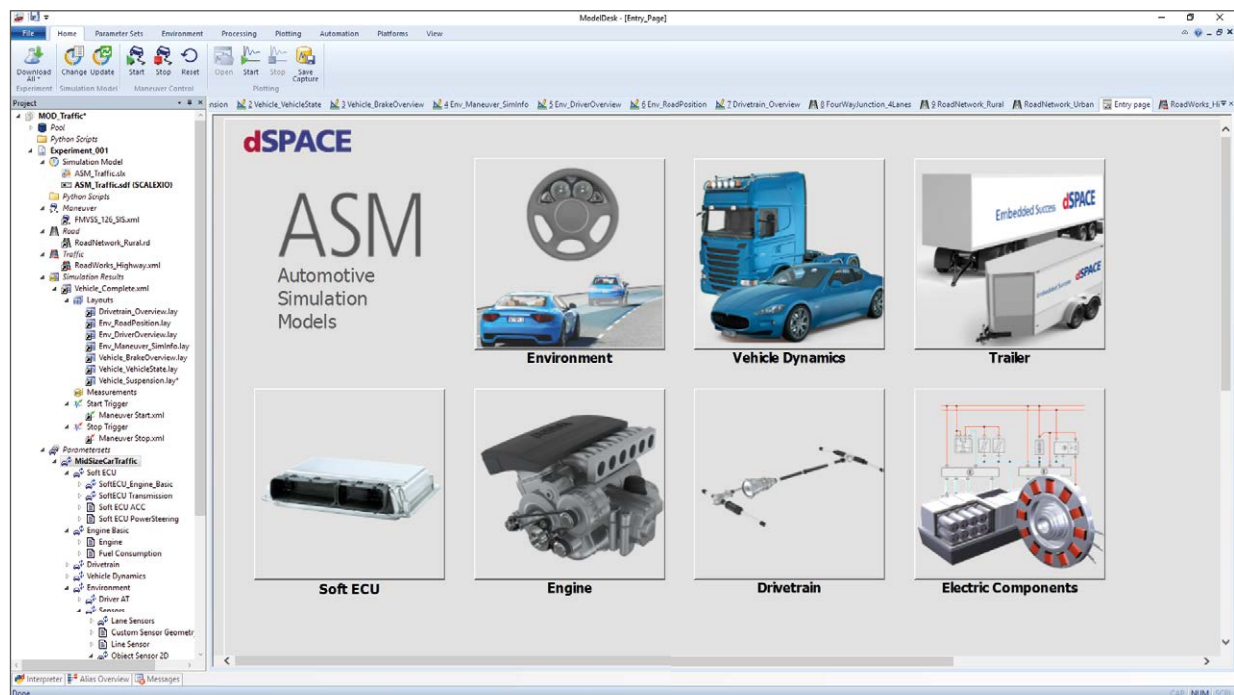


The Simulation Workbench

Automotive Simulation Models (ASM)

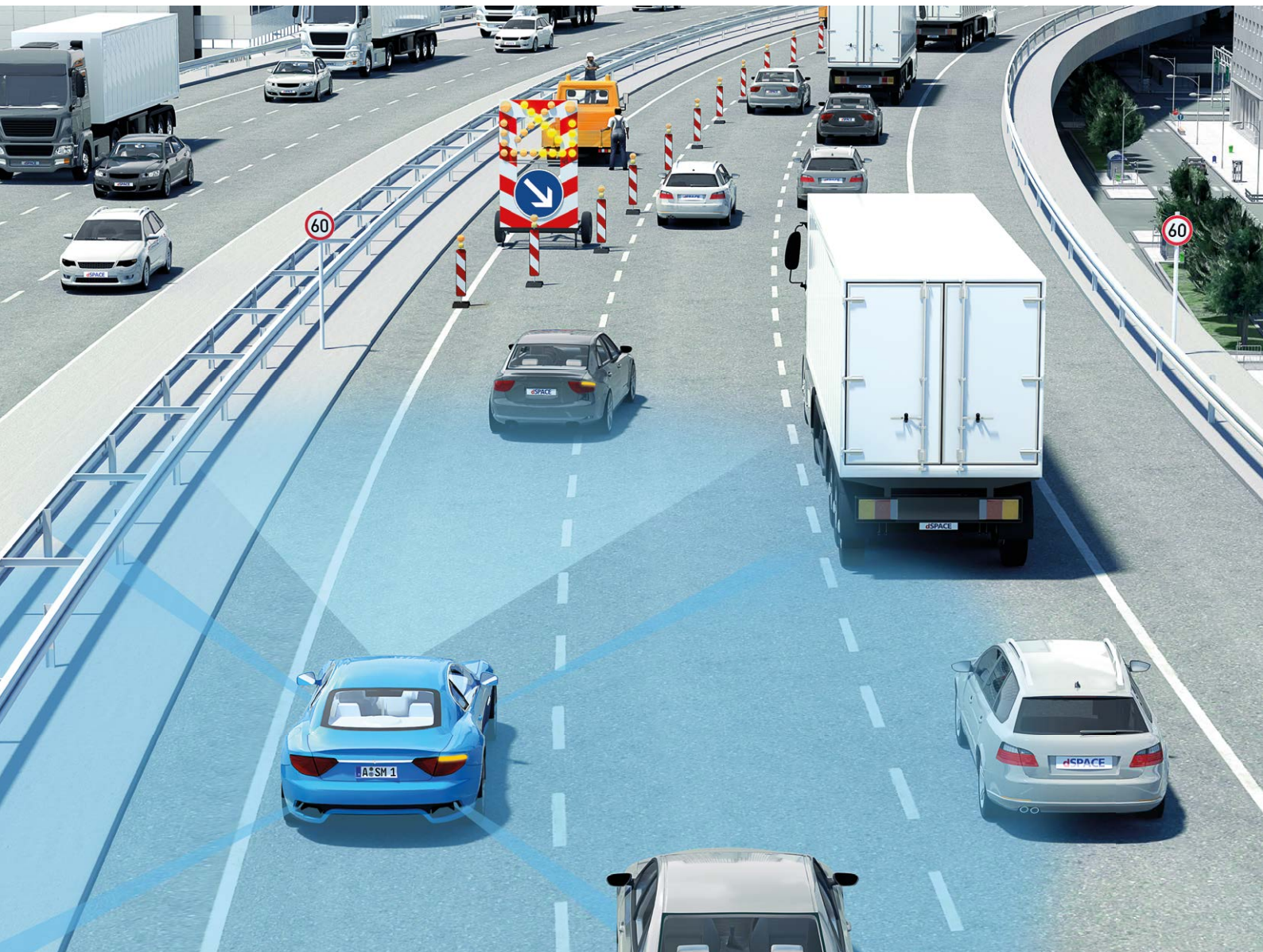
The simulation tool suite ASM by dSPACE is industry-proven virtual vehicle software. The simulation model ASM Traffic gives you realistic vehicle, sensor, traffic and environment simulations in real time. The model is the ideal choice for function design and controller testing in the model-based development processes.

Jump-start developments with easy-to-use, validated tools: a convenient user interface that handles all aspects of your tasks, and high-performance simulation models that perform under the hood to ensure precise simulation results.



Convenient User Interface

ModelDesk is the intuitive user interface for defining and initiating virtual test drives. With intuitive graphical methods for specifying vehicles, sensors, roads and traffic maneuvers. Plus efficient workflows and seamless parameter management.



High-Performance Models

ASM are open, validated Simulink models that major OEMs and suppliers rely on to develop controllers for cars, trucks, and off-road vehicles. They support the whole development process from function design to ECU testing.

Virtual Vehicle

The simulation tool suite ASM supports application areas such as combustion engines, vehicle dynamics, electric components, and traffic, including the traffic environment. It comprises models for the engine, hybrid drivetrain, suspensions, traffic sensors and many other components. You can easily combine them to build a whole virtual vehicle.

Overview

Traffic Simulation Software

ASM Traffic supports a broad variety of simulation capabilities and use cases in the area of traffic and environment simulation. This simulation model is an add-on to

ASM Vehicle Dynamics, the simulation model for vehicle dynamics examinations. Further tools complement the simulation workbench.

Basic Software

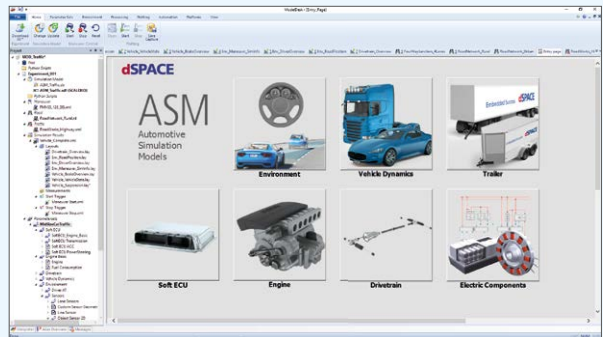
ASM Traffic is the model for simulating traffic vehicles, road users, traffic objects and vehicle sensors.

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ModelDesk is the graphical user interface to define the environment, create traffic maneuvers and manage the simulations.

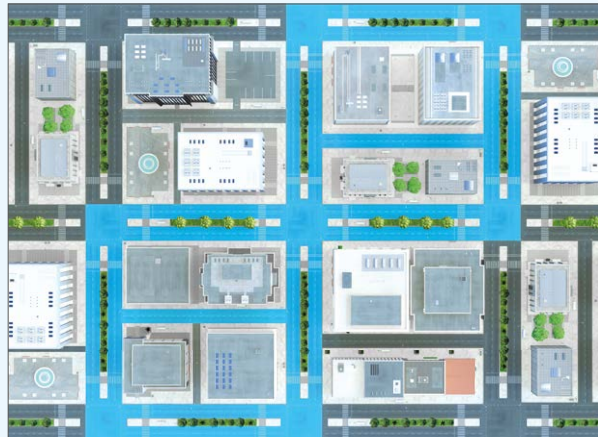
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ASM Traffic is an add-on to ASM Vehicle Dynamics.

ASM Environment is the model for simulating the road network, driver, and maneuvers.

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MotionDesk lets users observe simulations as realistic 3-D animations.

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Philosophy

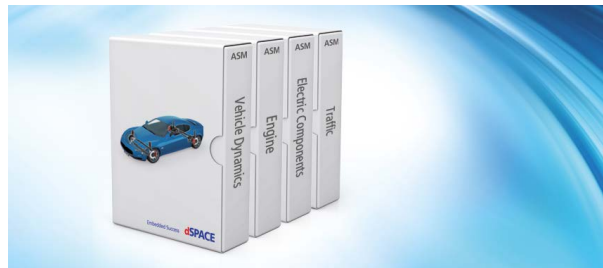
Supports Model-Based Design

- Real-time-capable Simulink models
- Provides access to internal modeling details, down to block level
- Supports all stages of controller software development (MIL, SIL, HIL)
- Soft-ECU network
- Signal interfaces for automotive applications



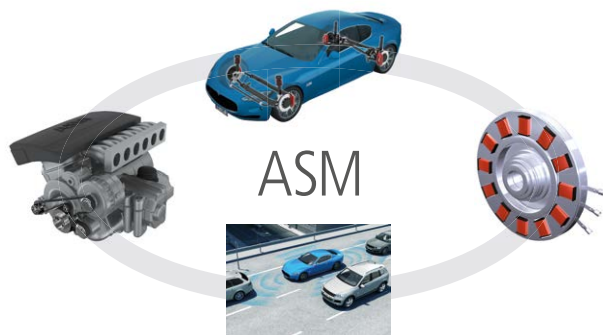
Ready-to-use Off-the-Shelf (OTS) Models

- One integrated tool chain for parameterization, validation and test automation
- Open documentation, including mathematical equations
- Supports migration, including between MATLAB releases
- Worldwide customer base and mature models



Complete ASM Product Portfolio

- Supports all automotive-relevant modeling areas
- Easily combinable models for building virtual vehicles
- Different levels of model complexity (e.g. mean value, physical) for all controller design and test use cases



Comprehensive Engineering and HIL Knowledge

- The one-stop supplier for all HIL-relevant tasks
- Customer training and worldwide support
- Combination of OTS models and custom specific model engineering



ASM Traffic

Real-time environment simulation with traffic and objects

Key Features

- Flexible definition of complex traffic scenarios
- Road network definition
- Simulation of static and moving objects like traffic signs and pedestrians
- Multiple traffic sensor types supported
- Graphical definition of roads, maneuvers, and environment



Application Areas

ASM Traffic adds traffic and environment simulation to dSPACE's Automotive Simulation Models (ASM). It supports you in developing and testing advanced driver assistance systems (ADAS) that react to other vehicles or objects, like adaptive cruise control (ACC) and intersection assistants. The model simulates a road network, the vehicle under test, a multitude of fellow vehicles and the necessary environment. The test vehicle can be equipped with multiple sensors for object detection and recognition (ego-vehicle). ASM Traffic is typically used for hardware-in-the-loop testing of electronic control units (ECUs) or for early function validation by offline simulation during the design phase of controller algorithms.

Key Benefits

ASM Traffic is so flexible that any kind of traffic scenario can be created to ensure thorough testing of ADAS controllers. It supports the creation of complex road networks, and you can define sophisticated traffic scenarios on the roads. The simulated environment can consist of static and movable objects, like traffic signs and pedestrians. Various sensor models and user-definable sensors are available to detect these objects. To test pre-crash functionalities, you can define traffic scenarios that in real life could result in an accident, and observe system behavior under challenging conditions. Traffic scenarios can be modified and immediately simulated without having to generate code again.

Components and Characteristics

ASM Traffic consists of a graphical user interface (GUI) and a set of simulation models that perform in real time. The GUI provides several interfaces to define the necessary components like road networks, traffic signs, traffic vehicles, and sensors. Trajectories for all vehicles, objects and pedestrians are calculated in real time according to the defined traffic maneuvers. ASM Traffic supports specific scenarios such as oncoming traffic, stop and go, and pedestrians. The Traffic Editor is the user interface for very flexible and easy traffic scenario definition.

Offline and Online Simulation

The ASM Traffic model can be used in combination with real controllers in a hardware-in-the-loop environment (HIL or online mode), or for simulating a vehicle in combination with software controller algorithms together with dSPACE VEOS® (PC or offline mode). The model comes in three different versions and license types for online and offline simulation: ASM Developer, and ASM Runtime (p. 36). It supports real-time code generation via The MathWork's Real-Time Workshop® and dSPACE's RTI for online simulation on a dSPACE real-time system.

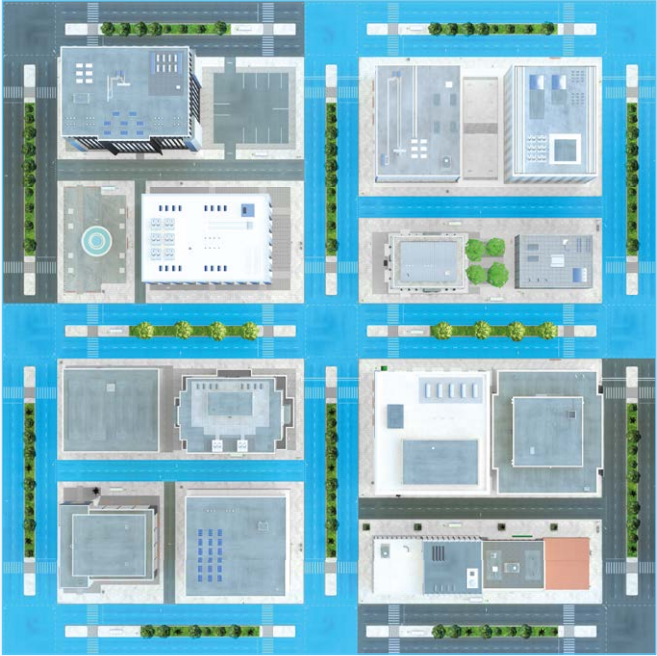
Working with ASM Traffic

Workflow for efficient traffic scenario creation

Workflow Steps

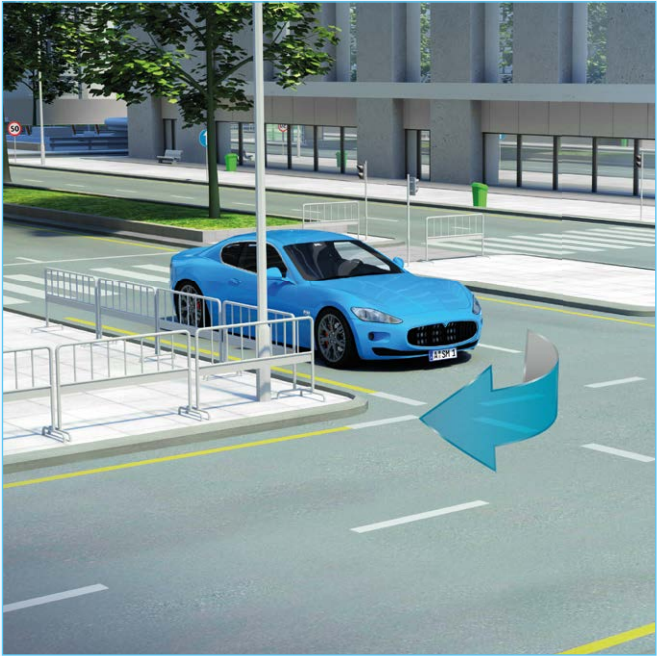
Road Network Definition

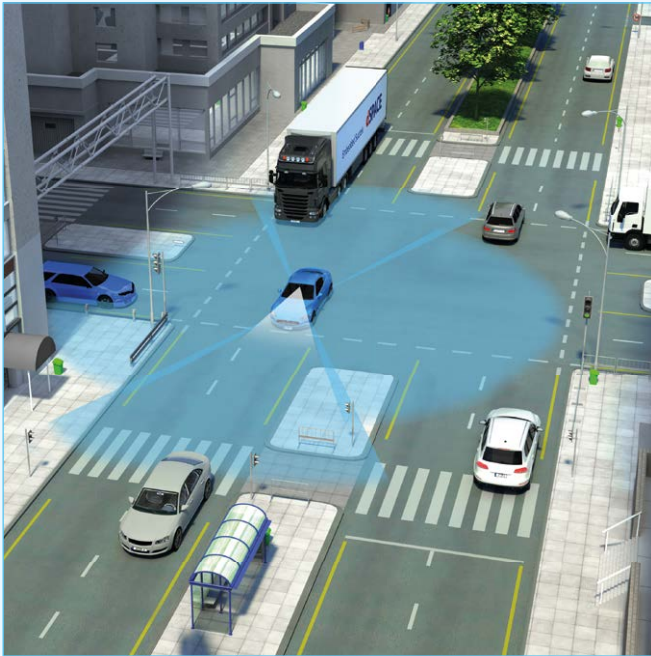
Start by defining roads and junctions graphically.



Maneuver Definition

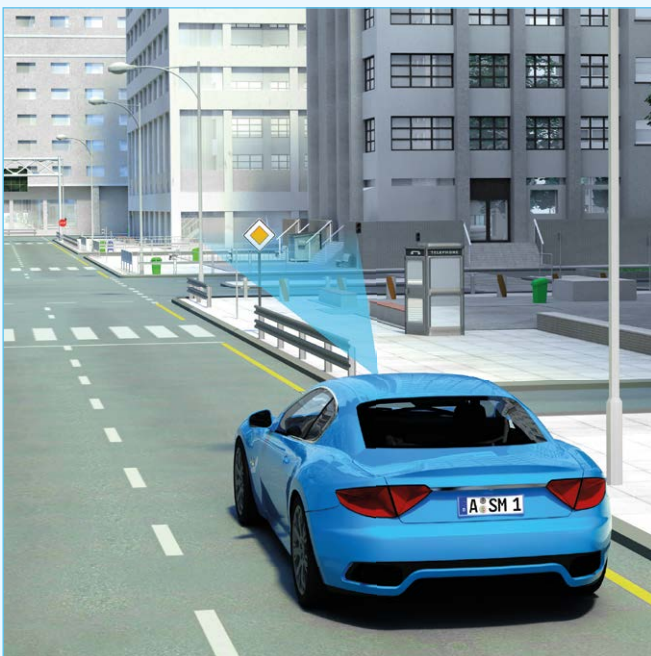
Define where and how the ego-vehicle drives on the road network.





Traffic Definition

Define where and how the surrounding fellow vehicles drive on the road network.



Object and Sensor Definition

Define traffic signs, obstacles and scenery along the road and sensors on the vehicle.

Road Networks

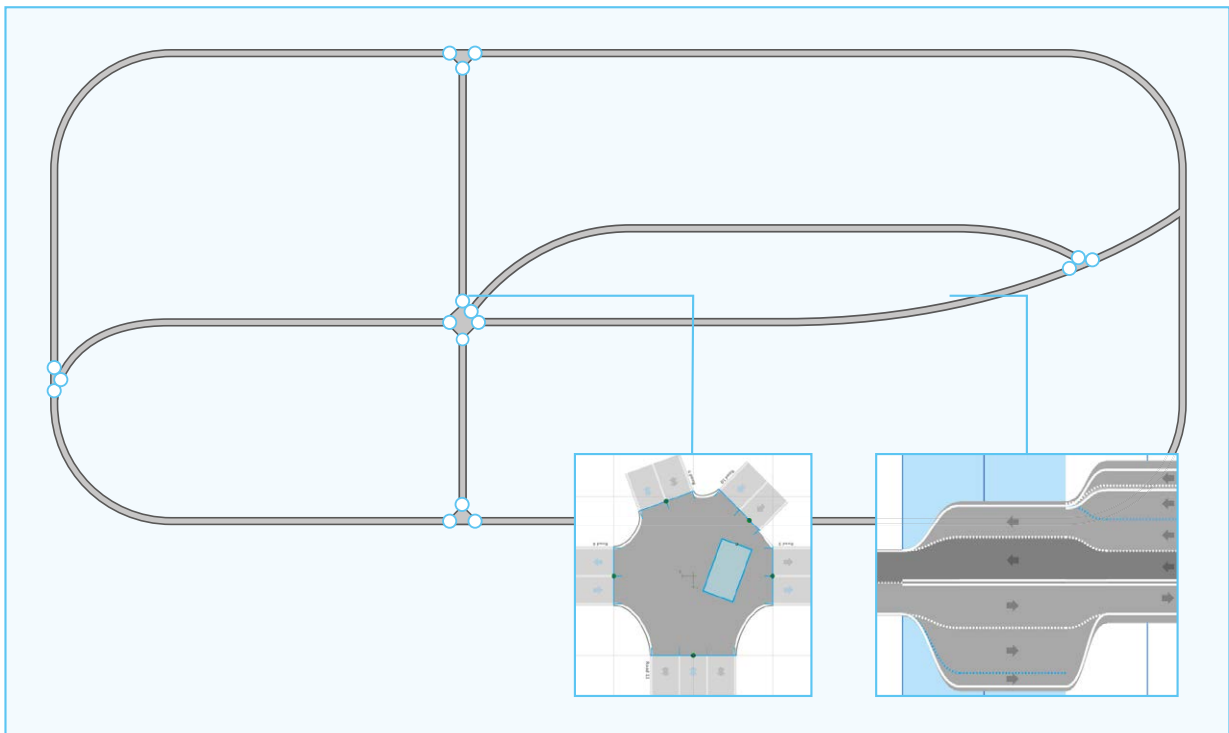
Virtual Road Definition

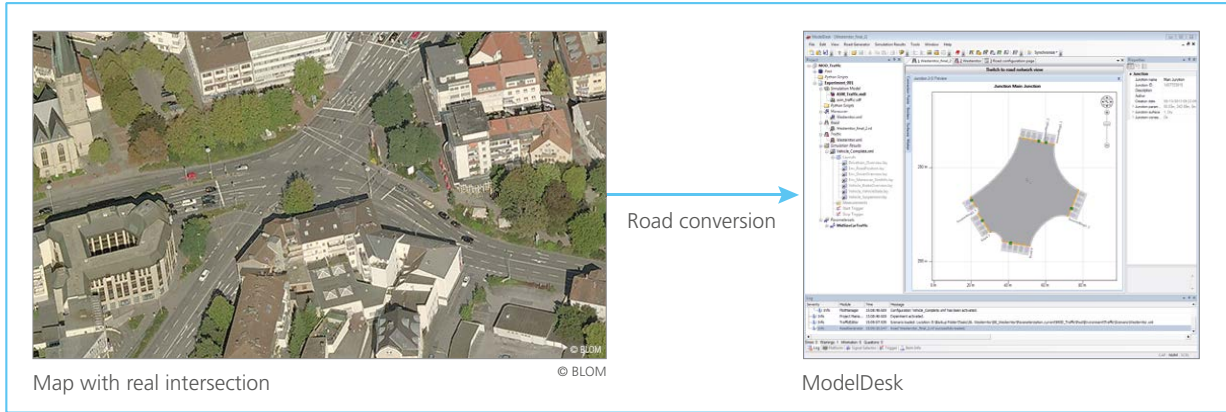
A road defines where to drive. ModelDesk provides a dedicated graphical user interface, the Road Generator, for creating road networks and sophisticated road features. A virtual road can be constructed manually from geometric segments, or complete road networks can be imported from map data. Features such as lanes, intersections, height, inclination, surface condition, etc., can easily be added to a

road by editing attributes that are displayed in 1-D diagrams. The whole road network is visualized in a 2-D view. The road design also interacts closely with the 3-D animation software MotionDesk to define the environment. The Road Generator gives ideal support to complex traffic scenario creation in the development and testing of advanced driver assistance systems (ADAS).

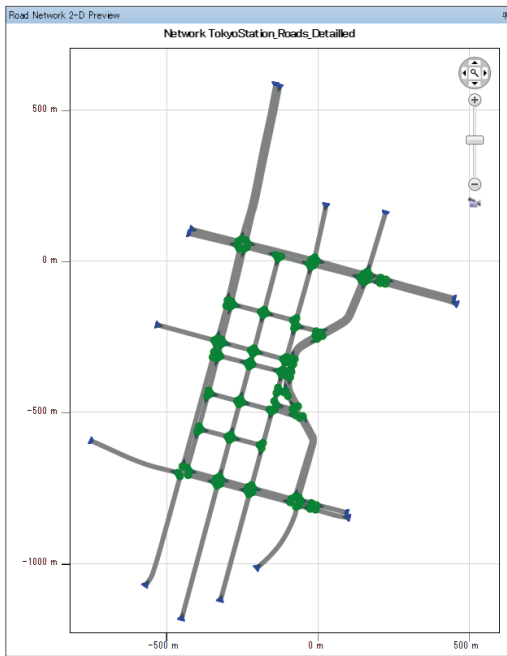
Features

- Road networks with roads and junctions defined graphically
- Segment- and coordinate-based road definition
- Up to 5 lanes per lane segment
- Lanes with smooth transitions and specific line definitions
- Height, inclination, and surface condition applied via segment-independent road coordinates
- Easy to define bumps, potholes, profiles, split μ areas, etc.
- Up to four different tire/surface conditions switchable online during maneuvers
- Road import from map data
- GPS coordinate exchange with turn-by-turn navigation development tools
- Road networks and predefined sceneries automatically imported and updated in MotionDesk (city center, country road, highways)
- Support for lane detection sensors
- **NEW:** Simulation of lines according to EU regulation 351/2012 and support of free lines and barriers for construction area simulation.
- **NEW:** Import and export of OpenDRIVE format





The Road Generator supports the import of map data and the definition of intersections and complex road networks.



Maneuvers

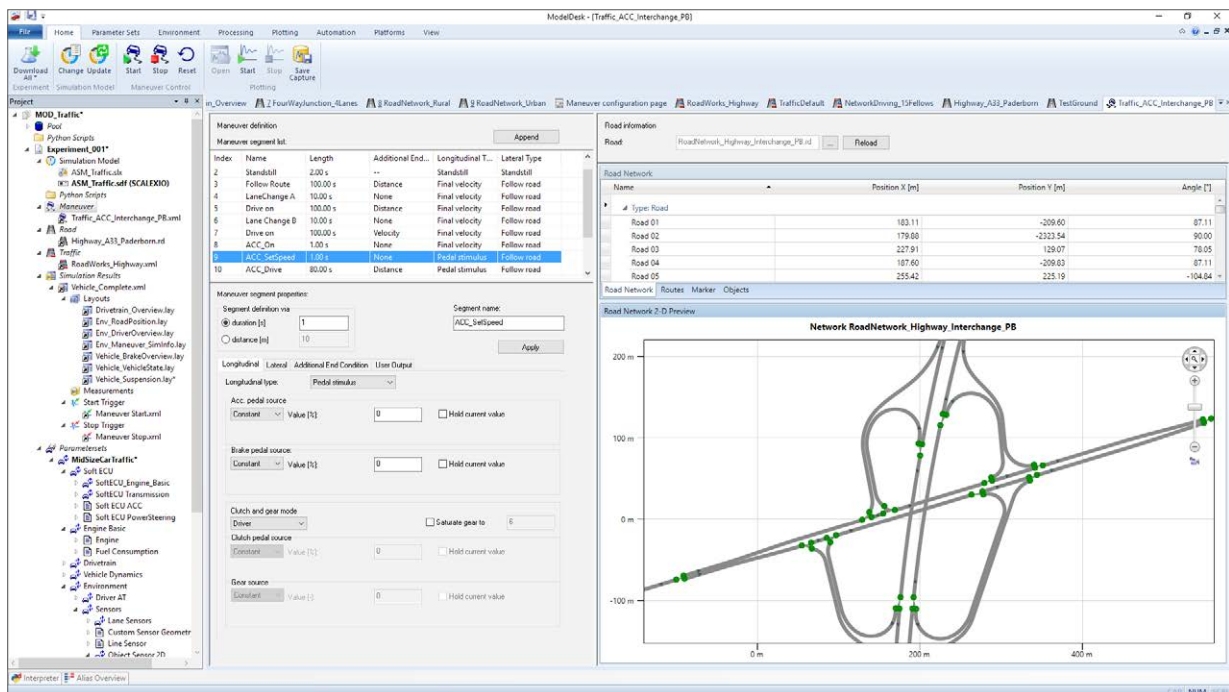
Ego-Vehicle Movement

A maneuver defines where and how the ego-vehicle drives on the road network. Maneuvers consist of several segments with their own individual properties. There can be simple maneuvers that just follow the road or very sophisticated ones based on several conditions and trigger events.

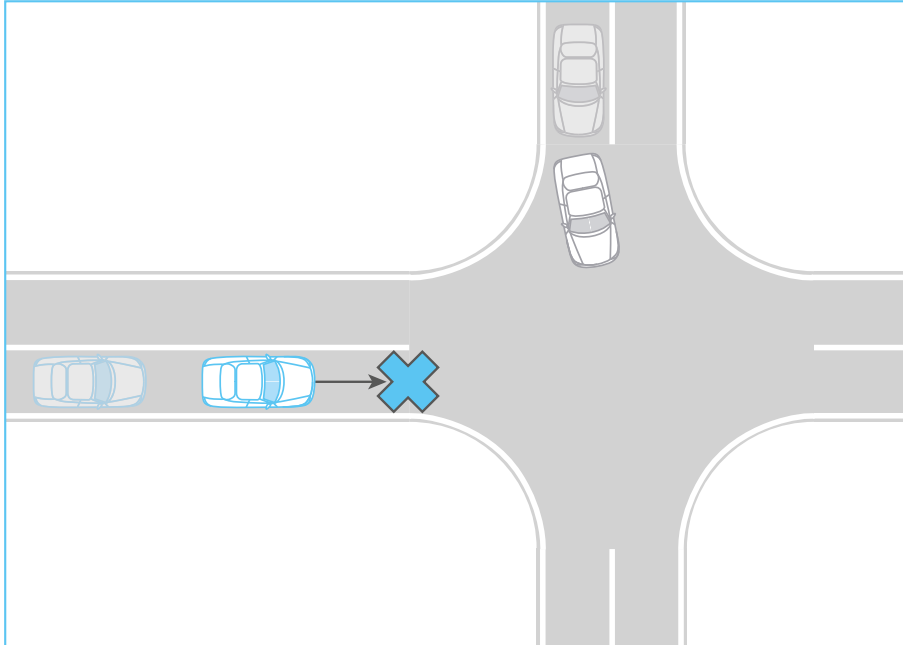
For instance, the ego-vehicle moves off into an intersection once another vehicle reaches a trigger point in the intersection. A maneuver also defines the driving lane and the lane changes of the ego-vehicle. The road or road network the maneuver relates to is visualized for intuitive maneuver creation.

Features

- Movement control of vehicle under test (ego-vehicle)
- Maneuver segments defined over distance or time
- Defining steering and pedal stimuli or driver-/road-based maneuvers
- Lane driving and lane transition/change definitions
- Trigger events for specific maneuver activities
- Velocity, steering or pedal actuation can be performed with measurement data (e.g., MAT files).
- User output signals programmable over time or distance
- External velocity and pedal access for man-in-the-loop use cases
- Open- and closed-loop maneuvers



The ASM Maneuver Editor: The list of maneuver segments and tabbed pages containing maneuver settings at the center, the imported road with segment information and a visual preview on the right.



Position markers on roads and junctions trigger actions when approached or left by a vehicle.



Visualization of the traffic scenario illustrated above.

Traffic

Traffic and Environment Simulation

A traffic scenario primarily defines where and how fellow vehicles and objects around the ego-vehicle move. The objects can be pedestrians, obstacles, etc. ASM Traffic supports traffic scenarios with one test vehicle and an unlimited number of independent fellow vehicles, all of which can perform any

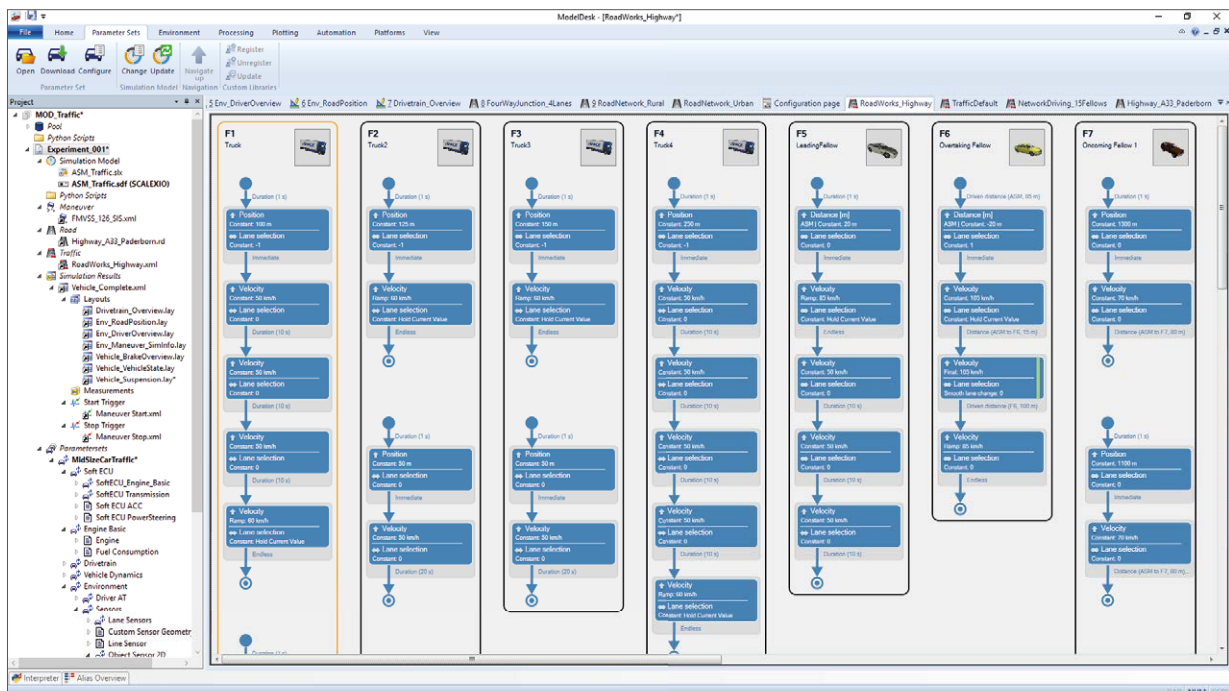
desired actions like lane changes, speed changes, crossing traffic, oncoming traffic, etc. The movements of the fellow vehicles on a road network are defined in the graphical user interface of the Traffic Editor.

Features

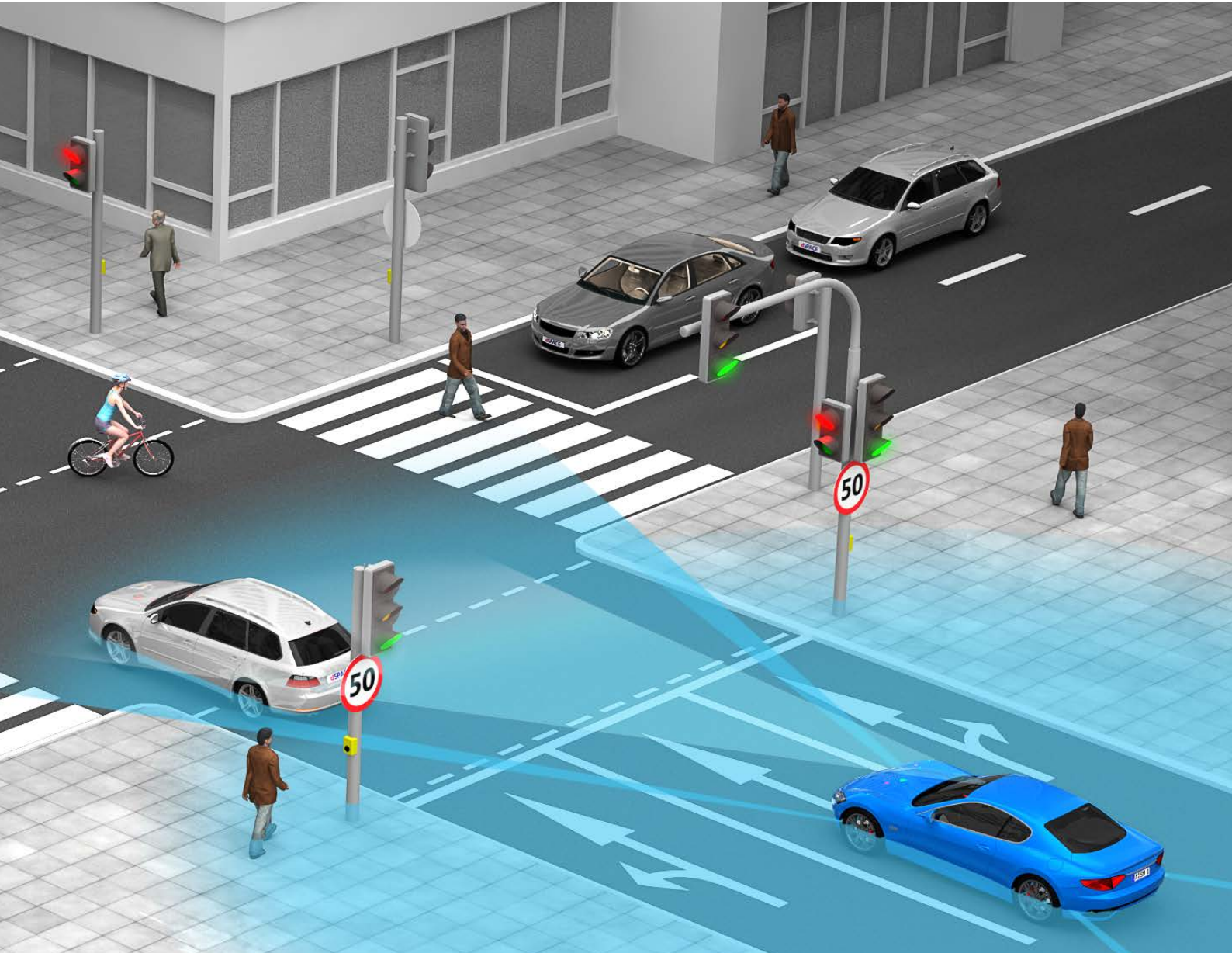
- Simulation of objects around ego-vehicle
- Definition of various traffic situations and complex scenarios
- Segment-based definition of fellow vehicle movements
- Lane driving and lane change definition
- Support for intersections
- Oncoming and crossing traffic
- Direct link between model and animation update
- **NEW:** Unlimited number of moving objects possible

Fellow Vehicle Movement

- Longitudinal
 - Velocity absolute or relative to another vehicle
 - Acceleration absolute or relative to another vehicle
 - Distance to another vehicle
- Lateral
 - Absolute distance to road center line
 - Relative distance to another vehicle
- Event-based transitions
 - Position
 - Distance
 - Velocity



Example of the traffic definition page.



The ego-vehicle and surrounding fellow vehicles.

Objects

Traffic Objects

Objects are the primary surroundings the ego-vehicle has to detect and react to. ASM Traffic supports static objects like traffic signs, traffic lights, parked vehicles, and houses,

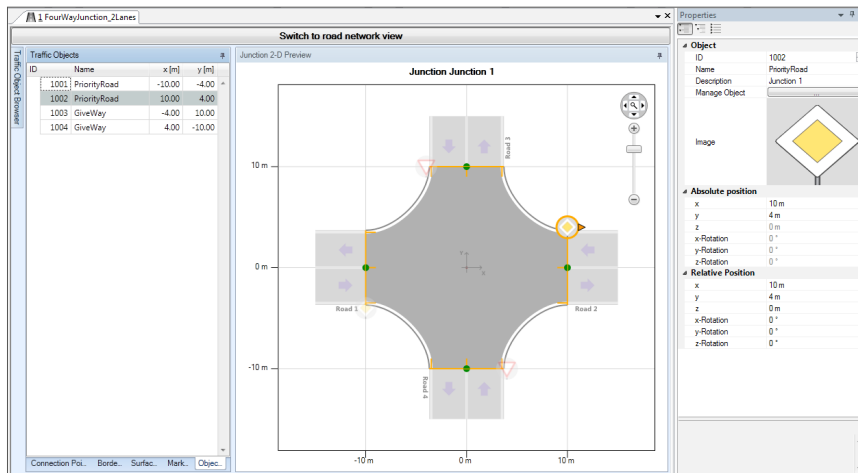
and moving objects like pedestrians. They can be placed on or beside roads and intersections. Objects are key elements in simulating ADAS maneuvers.

Features

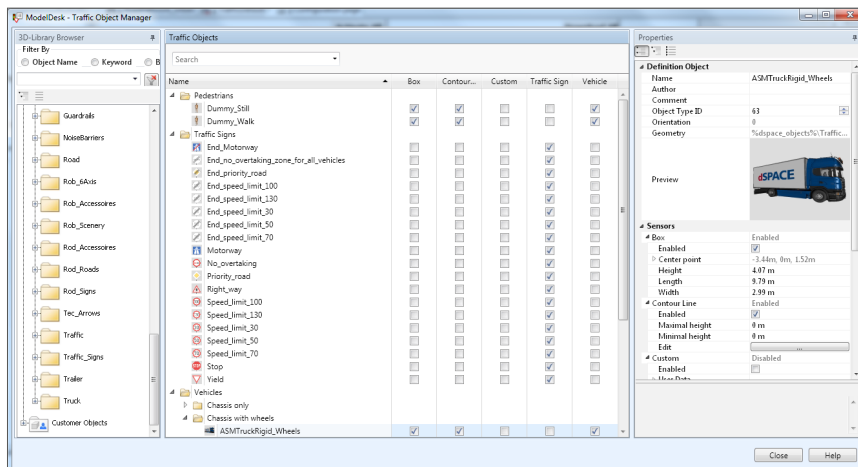
- Any number of traffic objects definable
- Road- and intersection-based positioning
- Graphical representation for MotionDesk
- Moving objects like pedestrians
- Non-moving objects like traffic signs, traffic lights, parked vehicles, houses

Environment Simulation for Various Use Cases:

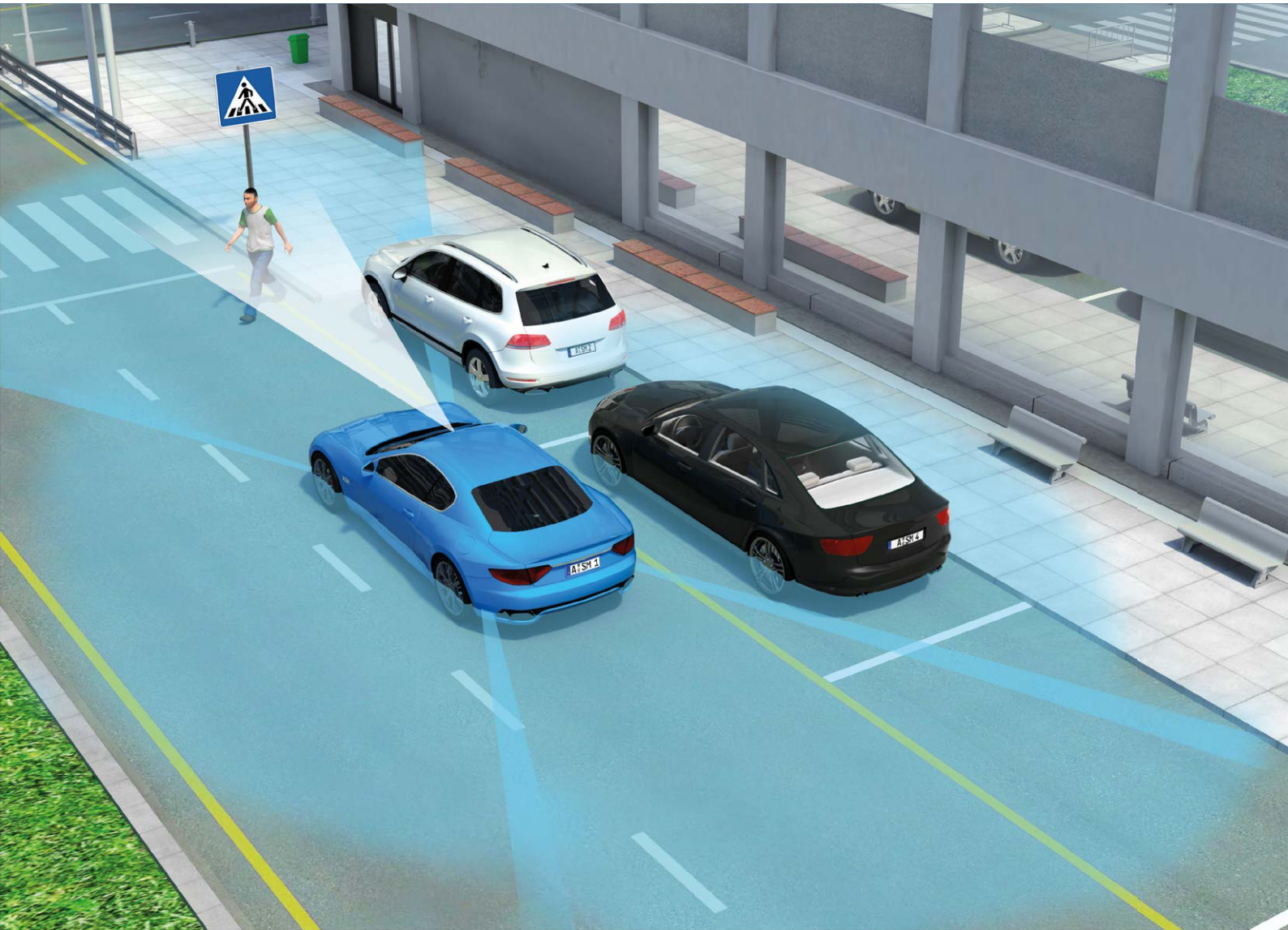
- Parking assistant
- Traffic sign recognition
- Car2x communication
- Emergency brake assistant



Definition of a traffic sign on an intersection.



Definition of a parked vehicle for parking assistant simulations.



The objects in ASM Traffic support various simulation scenarios: parked vehicles for automated parking, moving pedestrians for automated emergency braking, traffic signs for traffic sign recognition, etc.

Sensors

Sensor Models

Sensors are parts of the ego-vehicle that detect other traffic vehicles and traffic objects. ASM Traffic supports multiple sensors for distinct detection purposes, e.g., the contours of cars and humans, traffic signs, and obstacles. Contour recognition helps to identify humans and calculate the distance to a vehicle's side mirror during automated parking maneuvers.

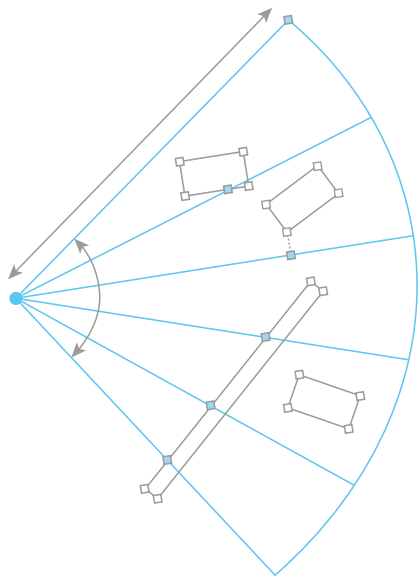
The sensor model uses a purely geometrical approach and supports sensors like radar, lidar and camera. Radio-wave-based sensors calculate the nearest point of each detected vehicle or object. The distance, relative velocity, relative acceleration, and relative horizontal and vertical angles for the nearest point of each detected object are also calculated.



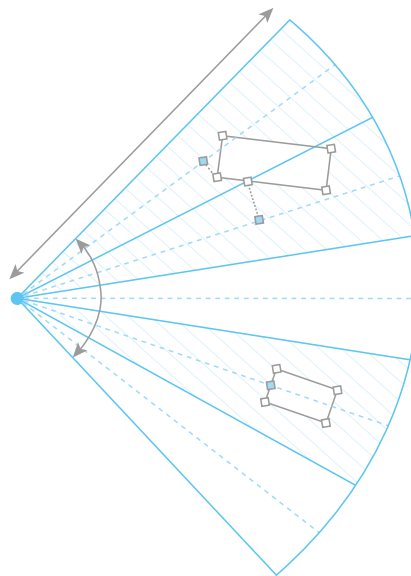
Detection of surrounding vehicles and traffic signs with the sensor model of ASM Traffic.

2-D Object Sensor

- Array of sensor rays in the x-y plane
- Detection of intersection points using the contour lines of traffic objects
- Calculation of relative distance and relative velocity
- Shadowing of objects
- Static and moving objects
- **NEW:** Free sector detection
- **NEW:** Realistic timing behavior



Detection mode: ray



Detection mode: sector

 occupied
 free

Custom Sensor

- Properties of traffic objects defined by the user
- Static and moving objects
- Size and orientation of objects not considered
- Sensor can be combined with other sensor types



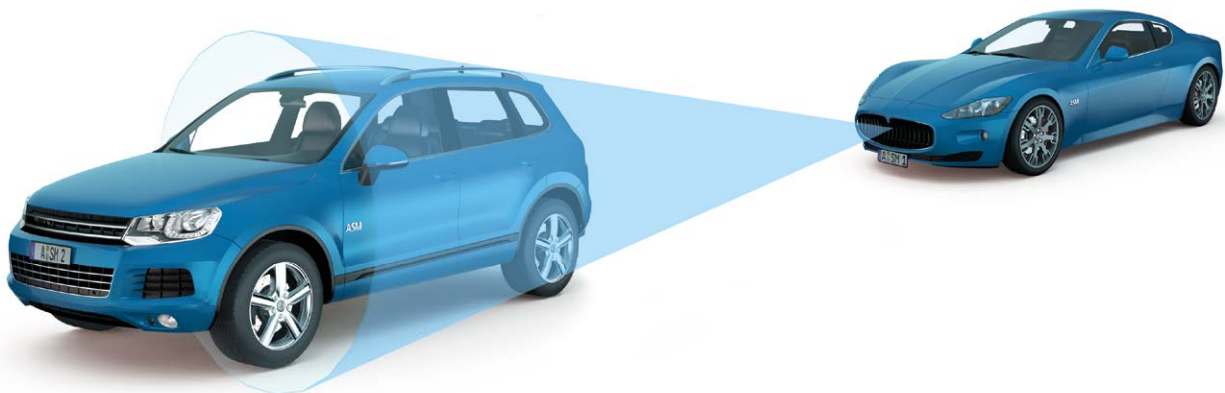
Traffic Sign Sensor

- Detection of traffic signs



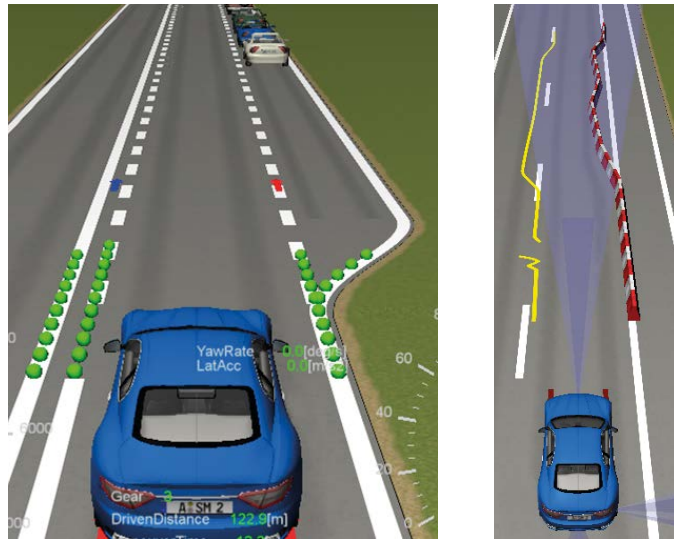
3-D Object Sensor

- **NEW:** 3D-sensor with realistic cone scope and timing behaviour
- Radar, lidar and camera sensors
- Detection of static and moving objects
- Distance measurement
- Relative velocity and relative acceleration measurement
- Horizontal and vertical angle measurement








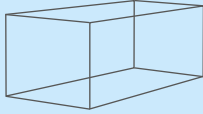
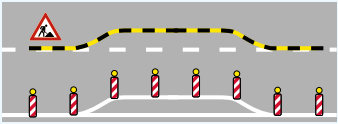

Line Sensor

- Detection of road markings, lines and objects
- Supported line/object types:
 - Road lanes
 - Junction borders
 - Free lines
 - Barriers



Detection of road markings, free lines and objects.

Overview of Objects and Sensors

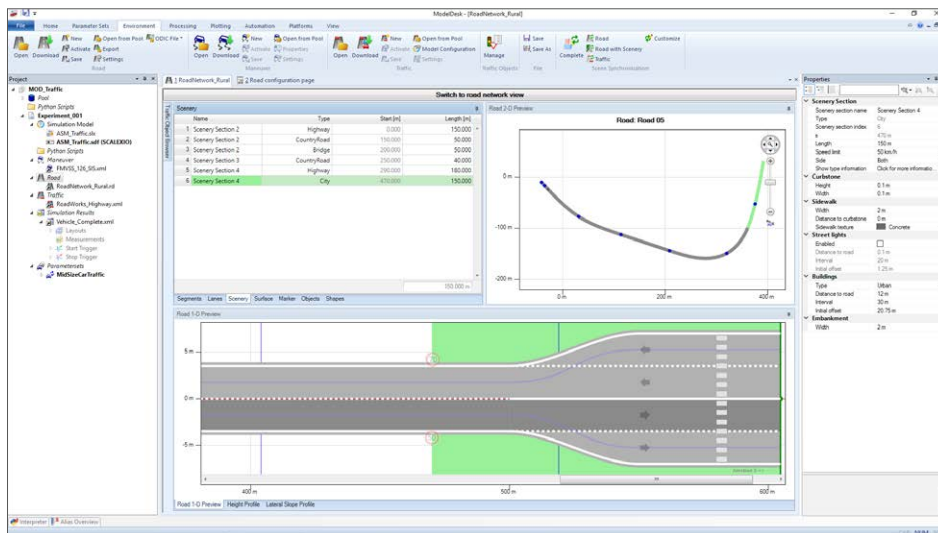
Sensor Type	Object	Sensor Output
Traffic Signs		Speed limit, 80
2D		
Custom		Adult / Child
3D		
Line		

Visualization and Animation

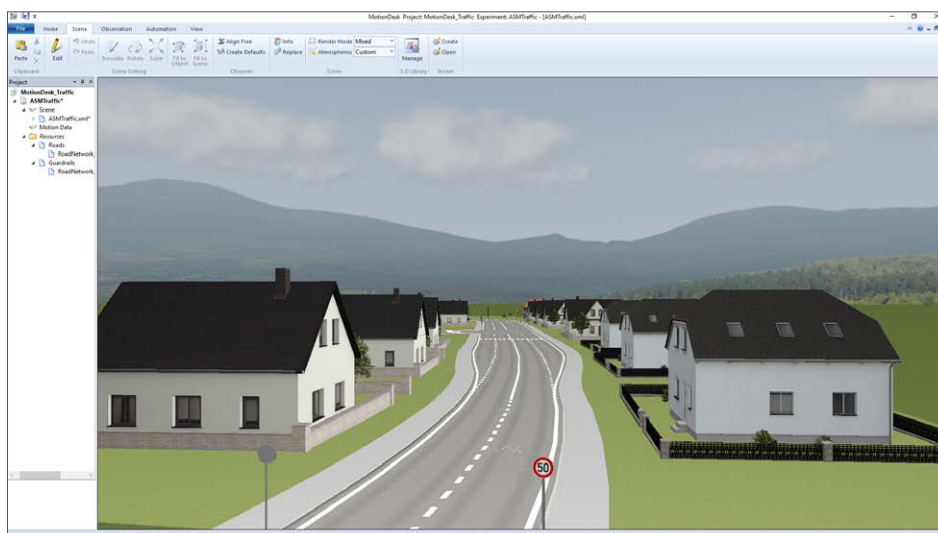
3-D Online Animation

Traffic scenarios simulated with ASM Traffic can be visualized by real-time 3-D animation in MotionDesk. ModelDesk and MotionDesk work hand in hand. Updates in ModelDesk can immediately be viewed in MotionDesk. ModelDesk lets you define scenes for the automatic generation of 3-D sceneries in MotionDesk. For example, you can define rural roads, tree-

lined roads, and urban areas. Moreover you can completely parameterize them with a road embankment or border area, tree spacing, reflector posts, street lamps, building types, and so on. Fine tuning can be made afterwards in MotionDesk and its integrated Scene Editor.



Defining scene types in ModelDesk ...

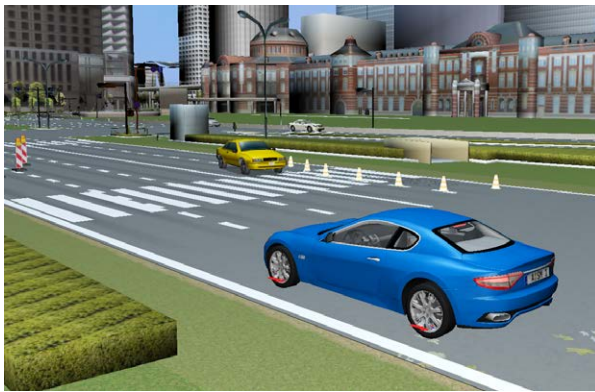


... automatically generates the scenery for MotionDesk.

Realistic Visualization

With MotionDesk, traffic simulations become clear and easy to understand because the real-time 3-D animation leads to realistic visualization. For best results, the 3-D animation software MotionDesk supports the import of 3-D models that precisely simulate the traffic environment. The scenery is always rendered in high resolution for realistic results.

Example renderings of urban scenarios:



Renderings based on 3-D models provided courtesy of ZENRIN CO., LTD.

ModelDesk

The Graphical User Interface

The ModelDesk Concept

ModelDesk is a graphical user interface for simulation, intuitive model parameterization and parameter set management. It also provides project handling and allows parameter sets to be downloaded to offline and online simulations. It

supports tool automation via COM interface. ModelDesk can be used seamlessly from parameterization to offline and online simulation, and finally to parameter and result management.

Main Features

- Graphical user interface
- Parameter set management
- Offline and online simulations
- Road Generator
- Traffic Editor
- Maneuver Editor
- Tool automation
- Custom model parameterization

Benefits

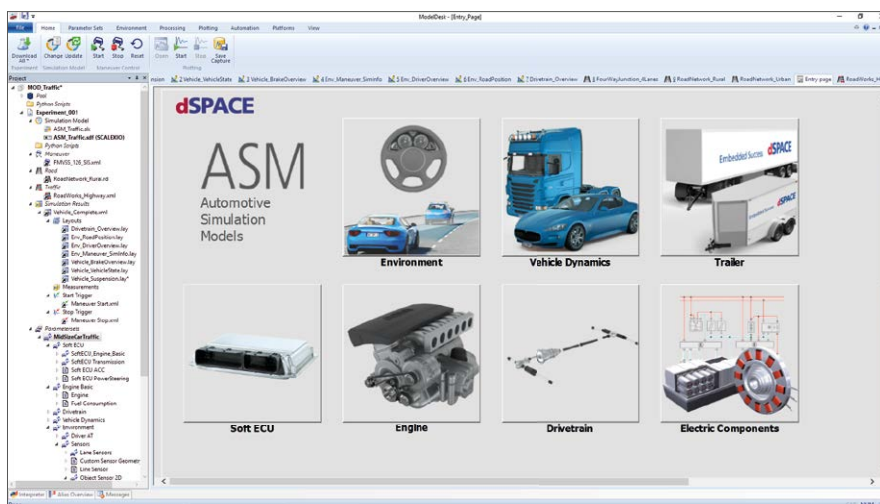
- Seamless simulation process from MIL to HIL
- Intuitive, graphically supported parameterization
- Parameterization during online (dSPACE SCALEXIO®) and offline (Simulink) simulations
- Managing parameter sets and entire projects

Graphical Handling

Graphically Supported Parameterization

The model components and their subsystems are represented by graphics that are structured in a hierarchy. The model components to be parameterized can be selected from the

top level. Users have the vehicle model in front of them and can browse through its systems, guided by graphical representations of the modeled components.



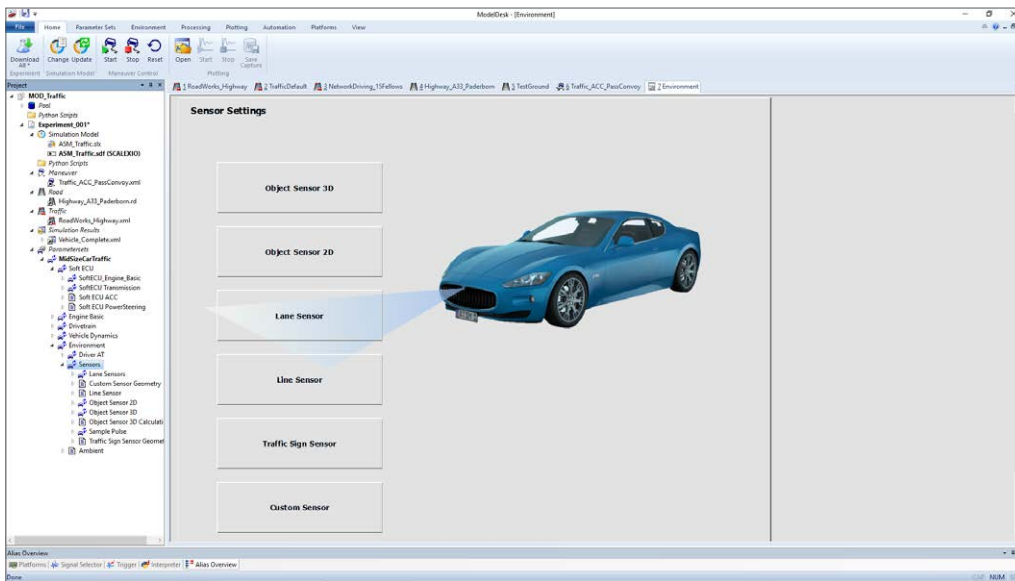
ModelDesk's top-level dialog for selecting model subsystems for configuration and parameterization.

Parameterization

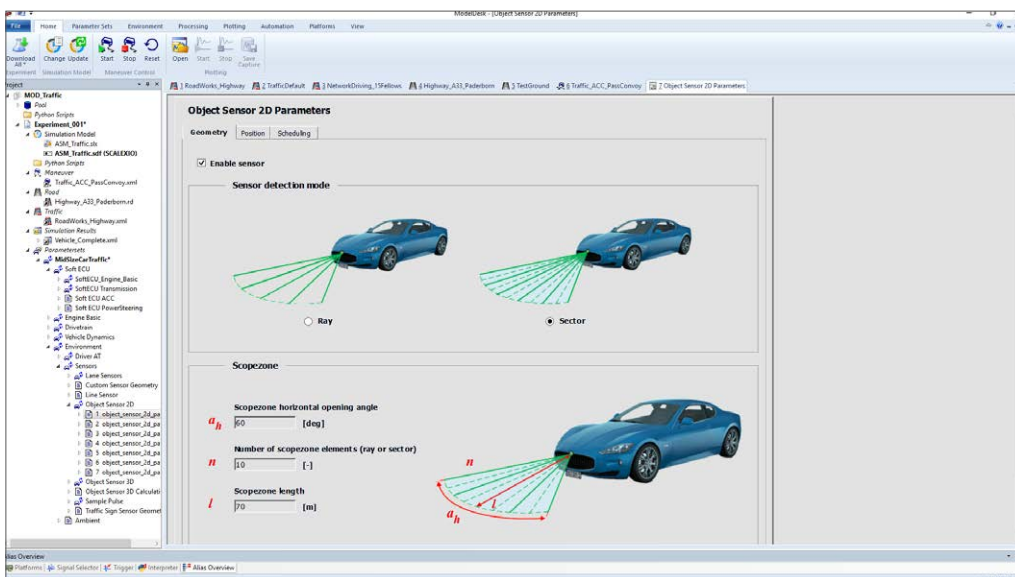
Parameter Handling

For manual parameter entry, ModelDesk has parameter pages with illustrations for each component. Parameters are entered in controls next to the components. Table param-

eters can be visualized as 3-D graphs and modified using a table editor.



Navigation page to select sensor types for parameterization.



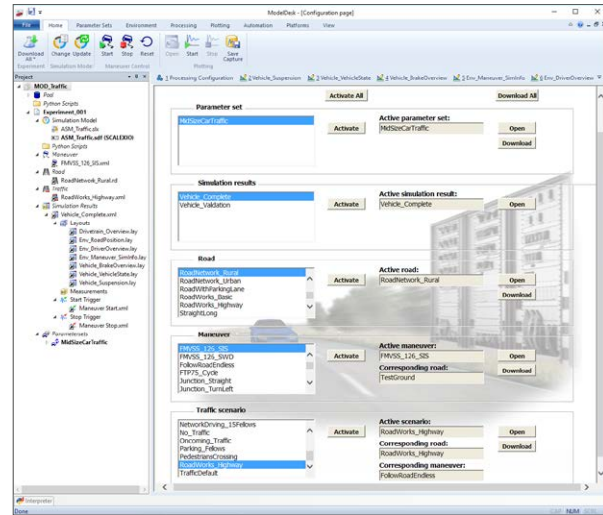
Parameter page for the sensor model.

Managing and Analyzing Simulations

Simulation Management

ModelDesk includes powerful functions for directly executing and displaying simulations, and managing their results:

- Starting and stopping a simulation
- **NEW:** Maneuver control: starting and stopping vehicle dynamics maneuvers and traffic scenarios.
- Plotters for visualization
- Saving, comparing and managing simulation and measurement data
- Saving simulation experiments (driving maneuvers, roads, traffic, etc.)



Configuration of a simulation experiment consisting of a vehicle model, road, maneuver and vehicle parameters.

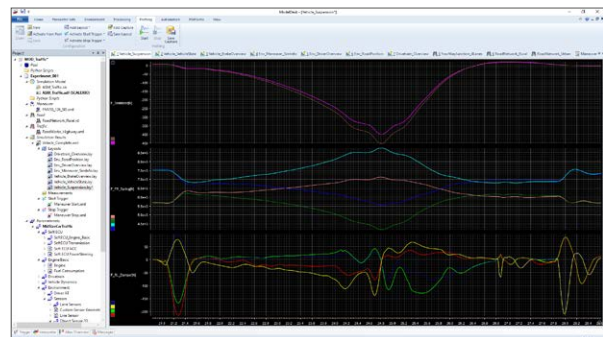
Plotter

ModelDesk features an integrated plotter which displays signals from the ASMSignalBus. The signals have the same structure as in the Simulink model. The bus can include user-defined signals. Plotter configurations can be defined and stored, and the same single configuration can be used seamlessly online (HIL simulations) and offline (Simulink

simulations). A configuration includes the following data: simulation results, measurements, and parameter sets consisting of vehicle parameters, roads, maneuvers, and/or traffic. A configuration collects together all the sources and conditions that the plotted results are based on.

Features

- Plots of ASM signal buses
- Plots of user-defined signals
- Plotter configurations can be saved
- The same configuration to be used online and offline
- Plot printouts
- Configuration comprises measurements, simulation and parameters



ModelDesk's plotter displaying various vehicle signals.

Automation Features

Tool Automation

Remote Control for ModelDesk

To perform long-term tests or parameter studies, ModelDesk provides script-based tool automation. This offers users maximum flexibility for defining custom simulation scenarios. Tool automation can be performed by means of scripting languages like Python and MATLAB M scripts.

Functionality

All ModelDesk's functions for experiment management and model parameterization that are available via its GUI can now also be accessed via its COM (Component Object Model of Microsoft Windows) interface. You can load existing model parameterization projects and activate predefined experiments. All the vehicle parameters such as the vehicle mass, suspension kinematics, engine torque, additional loads, and also environment or maneuver settings like road friction or vehicle velocity, can be controlled from within scripts.

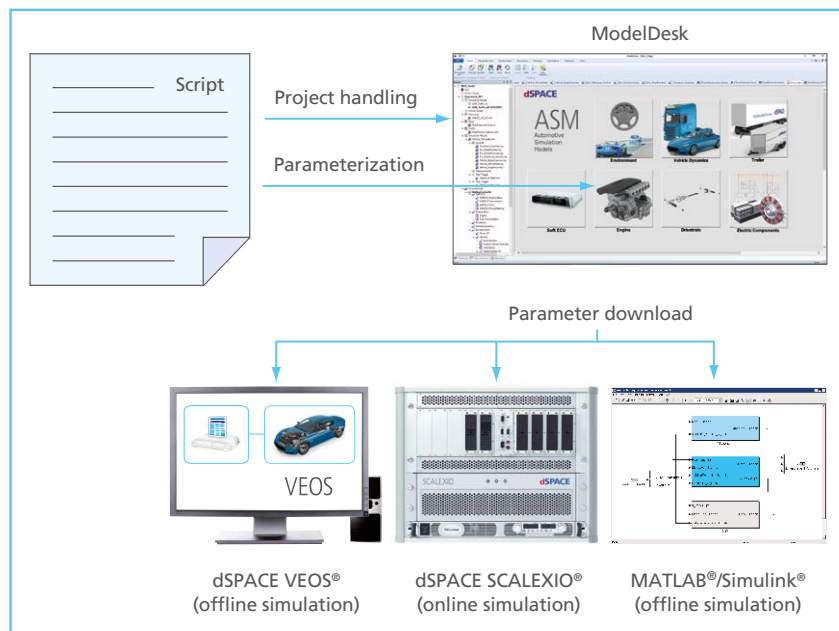
Features

- Script-based tool automation
- Direct access to project and experiment management
- Direct alteration of all vehicle model parameters
- Direct alteration of maneuver segments
- Direct alteration of road features

Benefits

- Simulation-based parameter studies
- Automated marginal condition analyses/detection
- Long-term behavior studies
- Sequential maneuver executions
- Seamless integration into automation systems for HIL test

The script-based tool automation for ModelDesk provides functionality for parameter set management and for direct model parameterization. The parameters of online and offline simulations can be changed during a simulation run.

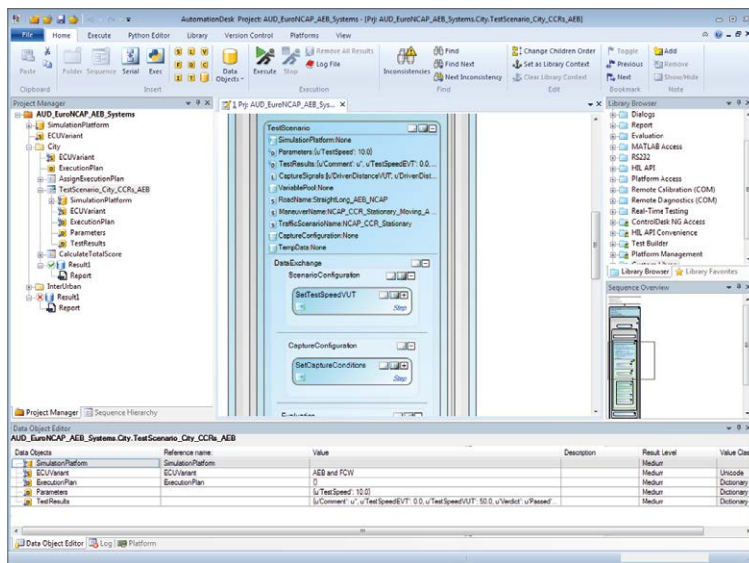


Test Automation

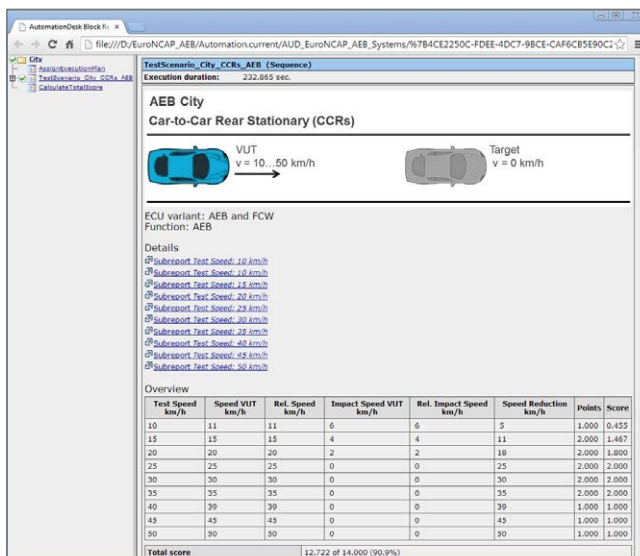
Traffic Test Scenarios

AutomationDesk is dSPACE's environment for powerful and convenient test automation. With the ModelDesk Access Library, tests created in AutomationDesk can control ModelDesk directly. Tasks such as changing parameters, switching between configurations and initiating simulation runs can therefore all be automated. Moreover project management,

road and maneuver handling, and parameter access are prepared by generic automation steps. Maneuver-based tests can easily be created when these steps are combined with standard evaluation routines that are applied to acquired measurements results. A comprehensive report details the results.



Test scenario for AEB City in AutomationDesk.



AutomationDesk test report for AEB City.

Simulating Autonomous Driving

Performing multiple instances of ASM Traffic by cluster simulation

The Task

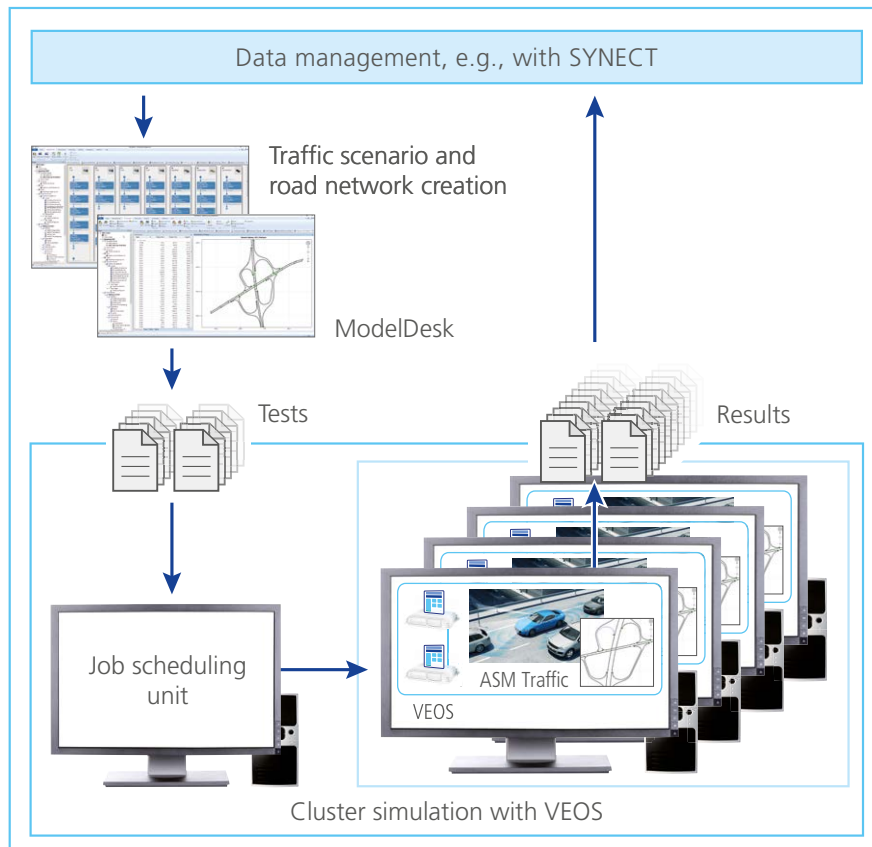
- Simulation-based evaluation of vehicle software for highly automated driving functions and self-driving cars.
- The introduction of a growing number of automated driving functions requires a powerful test environment that can handle an exponentially increasing number of tests in early development phases.

The Challenge

- Automated simulation of different traffic scenarios on a broad range of road networks and with different environmental conditions.
- Large number of tests due to scenario variations and randomized testing.
- Simulation of millions of test kilometers/miles.
- Consistent management of test parameters and result analysis.

The Solution

- Graphical definition of road networks and traffic scenarios in ModelDesk.
- Simulation of many different traffic scenarios comprising a multitude of road-users with ASM Traffic.
- Cluster simulation on the simulation platform dSPACE VEOS® that is faster than real-time.
- Data management and traceability via dSPACE SYNECT®.

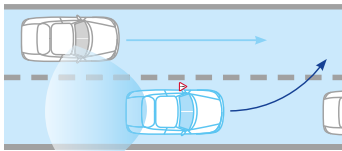


Outline: Multiple ASM Traffic scenarios are simulated on a VEOS cluster.

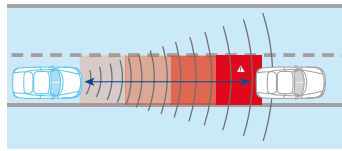
Use Cases

Typical traffic scenarios supported by ASM Traffic for ADAS development in the area of safety, comfort and efficiency.

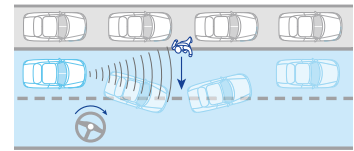
Safety and Active Safety



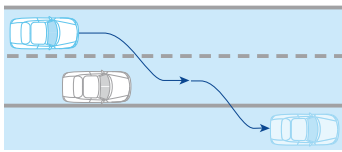
Blind spot detection



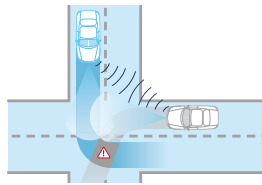
Brake assistant and autonomous emergency braking (AEB)



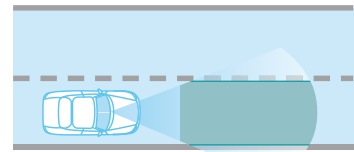
Emergency steer assistant



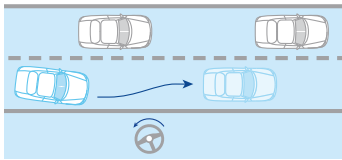
Emergency stop assistant



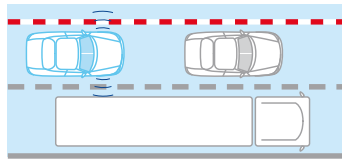
Intersection assistant



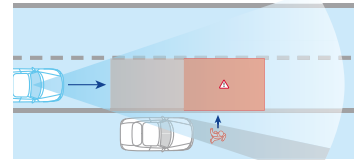
Lane departure warning



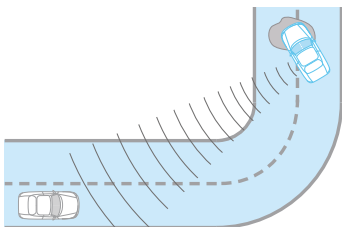
Lane keeping support



Narrow passage assistant



Pedestrian/VRU detection and AEB

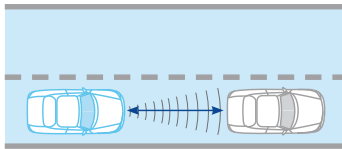


Emergency electronic brake light



More use cases:
ASM Video Channel
www.dspace.com/go/asm_video

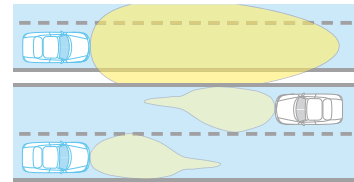
Comfort



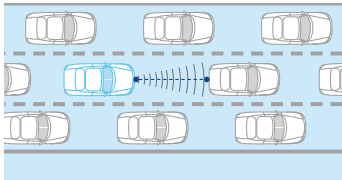
Adaptive cruise control (ACC)



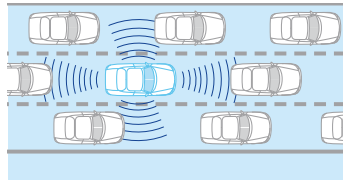
Automated parking pilot



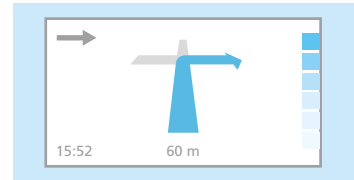
High- and low-beam assistant



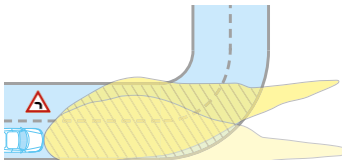
Highway assistant



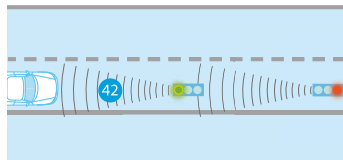
Highly automated driving



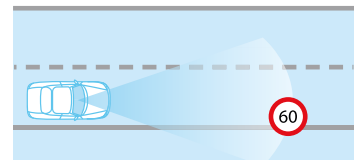
Navigation system



Predictive headlights

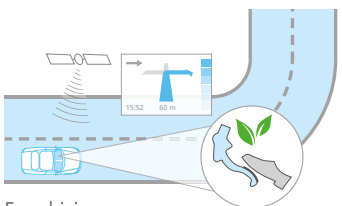


Traffic flow assistant

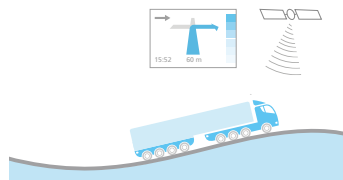


Traffic sign recognition

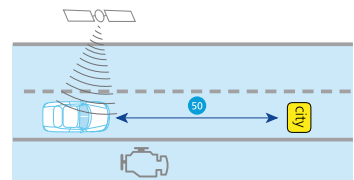
Energy Efficiency



Eco-driving

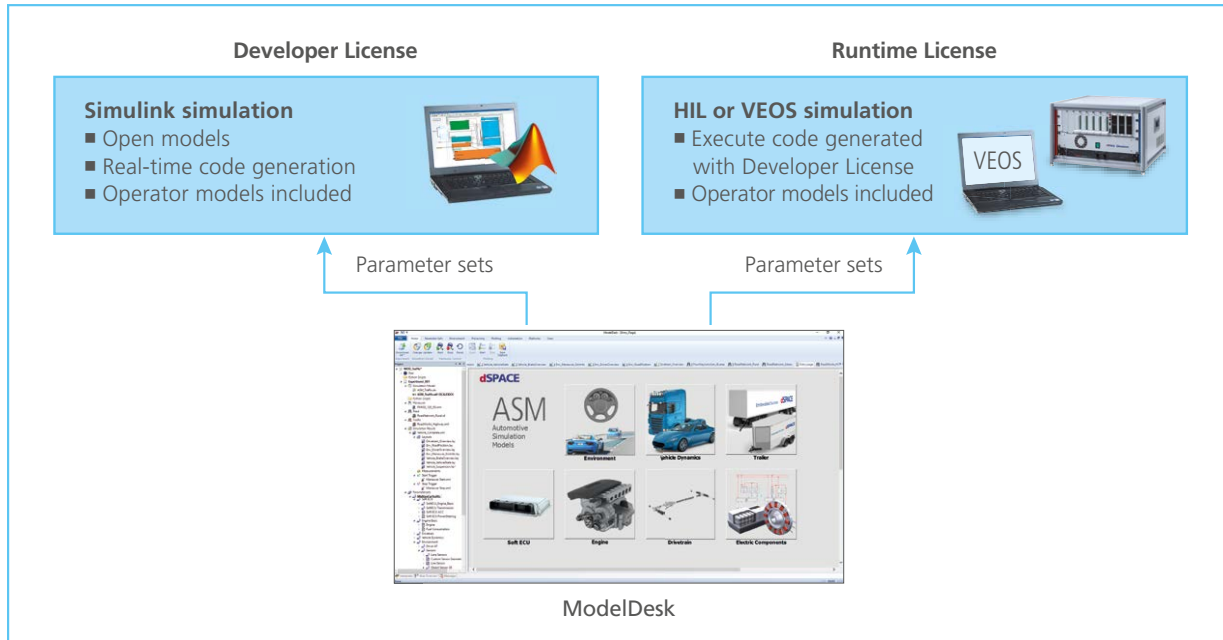


Predictive cruise control



Predictive engine management

ASM Versions and Licenses



The ASM License Concept

The ASM models come with two different license types: the Developer License and Runtime License. This lets users integrate the models in various kinds of applications, without losing any of the characteristic ASM flexibility.

- **Exchangeability** – You can use both licenses on one PC or split them to have one PC for model maintenance and one PC for simulation platform operation.
- **Mutual Parameterization** – Both license types let you parameterize all models with ModelDesk's parameterization options for simulation on a PC (offline) or on dSPACE real-time hardware (online).
- **Seamless 3-D Animation** – The vehicle dynamics and traffic models provide access to MotionDesk with both license types. The models must include the MotionDesk blockset.

The Benefits

- A simulation environment that seamlessly covers the offline and real-time worlds
- ModelDesk is the parameterization tool throughout the entire process, which means that you can reuse parameter sets.
- Cost-efficient license types for offline and online (real-time) simulation
- Simulation models are parameterized and reconfigured in ModelDesk with the Runtime License also. This enables real-time simulation on a dSPACE platform without an additional MATLAB license.

ASM Developer License

The Developer License is designed specifically for modifying, parameterizing and preparing the open Simulink models for simulation on a real-time platform. The license lets you generate real-time code. Moreover, the license can be used for Simulink simulation on a PC (offline).

Properties

- Modular *developer models* viewable down to the Simulink block level
- Modular, encapsulated *operator models*, designed specifically for Simulink simulation (offline)
- Easy substitution or extension of ASM models by customer-specific model parts
- Support for real-time and VEOS code generation
- Simulink simulation on a PC (offline)

ASM Runtime License

The Runtime License is designed specifically for simulation on a real-time platform (online) and Simulink simulation of *operator models* (offline).

Properties

- Code execution on dSPACE real-time hardware (dSPACE Simulator, SCALEXIO)
- Code execution on dSPACE VEOS
- Code already generated from the models via the Developer License
- Simulink simulation of *operator models*, which are modular, encapsulated, and designed specifically for Simulink simulation (offline).

Technical Aspects

Parameters, Signals, and Performance

Parameters Sets and Examples

The model is preconfigured with default data, which means that all parameters and tables have suitable values and are fully functional. The model comes with standard driving maneuvers like ACC cut in, ACC cut out, pedestrian recognition, AEB city, AEB interurban, etc. It is therefore ready to use immediately after installation.

Performance

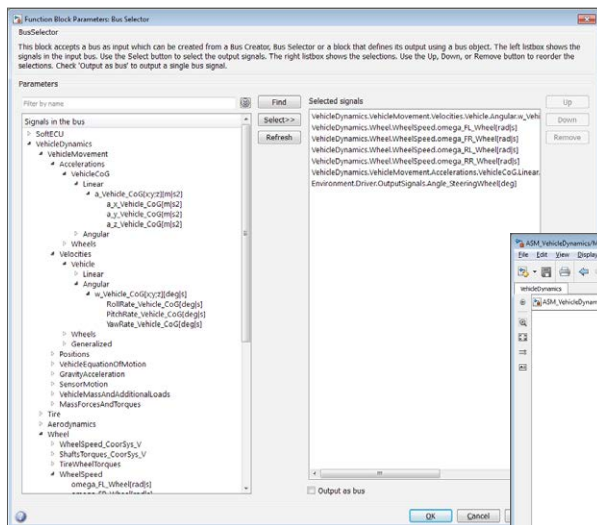
At a sample time of 1 ms, the model's turnaround time is about 10% of the total available processing time when executed on a dSPACE processor board clocked at 2.2 GHz. There is therefore enough headroom for I/O operations and other calculations.

Parameters Tunable Online

The parameters of the model can be tuned while the model is performing a real-time simulation on dSPACE SCALEXIO. A parameter (sensor position, etc.) is implemented as a single constant block in the model. ControlDesk provides access to each parameter when the model is used in online mode.

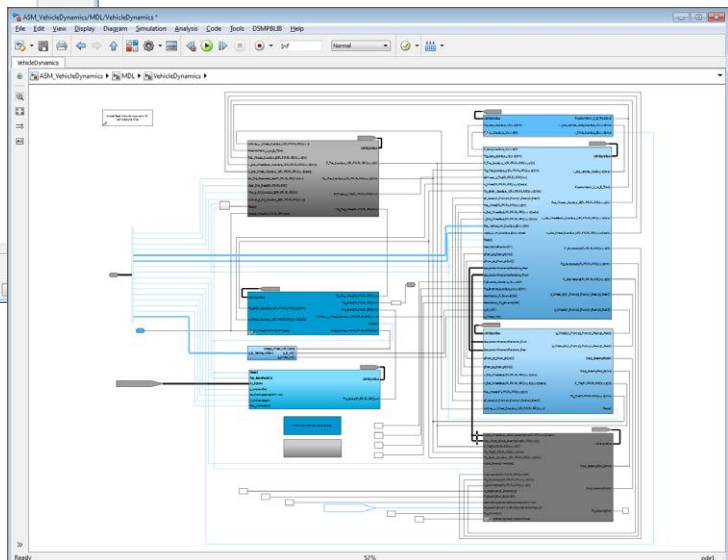
ASMSignalBus

The ASMSignalBus comprises the relevant signals of all model components in a hierarchical structure. Signals for I/O access with an interface board or for display with a Simulink Scope can be chosen conveniently via a Simulink Bus Selector.



ASMSignalBus displays all the relevant signals in a clear structure.

The ASM Simulink model with the main components and signals.



Main Features and Benefits

Feature	Description	Benefit
Open Simulink models	<ul style="list-style-type: none"> Almost all models are open down to the Simulink block level 	<ul style="list-style-type: none"> Custom models can easily be added or used to replace model components
ModelDesk	<ul style="list-style-type: none"> Graphical user interface with parameter and simulation management 	<ul style="list-style-type: none"> Easy, intuitive parameterization and seamless simulation handling
Online simulation	<ul style="list-style-type: none"> Real-time simulation on real-time hardware 	<ul style="list-style-type: none"> Hardware-in-the-loop simulations with ECUs
Offline simulation	<ul style="list-style-type: none"> Simulations as early as the design phase 	<ul style="list-style-type: none"> Controller validation in early development stages
ASMSignalBus	<ul style="list-style-type: none"> Simulation signals are part of a structured Simulink signal bus 	<ul style="list-style-type: none"> Standardized and fast access to model variables
Online tunable parameters	<ul style="list-style-type: none"> Direct parameter access during real-time simulations 	<ul style="list-style-type: none"> Online parameter optimizations and behavior studies
Model interoperability	<ul style="list-style-type: none"> ASM models are easy to combine to create a virtual vehicle 	<ul style="list-style-type: none"> An entire virtual vehicle can be simulated

Order Information

Classification	Type	Order Number
Packages	ASM – Gasoline Engine Basic Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Gasoline Engine Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Diesel Engine Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Gasoline Engine InCylinder Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Diesel Engine InCylinder Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Vehicle Dynamics Simulation Package for VEOS®	<ul style="list-style-type: none"> Please inquire
	ASM – Vehicle Dynamics Simulation Package	<ul style="list-style-type: none"> Please inquire
	ASM – Truck and Trailer Simulation Package	<ul style="list-style-type: none"> Please inquire
Libraries	ASM – Turbocharger	<ul style="list-style-type: none"> ASM_L_TC
	ASM – Electric Components	<ul style="list-style-type: none"> ASM_L_EC
	XSG – Electric Component	<ul style="list-style-type: none"> XSG_EC_LIB
	ASM – Brake Hydraulics	<ul style="list-style-type: none"> ASM_L_BH
	ASM – Diesel Exhaust System	<ul style="list-style-type: none"> ASM_L_DEXH
	ASM – Traffic	<ul style="list-style-type: none"> ASM_L_TRF
	ASM – Pneumatics	<ul style="list-style-type: none"> ASM_L_PNEU
	ASM – KnC	<ul style="list-style-type: none"> ASM_L_KNC

Relevant Software and Hardware

Software		
Required	Integrated development environment	<ul style="list-style-type: none"> MATLAB/Simulink from MathWorks Simulink® Coder™ (formerly Real-Time Workshop®)²⁾ Simulink Accelerator¹⁾
	dSPACE implementation software	<ul style="list-style-type: none"> Real-Time Interface (RTI)²⁾
	dSPACE experiment software	<ul style="list-style-type: none"> ControlDesk®²⁾
	Additional software	<ul style="list-style-type: none"> Microsoft® Excel®
	Operating system	<ul style="list-style-type: none"> www.dspace.com/go/os_compatibility

Hardware		
	Recommended system	<ul style="list-style-type: none"> Intel® Core™ i7 Processor Memory ≥ 8 GB RAM Dual-head graphics accelerator card matching the requirements of MotionDesk³⁾
	SCALEXIO or dSPACE Simulator (equipped with DS1006 Processor Board or DS1007 PPC Processor Board), MicroLabBox	

¹⁾ Offline simulations only ²⁾ Online simulations only

³⁾ Graphics accelerator required for MotionDesk which is part of the ASM Vehicle Dynamics Simulation Package.
More details on graphics card requirements and compatibility at www.dspace.com/go/mdhwreq

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Germany

dSPACE GmbH
Rathenaustraße 26
33102 Paderborn
Tel.: +49 5251 1638-0
Fax: +49 5251 16198-0
info@dspace.de

United Kingdom

dSPACE Ltd.
Unit B7 · Beech House
Melbourn Science Park
Melbourn
Hertfordshire · SG8 6HB
Tel.: +44 1763 269 020
Fax: +44 1763 269 021
info@dspace.co.uk

France

dSPACE SARL
7 Parc Burospace
Route de Gisy
91573 Bièvres Cedex
Tel.: +33 169 355 060
Fax: +33 169 355 061
info@dspace.fr

China

dSPACE Mechatronic Control
Technology (Shanghai) Co., Ltd.
Unit 1101-1105, 11F/L
Middle Xizang Rd. 18
Harbour Ring Plaza
200001 Shanghai
Tel.: +86 21 6391 7666
Fax: +86 21 6391 7445
infochina@dspace.com

Japan

dSPACE Japan K.K.
10F Gotenyama Trust Tower
4-7-35 Kitashinagawa
Shinagawa-ku
Tokyo 140-0001
Tel.: +81 3 5798 5460
Fax: +81 3 5798 5464
info@dspace.jp

USA and Canada

dSPACE Inc.
50131 Pontiac Trail
Wixom · MI 48393-2020
Tel.: +1 248 295 4700
Fax: +1 248 295 2950
info@dspaceinc.com