VI-GRADE

REAL-TIME SOFTWARE SOLUTIONS

BUILD. SIMULATE. INNOVATE.

ACCELERATE INNOVATION WITH REAL-TIME SIMULATIONS

"VI-CarRealTime enables us to develop new tires characterized by an excellent ride and handling performance. Since our tire models can be easily plugged into the vehicle model, we can easily analyze and improve their performance. The introduction of this new technology in our R&D team will help us raise our brand awareness in the global market by developing superior products characterized by specialized design and performance."

Executive Senior Vice President, Major Tire Manufacturer

BUILD. SIMULATE. INNOVATE.

The Challenge: how to implement efficient solutions for virtual vehicle development and ADAS testing in less time, with less risk and with less cost?

The Solution: VI-grade's suite of real-time software solutions is designed to accelerate your vehicle development process. Many OEMs and suppliers have already adopted these solutions, which enable them to efficiently move from physical testing to simulation. This process allows them to test more vehicle variants in less time, solving problems much earlier in the development process and ultimately reducing the number of physical prototypes.

See how VI-grade real-time software solutions can help accelerate your development process!

VI-GRADE


ACCELERATE YOUR
DEVELOPMENT PROCESS
WITH VI-grade REAL-TIME
SOFTWARE SOLUTIONS
VI-GRADE

THOUSANDS OF SIMULATIONS IN JUST A FEW HOURS

REAL-TIME SOFTWARE SOLUTIONS

Real-time simulations allow engineers to evaluate design changes and quickly make corresponding decisions. Thousands of simulations can be performed in just a few hours and Design of Experiment and optimization loops help engineers to make critical decisions in a fraction of the time that was needed even just a few years ago.

Real-time simulations play an important role in providing critical, real-time feedback to engineers and represent the foundation for vehicle and environment models for driving simulators applications. Driving simulators, and the subjective experience they allow, become increasingly important as you progress in the development cycle.

Real-time models are also the foundation of hardware-in-the-loop analyses where a hardware component (e.g. steering system, damper, brake, camera, radar or entire engine) interacts with the virtual vehicle model that runs on a hard real-time computer.

VI-GRADE

BUILD
ONE VEHICLE MODEL AND USE IT FROM CONCEPT TO SIGN-OFF

VI-CARREALTIME


VI-CarRealTime

SHIFTING FROM PHYSICAL TESTING TO VIRTUAL DEVELOPMENT

CHALLENGES

Vehicle dynamics and control engineers need a solution that optimizes vehicle and control system performances in a single vehicle model to accelerate the vehicle development process.

Automotive companies must mainly face three specific tasks while addressing the development of new vehicles: introduction of innovative solutions, investigation of the influence of all different components on the behaviour of the complete vehicle, and creation of a collaboration platform between OEms and 3rd party suppliers.

A simulation model is typically composed by these three main elements:
VEHICLE MODEL which comprises real-time models of all components of the car: tires, chassis, transmission, engine, steering, commands, controllers, ECUs ...
ROAD MODEL used to accurately and precisely reproduce different realistic test scenarios thanks to a proper model of interaction between vehicle and the road.
DRIVER MODEL needed to simulate different driving situations as it would be done in case of physical testing.

COMPLETE

WORKFLOW

A complete environment to build, analyze virtual vehicle models and postprocess results.

UNIQUE

ARCHITECTURE

With a seamless interface to Adams Car, accurate vehicle models can be imported from detailed multibody models.
A unique driver model then operates the vehicle through any kind of event.

OPEN

ENVIRONMENT

Interfaces to 3rd party tire models, to other softwares, to HiL platforms and driving simulators make VI-CarRealTime an OPEN environment.

ONE VEHICLE MODEL FROM CONCEPT TO SIGN-OFF

THE SOFTWARE

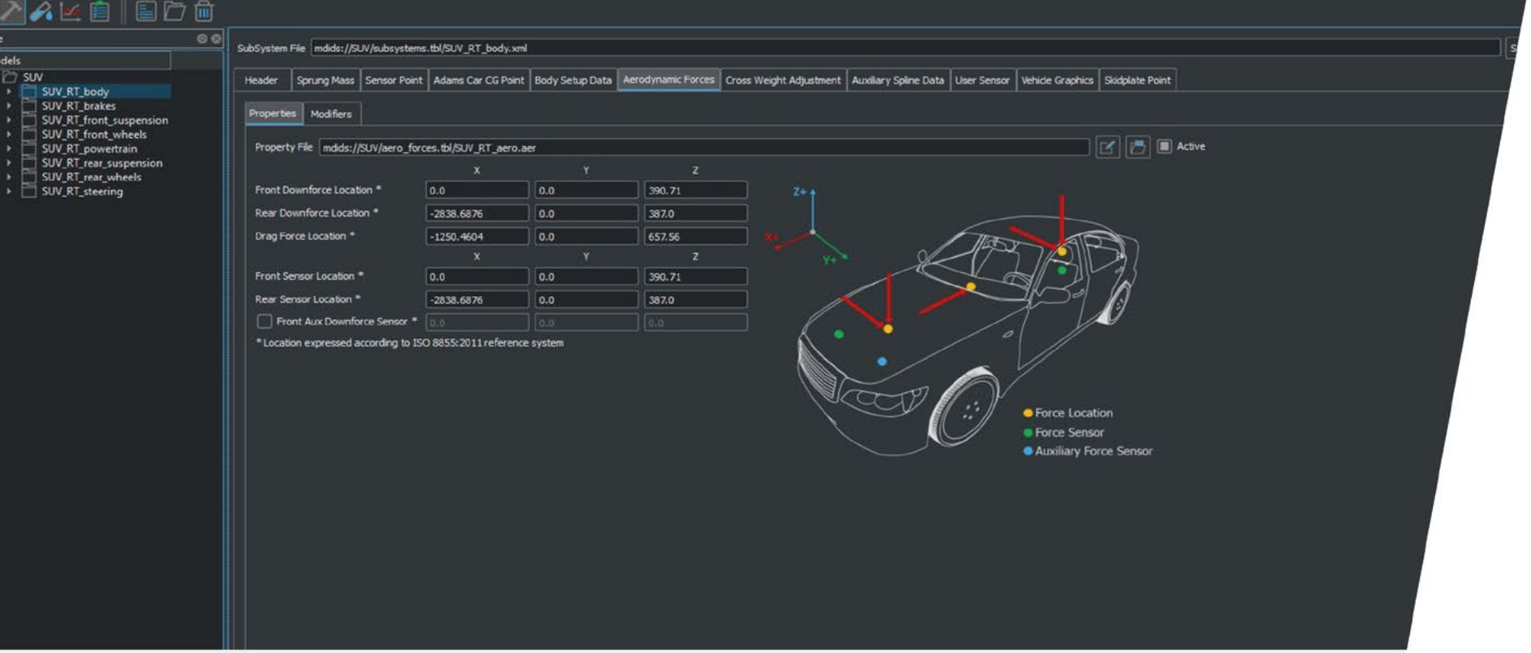
VI-CarRealTime is the only real-time solution available on the market that can automatically and seamlessly export a real-time vehicle model directly from Adams Car and/or K&C results. Similarly, VI-CarRealTime also lets you share component property files such as tires, springs, dampers, and bump stops with Adams Car.

VI-CarRealTime helps eliminate redundancy and reduces the time spent by different engineering teams to obtain and prepare essentially the same data. It also improves the consistency of the engineering approach while providing state of the art technology. The investment pays off because it can be leveraged by many different teams, including Hardware-In-the-Loop and driving simulator departments.

With VI-CarRealTime, vehicle dynamics engineers can quickly and easily perform large Design of Experiments (DOE) and multi-objective optimization studies.

VI-CarRealTime also features proprietary converters that enable the users to seamlessly use existing vehicle models developed in other real-time software solutions.

VI-GRADE



BUILD YOUR VEHICLE MODEL

MODEL CREATION AND VEHICLE DATABASE

1. EXPORT FROM ADAMS CAR

- *Automatic export*
- *Automatic validation*
- *Results comparison*

2. K&C INTERFACE

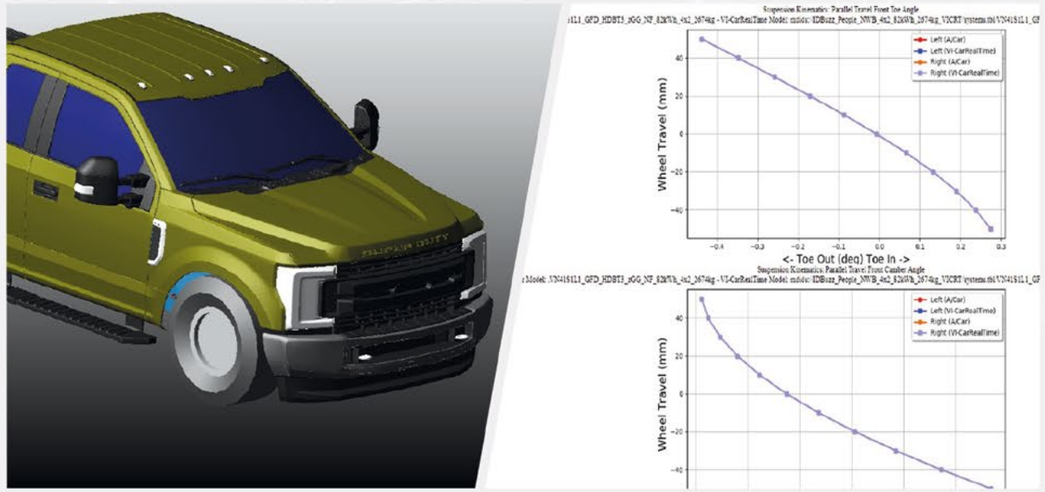
- *All major K&C rigs supported*
- *Graphical User Interface (GUI)*
- *All major suspension dependencies included*

3. VI-CARREALTIME GUI

- *Predefined vehicle models from shared database*
- *Dedicated GUI to define all major subsystems*
- *Library of template-based suspension models*

4. IMPORT FROM THIRD-PARTY SOFTWARE

- *CarSim*
- *CarMaker*



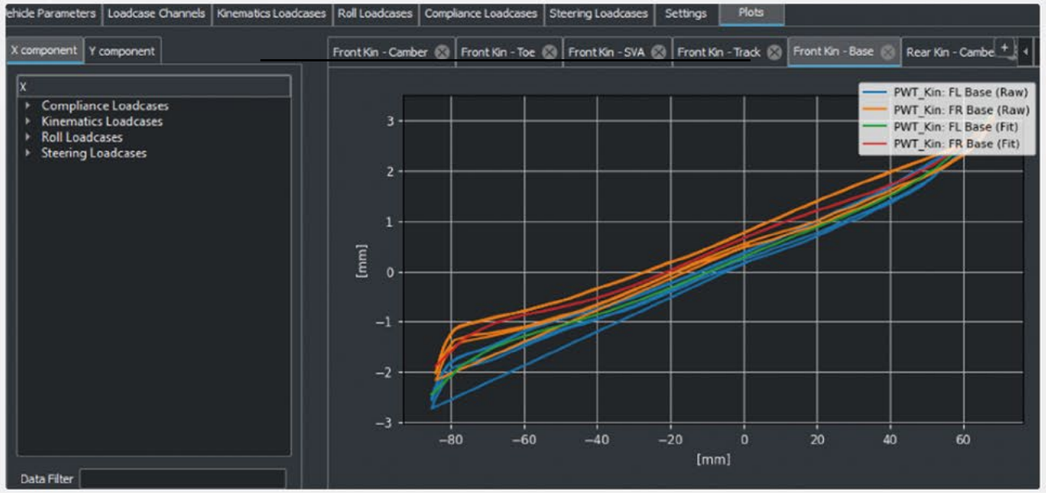
1. EXPORT FROM ADAMS CAR

AUTOMATIC EXPORT

- *All parameters can be defined in a single panel*
- *All analyses required to export the model are automatically executed*

AUTOMATIC VALIDATION

- *Adams Car and VI-CarRealTime results are then plotted against each other*



2. K&C INTERFACE

MOTIVATIONS

- *OEMs usually have K&C data for their vehicles at their disposal*
- *K&C analysis is a simple method to access data of competitive cars*
- *K&C is a powerful way to obtain suspension curves and other global vehicle data*

FEATURES

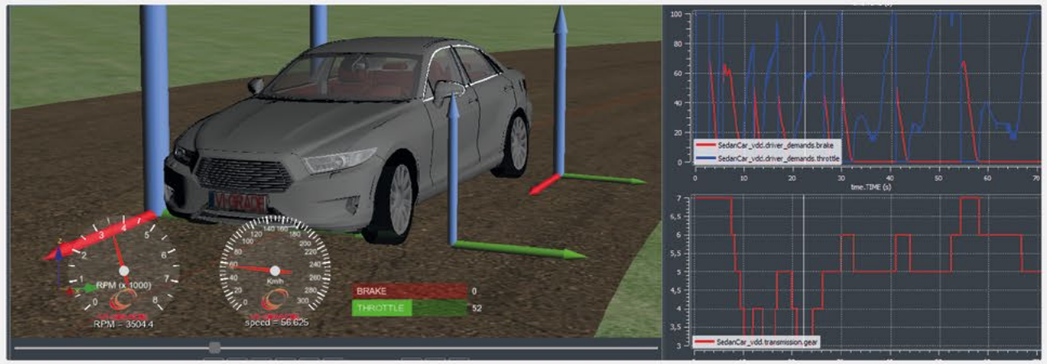
- *All major K&C rigs are supported*
- *An intuitive GUI is available*
- *All major suspension dependencies are included*
- *Fitting routine for experimental curves is also present*

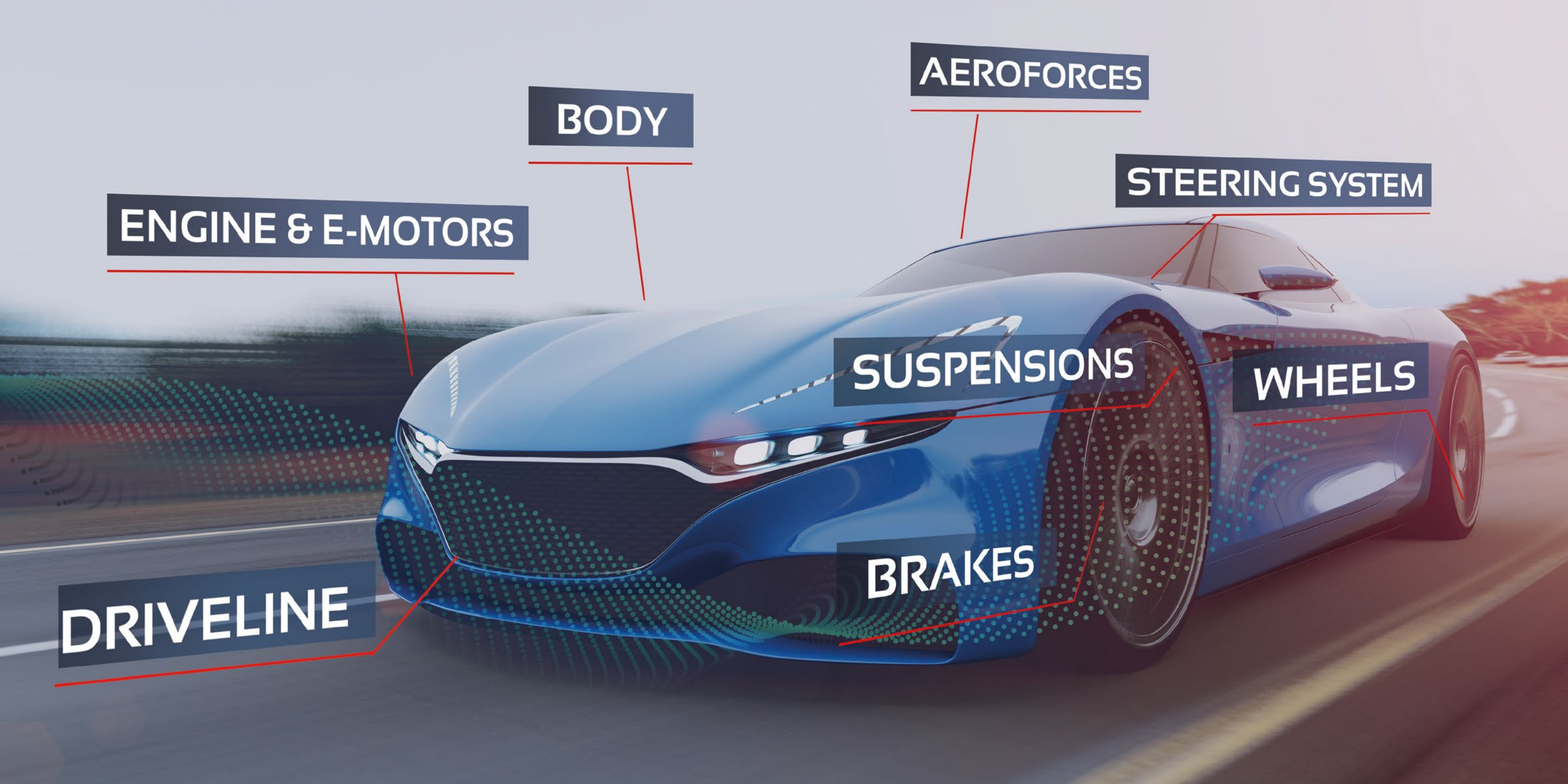
3. VI-CARREALTIME GUI

VI-CarRealTime comes with a database of predefined and validated vehicle models.

- *City car*
- *Compact*
- *Pick-up truck*
- *Sports car*
- *Sedan*
- *SUV*

Once the model is loaded in the VI-CarRealTime GUI, it is possible to use a dedicated GUI to define all major subsystems. To guarantee the continuity from offline to online applications, all vehicle models from the shared database are also validated for usage on all driving simulators.




AEROFORCES
BODY
STEERING SYSTEM
ENGINE & E-MOTORS
SUSPENSIONS
WHEELS
BRAKES
DRIVELINE

SUSPENSIONS

- DEPENDENT & INDEPENDENT
- EXTENSIVE KINEMATICS & COMPLIANCE MAPPING (100+ MAPS)
- NON-LINEAR COMPONENTS STIFFNESS (SPRINGS, ANTIROLL BAR, BUMPERS)
- NON-LINEAR DAMPERS
- WHEEL – HUB LONGITUDINAL DYNAMIC STIFFNESS
- INSTALLATION STIFFNESS
- SUSPENSION SETUP ADJUSTMENTS (ANGLES, RIDE HEIGHT, BUMPER GAPS)
- HIGH FIDELITY COMPONENTS (FREQUENCY DEPENDENT BUSHING, MXMOUNT, HYSTERETIC DAMPER)

STEERING SYSTEM

- BASIC STEERING

  STEERING WHEEL/RACK TO WHEELS KINEMATICS
  SYSTEM COMPLIANCE (TORSION BAR)
  KINGPIN GEOMETRY

- ADVANCED STEERING

  GEOMETRY
  COMPLIANCE
  FRICTION
  ASSISTANCE

WHEELS

- MASS AND INERTIA PROPERTIES
- TIRE MODELS

  VI-TIRE
  MF-TYRE
  FTIRE
  CDTIRE
  MF-SWIFT
  TAME TIRE
  THERMORIDE & ADHERIDE
  CUSTOM

BODY

- RIGID (6 DoF)
- FLEXIBLE (12 DoF)
- BODY ON FRAME
- BODY WEIGHT SETUP

  DRIVER
  BALLASTS
  PASSENGERS
  FUEL
  LUGGAGE

- SKIDPLATE
- USER SENSORS

  LOCATION, VELOCITY, ACCELERATION

AEROFORCES

- BASIC REPRESENTATION

  DRAG FORCE
  FRONT & REAR DOWNFORCE

- ADVANCED REPRESENTATION

  CENTER DOWNFORCE
  FRONT & REAR SIDE FORCE
  ROLL & PITCH MOMENT

BRAKES

- BRAKE PRESSURE DISTRIBUTION
- BRAKE DISC PROPERTIES
- FRICTION
- EMBEDDED ABS MODEL

ENGINE & DRIVELINE

- SUPPORTED LAYOUTS

  COMBUSTION, HYBRID, ELECTRIC

- ENGINE/MOTORS TORQUE MAP

  NON-LINEAR MODEL
  LUMPED PARAMETERS MODEL

- MECHANICAL EFFICIENCY
- INERTIA
- TORQUE REACTION
- CONTROLLERS

  STALL, IDLE, RPM LIMIT, TRACTION CONTROL

- ENGINE MOUNT MODELS

  RIGID, NON-LINEAR BUSHINGS, VI-MOUNT

- FUEL AND ENERGY CONSUMPTION
- BATTERY

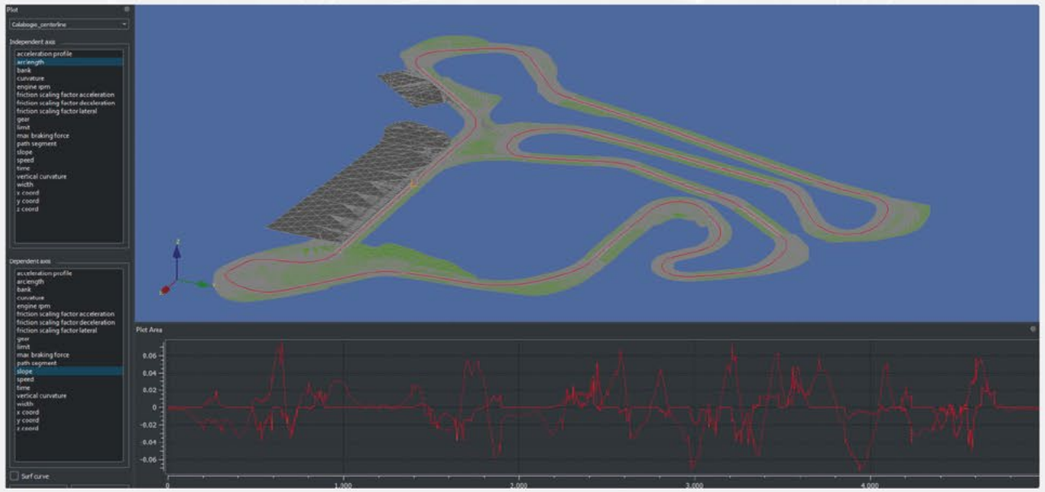
  NI-MH, NI-CD, LI-ION, LEAD-ACID

- GEARBOX

  MANUAL & AUTOMATIC

- CLUTCH/TORQUE CONVERTER
- DIFFERENTIAL

  OPEN, LIMITED SLIP, LOCKED, ACTIVE DIFF



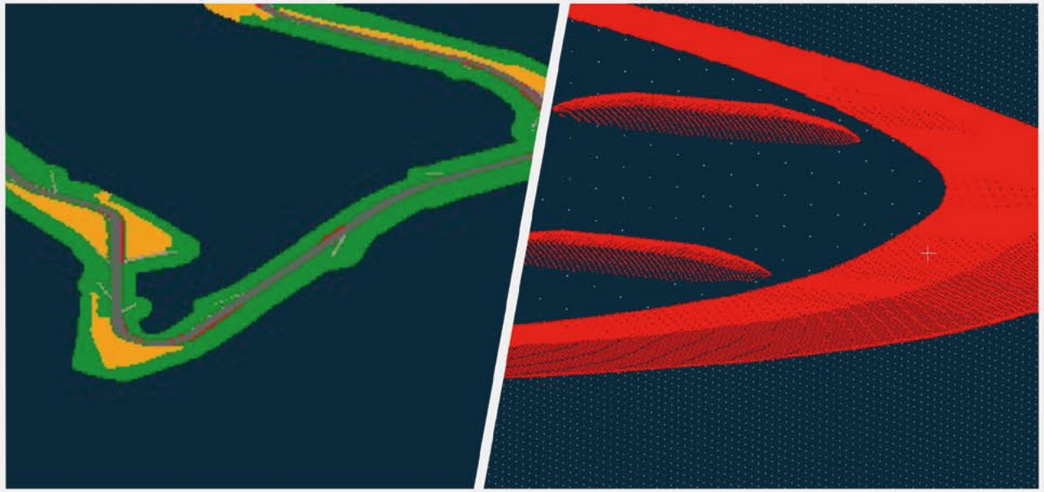
ROAD MODEL

VI-ROAD

VI-Road is VI-grade's specialized software for three-dimensional road design. Its user interface provides access to specific tools for creating, manipulating and smoothing driver lines.

FEATURES

- *Multiple road models (analytic and measured)*
- *Automatic and fast road design tools*
- *Kerbs, Irregularities, Surface Friction*
- *Driver trajectories processing (corner cutting, smoothing)*
- *Road data export*



GRIDMESH ROAD

VI-ROAD

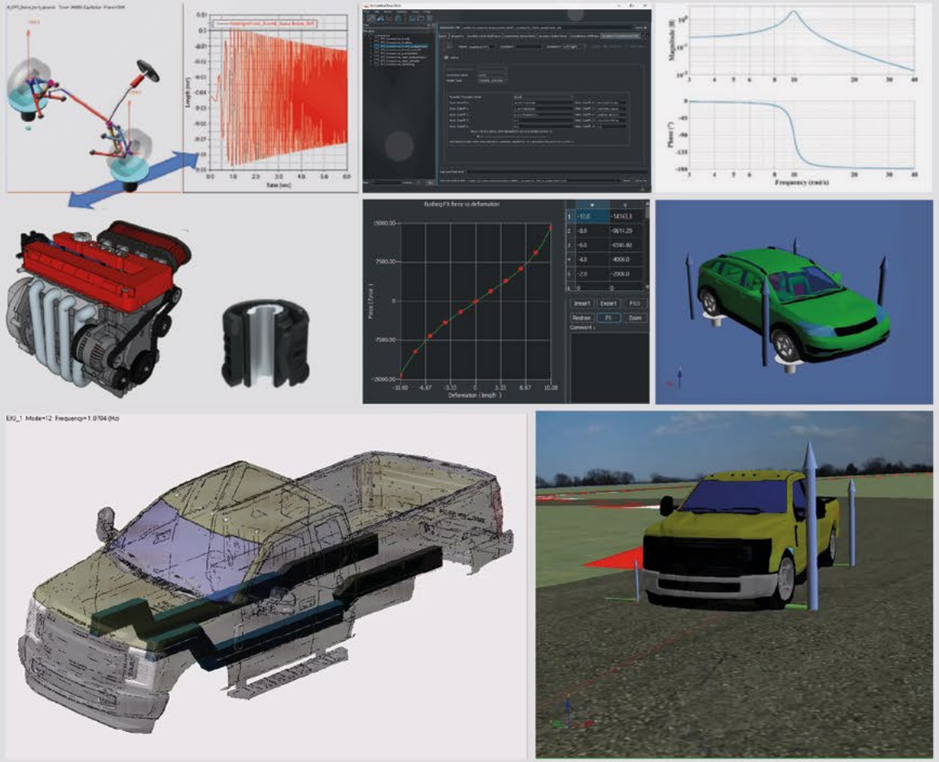
VI-Road features a new road model that has been optimized to handle large datasets at high resolution.

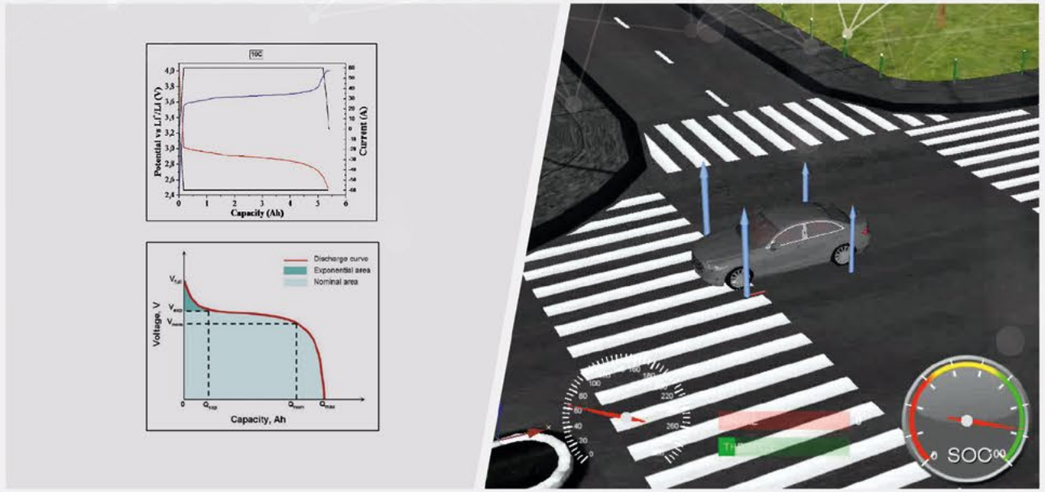
Resolution	• *Down to 1 cm*
Computational efficiency	• *Location independent* • *Resolution independent* • *Faster than current mesh model*
IP protection	• *License* • *Obfuscation*
Dataset generation	• *From point cloud* • *From existing mesh model*

INCREASING MODEL FIDELITY

VI-CARREALTIME RIDE ELEMENTS

- *Suspension auxiliary DOF*
- *Engine suspension configuration*
  - *Fixed*
  - *Bushing mounts*
  - *Rods*
- *Bushing models*
  - *Elastomeric*
  - *Frequency dependent*
  - *Hydraulic*
- *Body-on-frame chassis architecture*





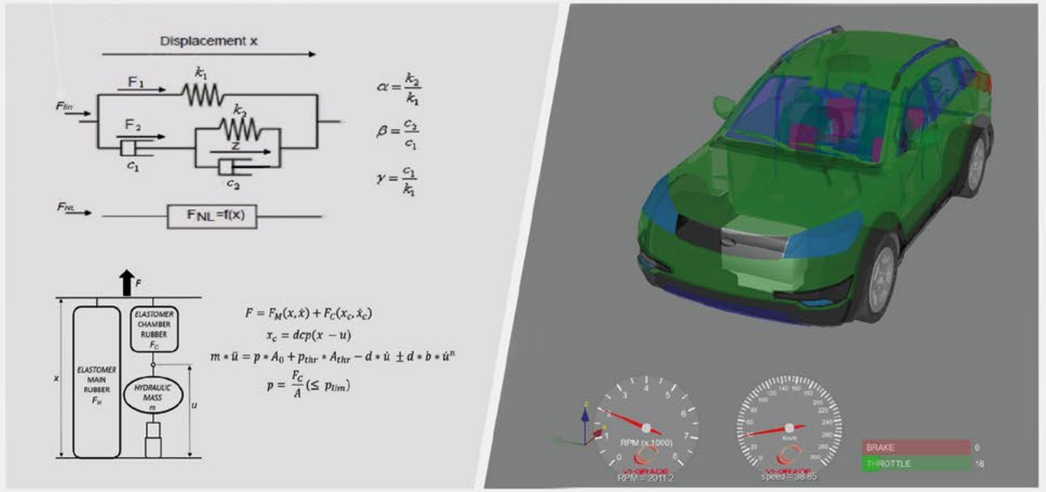
BATTERY MODELS

BUILT IN BATTERY MODELS

- *Lead-Acid*
- *Li-Ion*
- *Ni-Cd*
- *Ni-Mh*

FULL PARAMETERIZATION

- *Voltage (constant or function of SOC)*
- *Polarization constant*
- *Maximum battery capacity*
- *Response time*
- *Resistance*
- *State of charge*
- *Exponential voltage*
- *Exponential capacity*
- *Max peak current*



ADVANCED BUSHING MODELS

VI-MXMOUNT

VI-MxMount allows to represent high-end hydro and rubber mount models capturing theit amplitude and frequency dependent behaviour. VI-MxMount components are now supported as bushing types for chassis separated masses: engine, body on frame.

MODELLING VARIANTS

- **Elastomer** - *Sum of frequency dependent force component and amplitude dependent force component.*

- **Hydrobushing / Hydromount** - *Two elastomer models (main rubber and chamber rubber) and a damped fluid mass arranged as shown in the scheme.*

VI-CARREALTIME APPLICATIONS

RIDE & HANDLING

- **Handling**
  - *Open loop events*
  - *Closed loop event*
- **Driver sensitivity**
  - *Human*
- **DOE analysis**
- **Ride**
  - *Auxiliary suspension DOF*
  - *Mounts*
- **Testrigs**
  - *K&C importer*
  - *Tire*
  - *Suspension*
  - *4-Post*

MOTORSPORT

- **Sensitivity analysis**
  - *Suspension setup*
  - *Tires effects*
    - *Thermal*
    - *Grip*
    - *Gravel*
  - *Aerodynamics*
  - *DRS Strategy*
- **Driver line analysis**
- **Dynamic lap time simulation**

ENERGY MANAGEMENT

- **Internal combustion engine**
- **Electric and hybrid driveline**
- **Regeneration strategy**
- **Driving cycles analysis**

CONTROL SYSTEM DESIGN

- **Active systems**
  - *Dampers*
  - *ARB*
  - *Air springs*
  - *Aerodynamics*
  - *Powertrain*
  - *ABS*
  - *TCS*
  - *ESP*
  - *Torque vectoring*

SUPPORTED TIRE MODELS

MF-Tyre/MF-Swift

- *Support for latest software versions*
- *MF-Swift + Road enveloping + GridMesh is realtime capable*
- *Support for National Instruments HiL platform*

FTire

- *Support for latest software versions*

AdheRide/ThermoRide

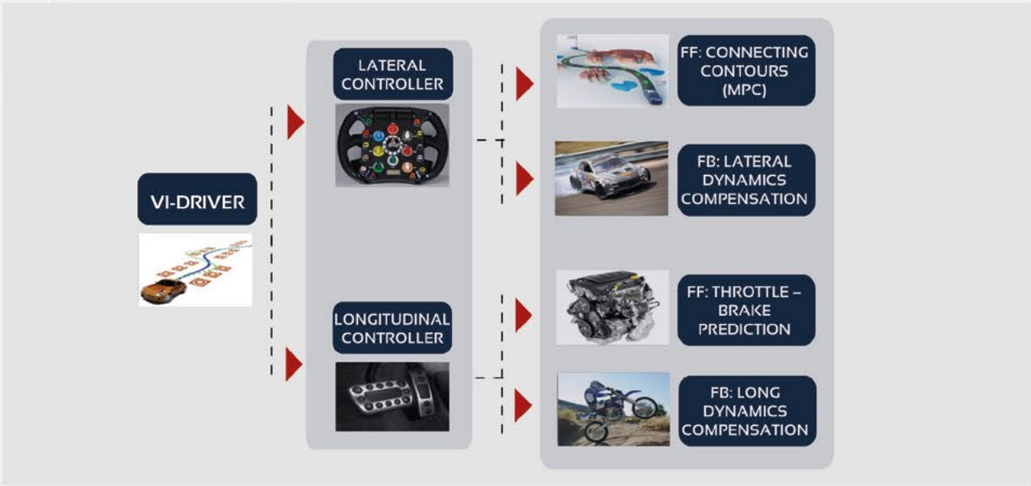
- *Support for latest software versions*
- *Tread wear effects in thermal and dynamic performance*

CDTire

- *Direct interface replaced the former user tire integration, leading to improved efficiency*

TameTire

- *Support for latest software versions*



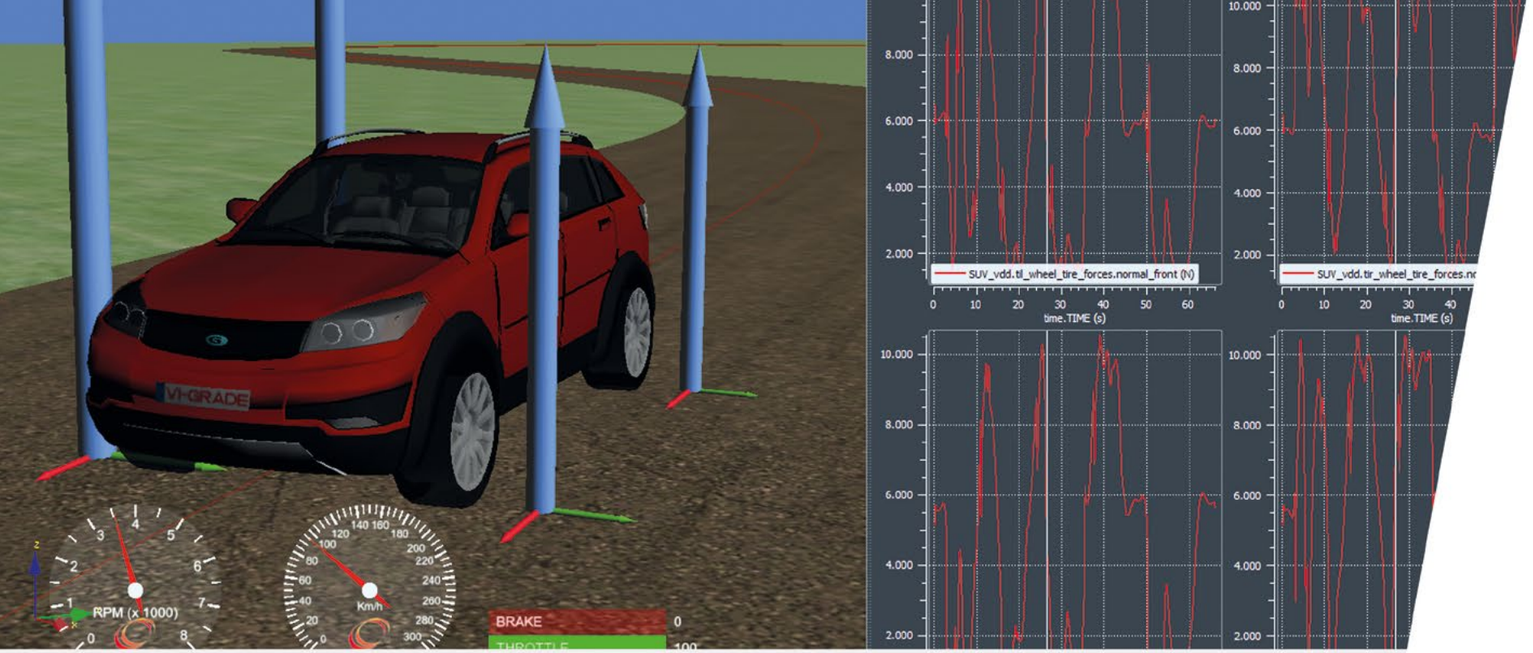
DRIVER MODEL

VI-DRIVER

- *Advanced virtual driver model for multi-maneuver open and closed loop events*

FEATURES

- *Supporting multiple road models (analytic and measured)*
- *Automatic and fast road design tools*
- *Kerbs, irregularities, surface friction*
- *Driver trajectories processing (corner cutting, smoothing)*
- *Road data export*



SIMULATE YOUR VEHICLE MODEL

LIBRARY OF PREDEFINED ANALYSES

VI-DRIVER

- *File driven*
- *Course events*
  - *Max performance*
  - *Press maneuvers*
  - *Path compensation*
- *Cornering*
  - *Braking In turn*
  - *Constant radius cornering*
- *Open loop steering*
  - *Impulse steering*
  - *Ramp steer*
  - *Sine steer*
  - *Step steer*
  - *Swept sine steer*
- *Straight line*
  - *Straight acceleration*
  - *Straight braking*

VI-SAFETY

- *Curb trip rollover*
- *Misuse event*

VI-SPEEDGEN

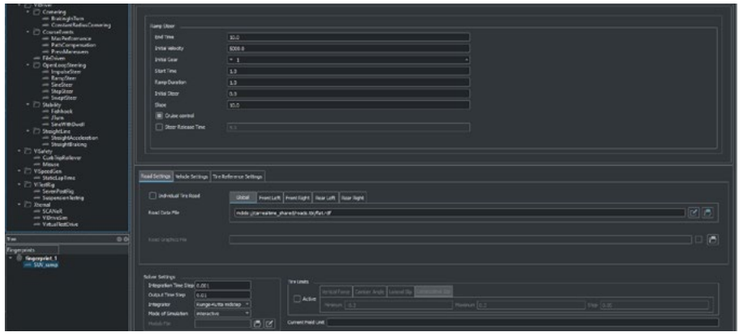
- *Static lap time*

VI-TESTRIG

- *Suspension test rig*
- *Seven post rig*

EXTERNAL EVENTS

- *VI-DriveSim*

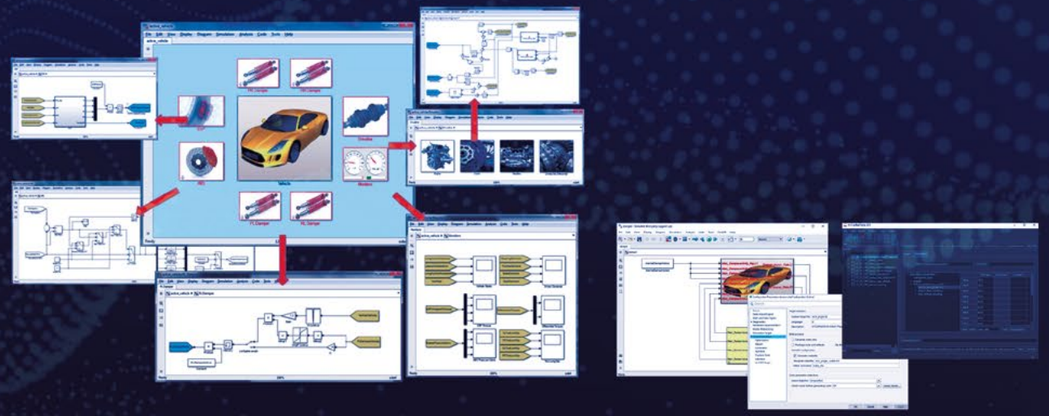


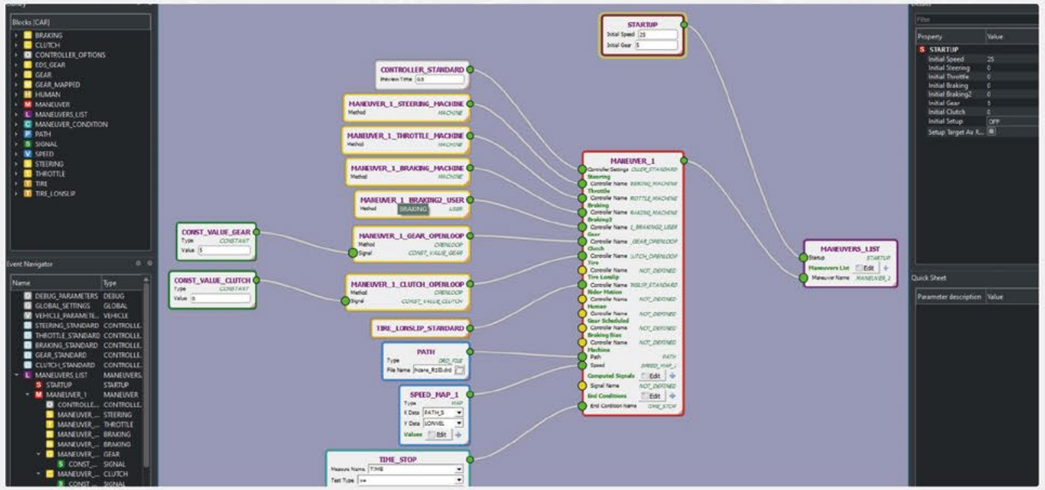
MATLAB SIMULINK INTERFACE

- *Co-simulation between VI-CarRealTime and MATLAB Simulink*

- *In MATLAB Simulink*
  - *VI-CarRealTime vehicle model available as S-function*
  - *Vehicle plant exposing inputs and outputs to be connected to other Simulink blocks*
  - *Vehicle data retrieved from VI-CarRealTime data file*

- *In VI-CarRealTime*
  - *MATLAB Simulink model can be exported as VI-CarRealTime solver plugin*





CUSTOM ANALYSES WITH EVENT BUILDER

VI-CarRealTime features an advanced editor, capable of creating, importing, modifying and exporting event files.

FEATURES

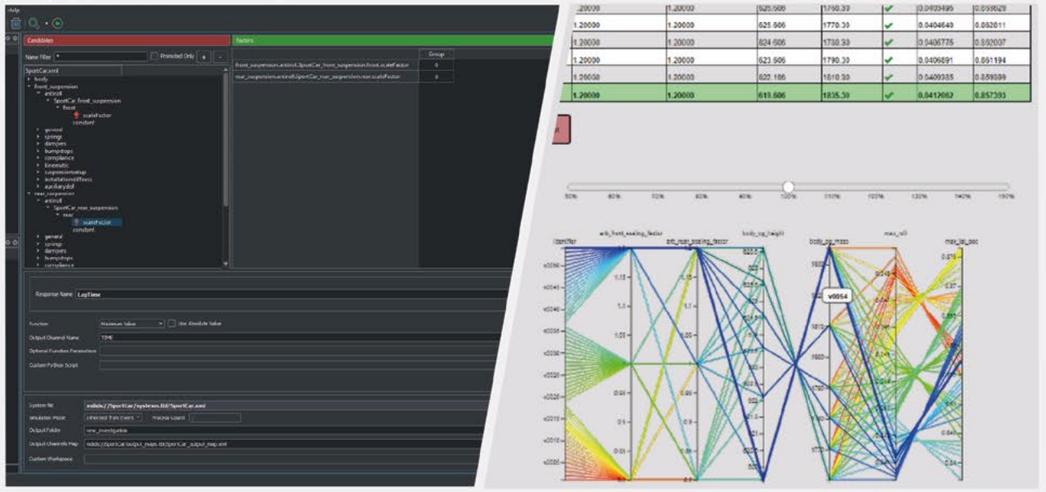
- *Open loop and closed loop events*
- *Single and multiple maneuvers*
- *Visual event representation*
- *Canned events*
- *Customizable event parameters GUI (Quick sheet)*
- *Support for Adams Car event files import (xml)*

LAPTIME SIMULATION

The laptime simulation feature available in VI-CarRealTime enables to analyze the limit performance of a vehicle via static prediction and dynamic solution.

FEATURES

- *StaticLapTime + VI-CarRealTime dynamic solver*
- *Automatic detection of the maximum performance on a given driver line*
- *Online check of speed profile feasibility*
- *Online local correction of the speed profile if any unfeasibility is detected*



INVESTIGATION MODE

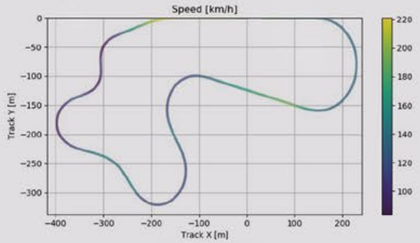
VI-CarRealTime's Investigation Mode allows to automate the studies on model variant responses through design sensitivity and DOE.

FEATURES

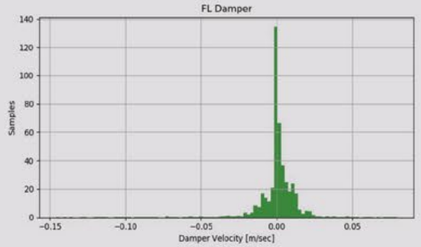
- *All model parameters can be included in the investigation*
- *Multiple events*
- *Factor grouping*
- *Predefined and custom response*
- *Metrics monitored on each run*
- *Investigation summary report*

Time History

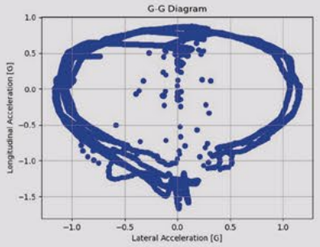
Multicolor



Histogram



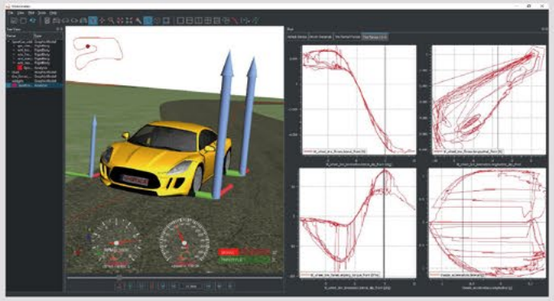
G-G Diagram



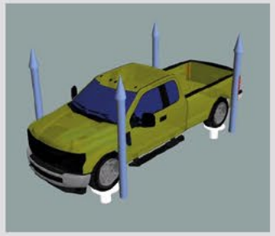
PLOTS/REPORTS

- *Time domain*
- *Custom*
  - *Multicolor*
  - *Histogram*
  - *Scatter (e.g. G-G diagram)*

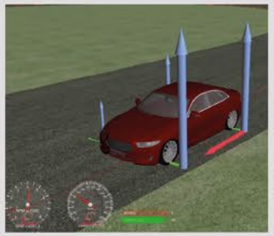
Animations & Plots



Fourpost Rig



Lap Simulation



ANIMATIONS

- *Lap simulation playback*
- *4-post rig*
- *Widgets (speed, RPM, river demands, ...)*
- *Tire forces visualizations*

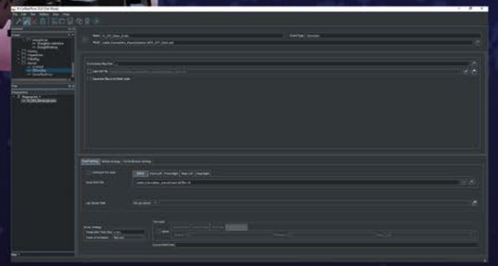
DRIVER-IN-THE-LOOP

Once the VI-CarRealTime vehicle model has been created and validated, it's time to publish it on the Driving Simulator, in order to subjectively assess its behaviour with a real driver.

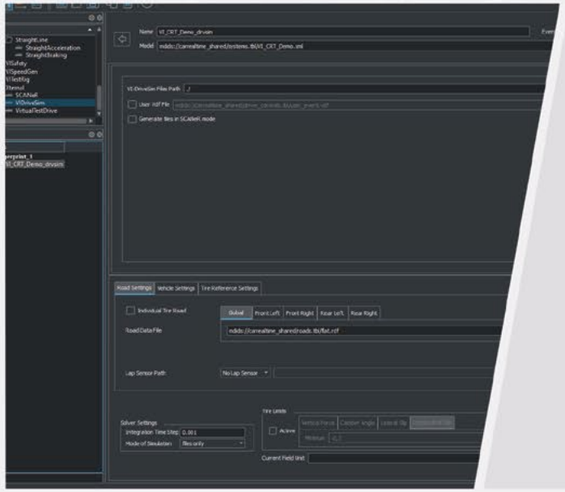
- *Creating vehicle model*
- *Running off-line simulations and validation*
- *Publishing model to Driving Simulator*
  - *Vehicle*
  - *Controllers*
  - *Tracks*
- *Running Driving Simulator session*

Driving Simulator

VI-DRIVESIM event



VI-CARREALTIME event



HiL platforms

concurrent REAL-TIME

NATIONAL INSTRUMENTS

dSPACE

HARDWARE-IN-THE-LOOP

PLATFORMS

- *CCRT SIMulation Workbench*
- *NI-PXI Veristand 2015 SP1*
- *dSPACE Scalexio*

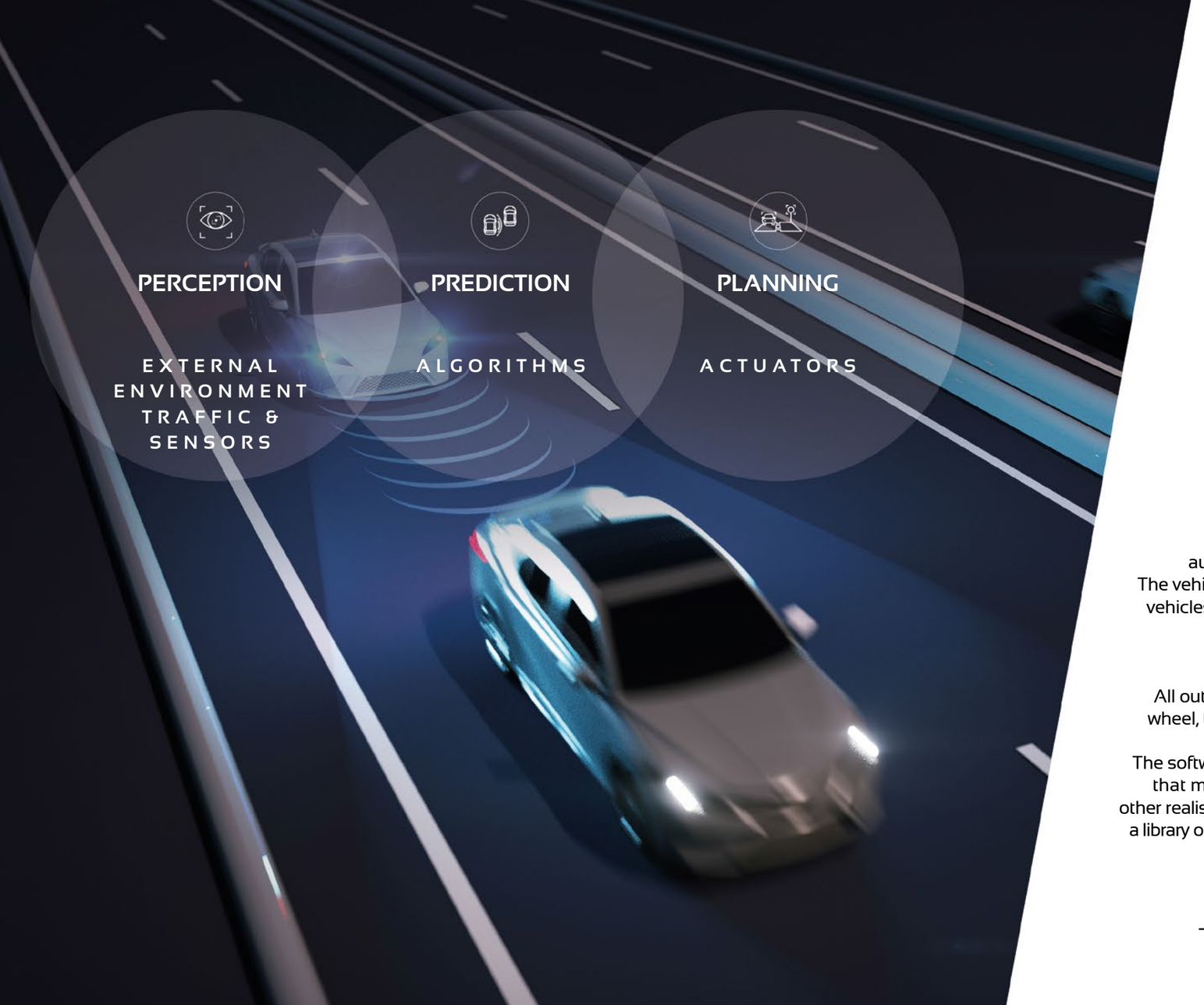
PROCESS

- *Creating vehicle model*
- *Defining events*
- *Deploying model to HiL platform*
- *Vehicle*
- *Controller*
- *Events*
- *Running HiL tests*

SIMULATE
IN A FULLY IMMERSIVE GRAPHIC ENVIRONMENT

VI-WORLDSIM


RT HOOK
RT HOOK
VI-WorldSim



DEVELOPMENT AND VALIDATION OF ADVANCED DRIVER ASSISTANCE SYSTEMS

CHALLENGES

When the vehicle model is ready, it needs to be immersed in a representative environment, to be tested under different operating conditions. Specifically looking into ADAS and Autonomous Vehicle development, automotive companies and suppliers must mainly focus on the following aspects: The vehicle must be able to perceive the external world around it, which is made of other vehicles, pedestrians, sometimes animals, road works and other unexpected obstacles. All information collected by sensors must be combined, verified and merged into inputs for all control algorithms that are in charge to predict the behaviour of autonomous or assisted cars. All outputs of the control algorithms are sent to the vehicle actuators, such as steering wheel, throttle, brake and others, to safely drive the car through the predefined mission.

The software environment needed for such tasks needs to support a realistic ego vehicle that moves around in the environment with the correct dynamic behaviour; traffic and other realistically moving agents such as pedestrians, animals, bicycles, scooters, strollers; and a library of sensors required to perceive which objects and entities are around the ego vehicle.

A HIGH RESOLUTION GRAPHIC ENVIRONMENT FOR ACCELERATED VEHICLE DEVELOPMENT

THE SOFTWARE

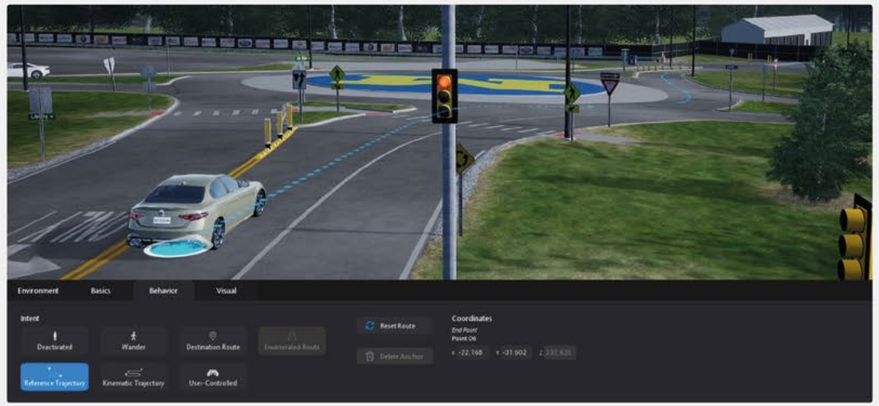
VI-WorldSim Offline is available as a complete stand-alone product, independent from VI-DriveSim to focus on offline experiments. It also adds the features needed to test on CAV sites, urban environments and public roads for ADAS and Autonomous Vehicle Testing.

The VI-WorldSim Online enhances your driving simulator's capabilities with realistic, multi-agent AI traffic behavior and sensor simulation.
Being another member of the VI-grade software ecosystem it is fully integrated into VI-DriveSim, and supports all VI-grade driving simulators while elevating traditional track modeling to a higher level of realism based on the UNREAL graphic engine.

VI-WorldSim features an intuitive desktop editor and rich test environments. Making it possible to quickly build traffic simulation containing various types of vehicles, pedestrians, cyclists, animals and various environmental situations involving weather and time of day. Cars, pedestrians and animals are powered by our start of the art traffic AI that behave in a natural manner by default or can be overridden allowing for all types of specific naughty behaviors and external controllers.

VI-GRADE

VI-WORLDSIM OFFLINE



INTEGRATED

VI-WorldSim is seamlessly integrated with VI-CarRealTime and VI-DriveSim.

EASY TO USE

WorldSim Studio requires no programming knowledge to build rich, realistic and interactive scenarios with environmental settings, traffic and pedestrians easily defined in few seconds.

HIGH QUALITY GRAPHICS

Based on an open-source graphics engine (Unreal Engine).

VI-WORLDSIM ONLINE

INTEGRATED

VI-WorldSim has been developed to be fully integrated with VI-grade Driving Simulators.

OPTIMIZED

VI-WorldSim is optimized for multi projector systems and large screens.

UNIFIED

Ego Vehicle can be easily transferred from off-line to online simulations. The same model is used throughout the entire cycle.

VI-WORLDSIM STRUCTURE

ONLINE

OFFLINE

TRAFFIC

ROAD NETWORK

EGO VEHICLE

WEATHER LIGHTING

PEDESTRIANS ANIMALS

SENSORS

PERCEPTION

PREDICTION

PLANNING


SCENARIOS
TERRAIN, ROADS, TRAFFIC, EVENTS
SENSOR MODELS
DRIVER
OCCUPANT FEEDBACK
CONTROLLERS
ADAS & AV
VEHICLE
PHYSICS MODEL
ONLY
Liberty
M city

AN IMPRESSIVE AND REALISTIC REPLICA OF THE REAL WORLD

ENVIRONMENT CREATION

VEHICLES

- *Passengers coupes, hatchbacks and sedans*
- *Commercial vehicles (vans, trucks)*
- *Emergency vehicles (fire, ambulance, police)*
- *Special purpose (autonomous platforms)*

TRAFFIC

- *Traffic intelligence*
- *Different trajectory strategies*
- *Triggers*

OBSTACLES

- *Residential*
- *Construction*
- *Furniture*
- *Miscellaneous*

WEATHER

- *Rain*
- *Fog*
- *Wetness*
- *Overcast*

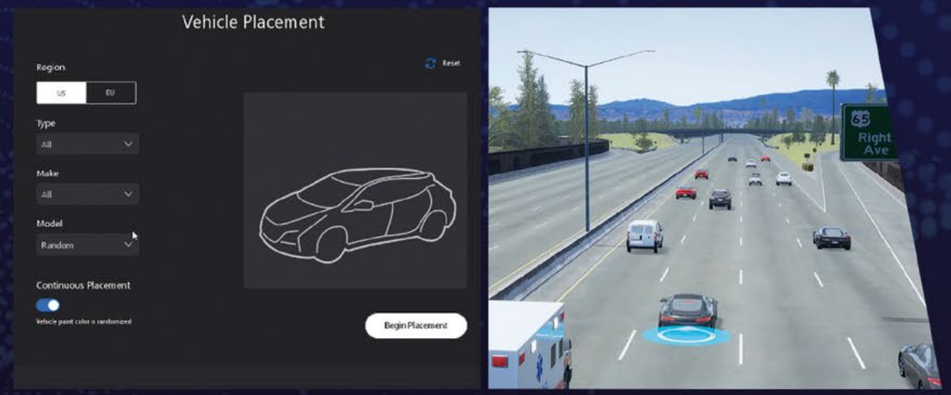
SENSORS

- *See next pages for details*

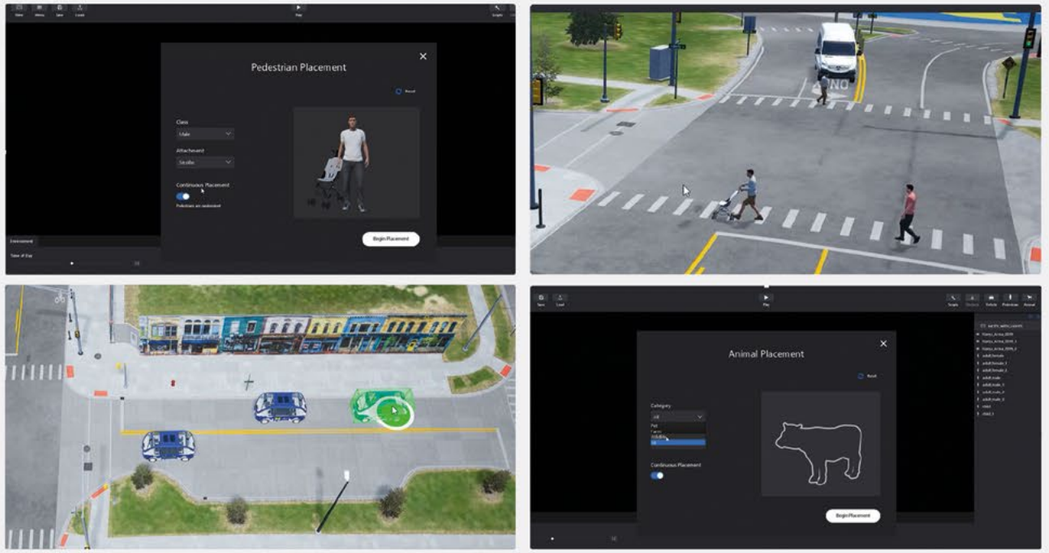
WORLDSIM STUDIO

Scenarios can be created in the WorldSim Studio where the user can start by selecting an environment (e.g. Mcity, highway or others).
It is then possible to position different vehicles and other agents, such as pedestrians and animals, until the level of complexity needed by the simulation is reached. Users can easily create their own events without any programming.

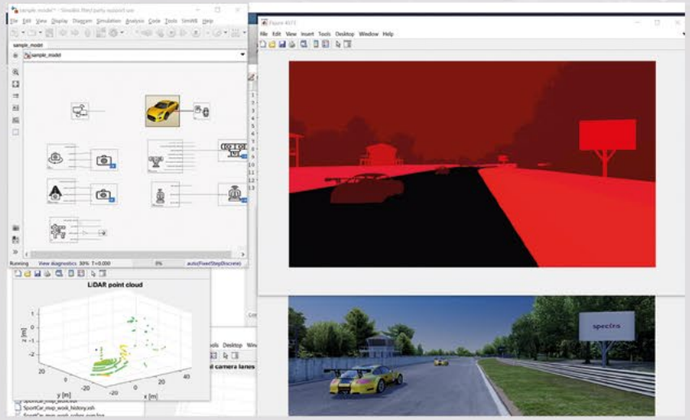
WORLDSIM STUDIO | Highway



WORLDSIM STUDIO | Examples



- *Different types of vehicles (according to different regions, US or EU)*
- *Various configurations for pedestrians, starting from random and adjust age, height, weight, skin, clothing and attachments (bicycles, scooters, strollers)*
- *Animals (pet, farm, wildlife)*
- *Visual trigger and path editing*



AN OPEN FRAMEWORK TO CONNECT ALL COMPONENTS

VI-CarRealTime and VI-WorldSim come with a native Simulink integration which enables running vehicle dynamics events after having instrumented the vehicle with the desired set of sensors.

Sensor data are collected and iterations are calculated for the different components of the system, such as:

- *Sensor setup*
- *Vehicle configuration*
- *Autonomous driving algorithm*
- *Weather conditions*
- *Experiment setup*

"The new offline version of VI-WorldSim gives users the ability to first develop ADAS algorithms entirely on their desktop PC and then use the online version of the software to validate their functionality with the driving simulator."

Roberto De Vecchi

Product Development Manager, VI-grade

Vehicles

Pedestrians

Animals

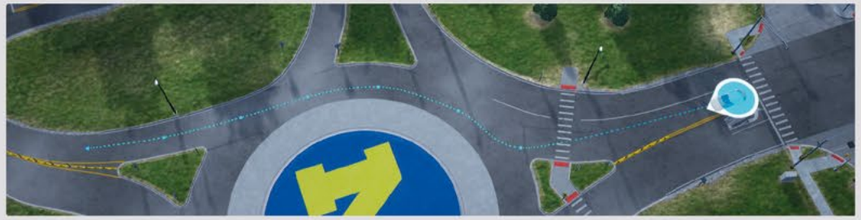
VEHICLES, PEDESTRIANS AND ANIMALS

Different types of vehicles are defined in VI-WorldSim:

- *Passenger coupes, hatchbacks and sedans*
- *Commercial vehicles (vans, trucks)*
- *Emergency vehicles (fire, ambulance, police)*
- *Special purpose (autonomous platforms)*

Destination route

Reference trajectory



VEHICLES & TRAJECTORIES

Different types of vehicle models are defined in VI-WorldSim:

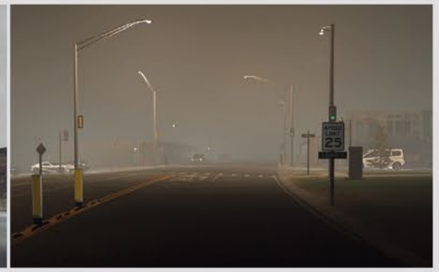
- *Deactivate: to simulate a parked car, broken down, accident or waiting for a passenger*
- *Wander: to create background traffic, object will wander within the environment*
- *Destination route: to travel to a specific location, a vehicle using road network logic*
- *Reference trajectory: user defines a path for the vehicle to follow*
- *User-controlled: the ego car on the driving simulator or AI/Controller for system-in-the-loop.*

Overcast

Wetness

Rain

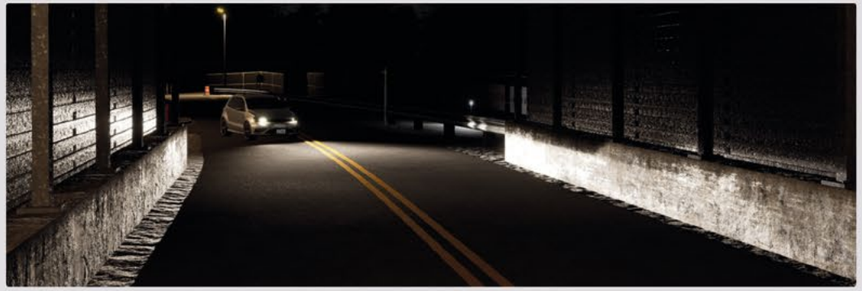
Fog



WEATHER

VI-WorldSim gives the user the possibility to define different weather conditions:

- *Rain*
- *Fog*
- *Wetness*
- *Overcast*



LIGHTING

In VI-WorldSim, users can set lighting system, environment and vehicles to offer:

- *Vehicle headlight tuning through IES profiles*
- *More realistic traffic vehicles illumination*
- *Integrated configuration user interface*

Construction

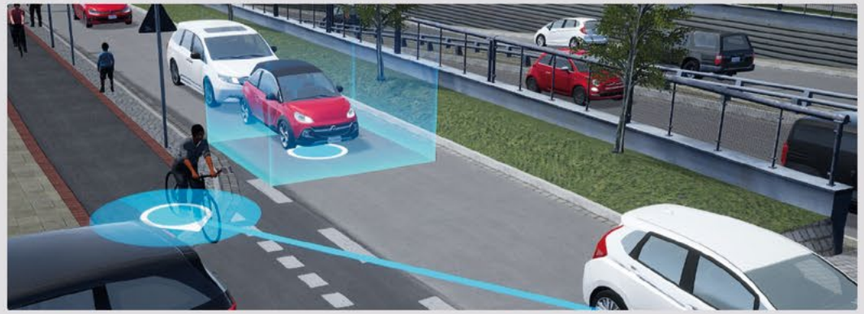
Static objects avoidance

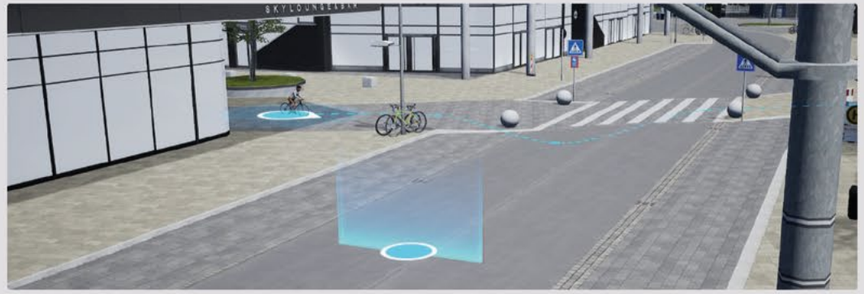
OBSTACLES

A vast library of obstacles is available in the VI-WorldSim software:

- *Residential*
- *Construction*
- *Furniture*
- *Miscellaneous*

Triggers





TRIGGER

In the WorldSim Studio, users can define triggers that, when activated, commence a specific event such as a pedestrian crossing the street, an animal running in front of a car, or another car unexpectedly changing lanes. Triggered objects will follow a certain trajectory defined by the user. Triggers are very useful to test ADAS and AVs control systems and the dynamic response of the car.

Mcity

Highway

US urban

European urban

European urban

ENVIRONMENTS

VI-WorldSim is delivered with some predefined environments:

- *Mcity*
- *Highway*
- *Neighborhood (a typical suburban US environment)*
- *A European urban environment*
- *Other racing environments are also available (check our website for complete list)*

Nurburgring GP

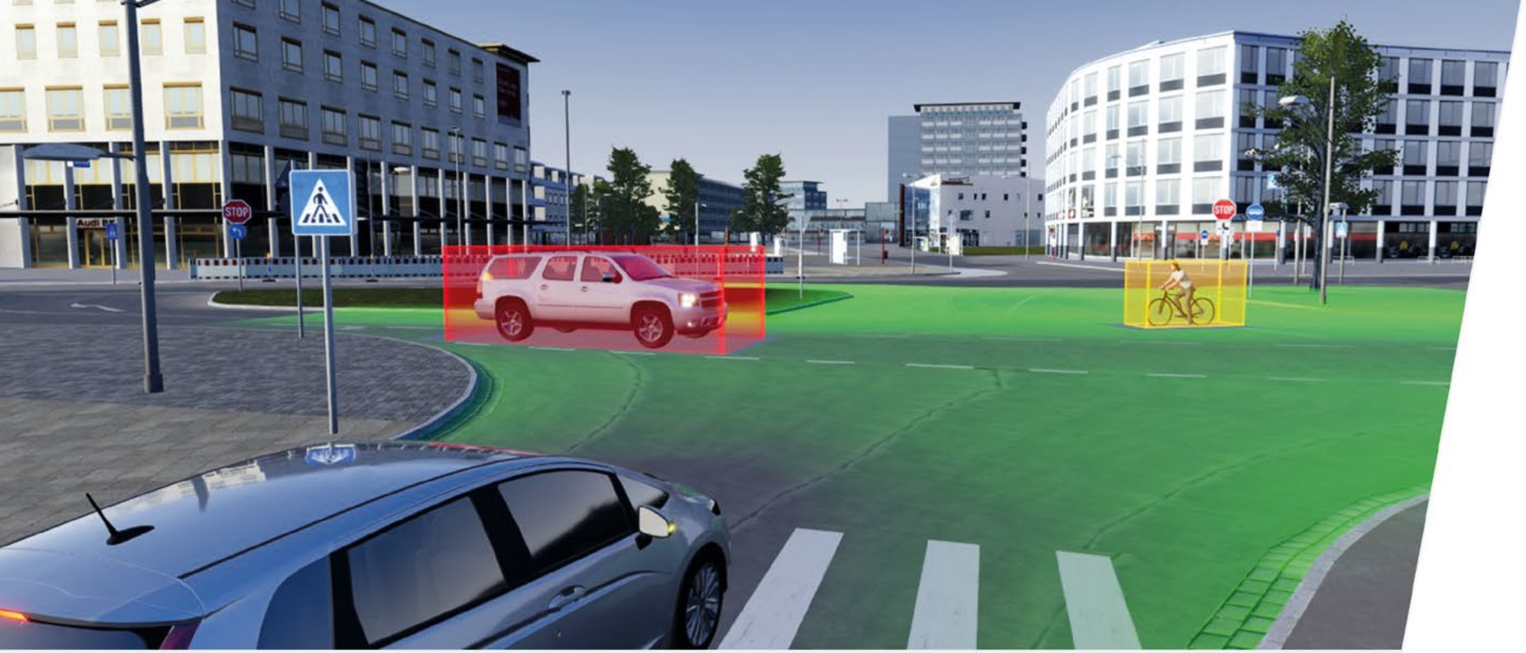
Idiada Dry Handling

Calabogie

Calabogie

Hockenheim

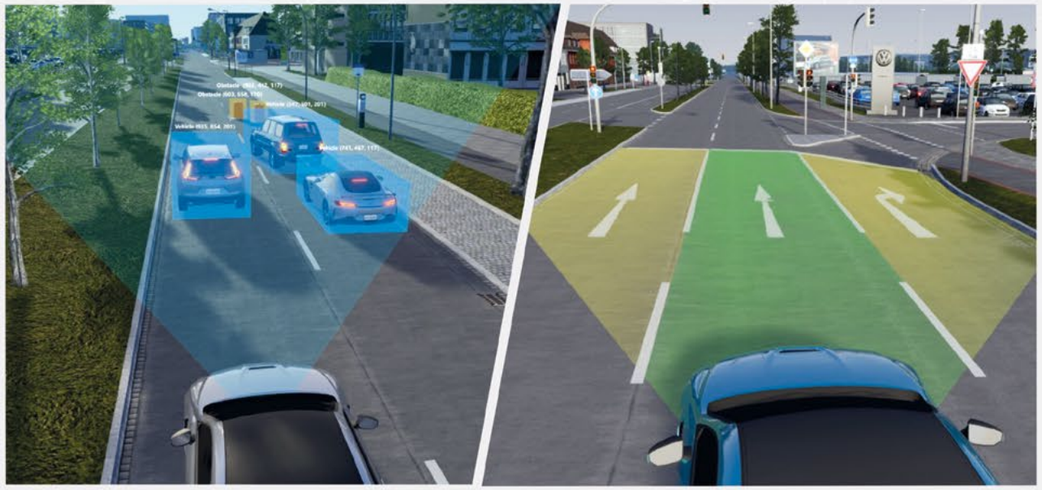
Hockenheim



A COMPREHENSIVE LIBRARY OF SENSORS MODELS

VI-WORLDSIM SENSORS

- OBJECT SENSOR
- ROAD / LANE SENSOR
- OBJECTS BY LANE SENSOR
- TRAFFIC SIGN SENSOR
- COLLISION SENSOR
- TELEMETRY SENSOR
- GROUND TRUTH SENSOR
- IMU SENSOR
- FREE SPACE SENSOR
- ENHANCED FREE SPACE SENSOR
- DEPTH SENSOR
- GPS SENSOR
- INSTANCE SEGMENTATION SENSOR
- RADAR SENSOR
- ULTRASONIC SENSOR
- SOLID STATE LIDAR SENSOR
- LIDAR SENSOR



OBJECT SENSOR

This sensor identifies various types of static and dynamic objects in the scene and returns a reference to the object or objects in 3D space based on the source location of the sensor.
This sensor's data would be used to develop a system like pre-collision warning or AEBS controllers, without needing to put the camera and computer vision system in the loop. This would be used for the closed loop motion controller.

ROAD / LANE SENSOR

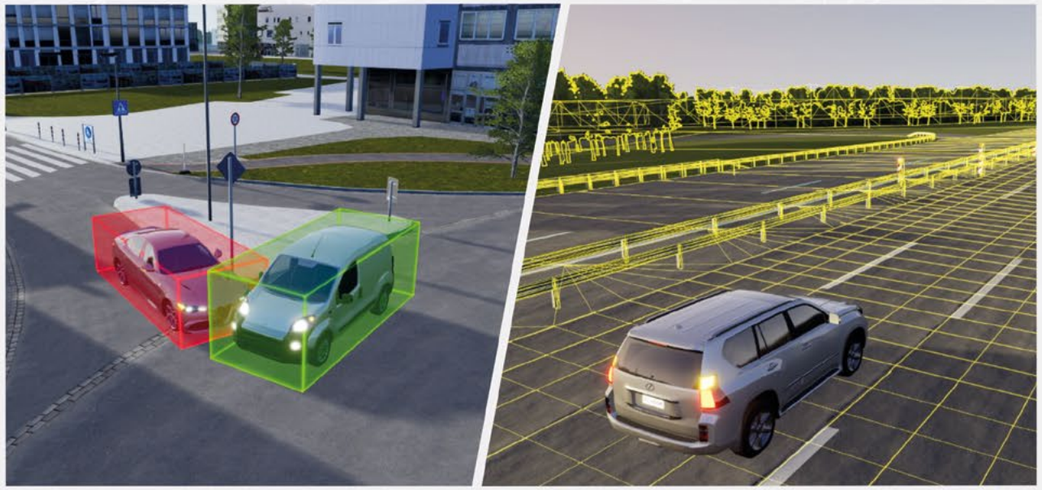
This sensor identifies drivable surfaces, lane edges (if detectable), and lane centers (if detectable) and returns the geometric information in a 3D projection of the environment. This sensor would be used to develop a lane keeping system, where the user is trying to either develop a controller without the camera/vision system in the loop, or to close the loop and validate the output from a vision system – by connecting the camera to a scene visual and then processing the camera's output against the lane sensor.

OBJECTS BY LANE SENSOR

This sensor identifies road users in the scene and returns a spatial reference, bounding box and present lane identifier.
This would be mostly used to score a vision system to determine if it is concerned about the right objects in the scene. If the system was used for pre-collision warning, it would correctly track objects in the lane.

TRAFFIC SIGN SENSOR

This sensor identifies road users in the scene and returns a spatial reference, bounding box and present lane identifier.
This would be used to develop the controller or aspects of the HMI for a system like ISA, or smart traffic alert (IE systems can alert the user with an audible chime when the traffic lights turn green).

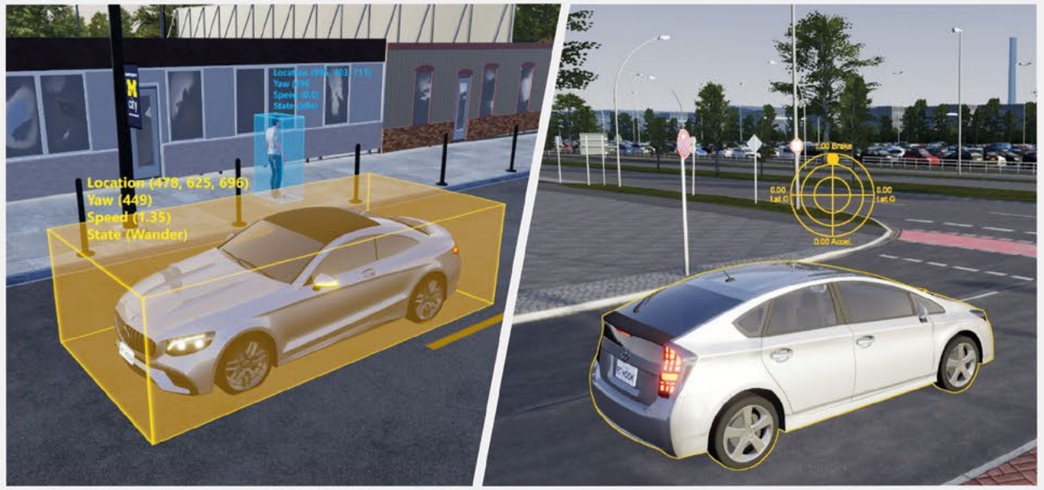


COLLISION SENSOR

This event driven sensor publishes real time collision data on any object to object or object to environment in the scene.
This sensor is primarily used to evaluate if a vehicle under test has had a collision with a static or dynamic object, and is typically used for evaluating pass/fail in testing.

TELEMETRY SENSOR

This sensor publishes real time environment and road surface events as fast as 1,000 Hz to the real-time database.
Used for integrating third party dynamics or tire models, this data allows for the user to skip the integration with the VI-WorldSim SDK, going directly to the shared memory variables in the real-time database.



GROUND TRUTH SENSOR

This sensor publishes real-time location (x,y,z), speed, yaw, and state data on all dynamic objects in the scene to either the SDK interfaces or a connected real-time database (i.e. Concurrent RT).
This sensor would be used when validating a object detection algorithms, such as a computer vision system based on cameras, lidar or sensor fusion with multiple sensors in the loop.

IMU SENSOR

Inertial Measurement Unit sensor or IMU provides a virtual interface to the vehicle's motion, orientation and acceleration.
This sensor is used for developing motion controllers without having the real hardware in the loop. This allows for the user to understand a measurable feedback of feel from the user and chassis standpoint, allowing for developing smoother acceleration and braking controls that take in feedback from road surface and elevation changes, while actively responding to traffic's influence on the motion plan.

FREE SPACE SENSOR

This sensor publishes a 2D projection of all 3D space that is free to be occupied. This sensor would be used for developing system such as ACC or similar enhanced tools allowing for the car to drive semi-autonomously on a highway.

ENHANCED FREE SPACE SENSOR

This sensor publishes a 3D model of occupied and unoccupied space in the projection of the vehicle. It is used for developing more advanced system such as navigate on autopilot by incorporating cross traffic and other road users.

DEPTH SENSOR

This sensor returns an image with 3D special information associated with every pixel. This is a ground truth/perfect sensor. The depth sensor would be used when validating stereo camera depth data, or points of a rotational lidar sensor. This could use used as perfect “fused” data from a sensor fusion algorithm for development of a control or path planning system.

GPS SENSOR

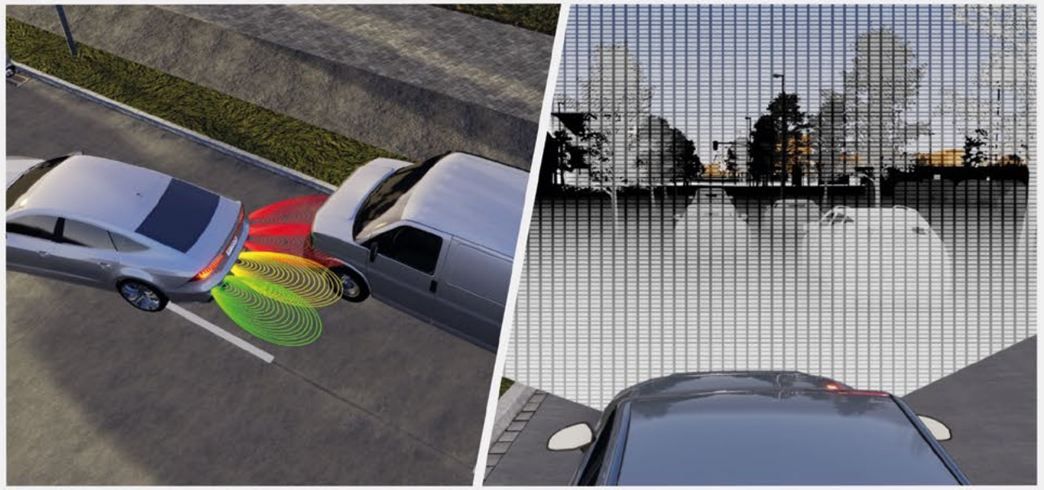
The GPS sensor returns a virtual GPS signal in a special coordinate system if the environment or map being used was based on real world data. The GPS sensor would be used in any situation where geo-location data is needed, development of new HMI for navigation, testing and validating navigational maps, or designing a traffic responsive system that uses GPS and V2X data.

INSTANCE SEGMENTATION SENSOR

The segmentation camera provides an instance based unique label for every pixel in the scene as they relate to each instance of an object, great for generating training data or closing the loop around a perception system. The instance segmentation sensor can be used to validate output from a camera based vision system, both in open or closed loop scenarios.

RADAR SENSOR

The radar sensor returns form of data called a “track”, a track is processed representation of what the radar sees in front of the vehicle. Most advanced radars can return as many as 64 tracks of data, usually over the CAN-BUS. Forward facing radar systems are using the development and deployment of emergency pre-braking, advanced emergency braking, adaptive cruise control, and other safety and autonomous applications. Rear and side facing radars are used for blind spot detection and cross traffic alert.

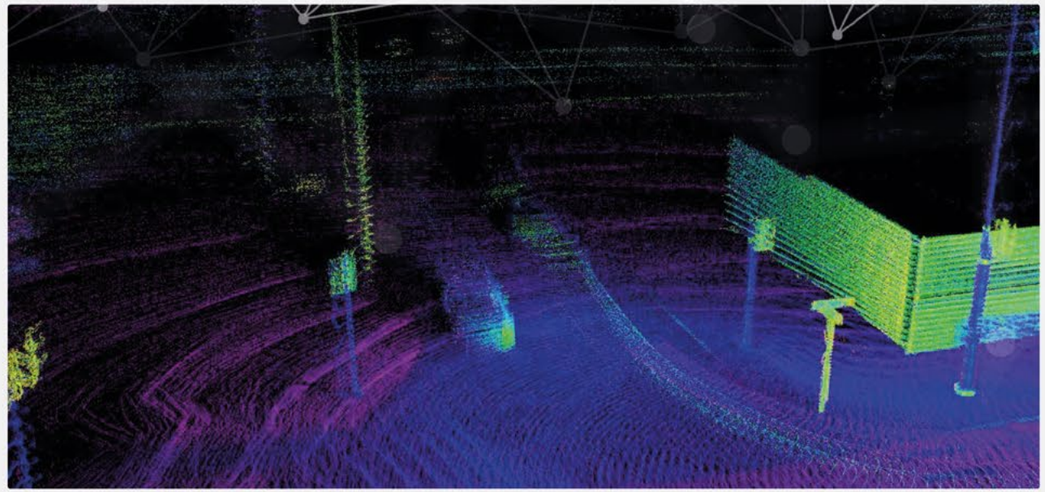


ULTRASONIC SENSOR

The ultrasonic sensors report back near by ultrasonic radar returns, typically used for parking assist systems.
Ultrasonic are simply a low cost – ultra close range radar like sensors, they are most commonly used in parking assistance systems.

SOLID STATE LIDAR SENSOR

Returns a continuous point cloud – for solid state and flash lidar simulation.
Flash and solid state lidar emit a single high power burst of light and measures the return, they are not popular currently in automotive because they have a very limited range in order to be eye safe.



LIDAR SENSOR

The rotational Lidar sensor returns a point cloud object of ranged points with reflectivity properties.

Lidar sensors are highly precise depth measurement devices, they typically operate in one of a few modes (as determined by the design of the sensor). A rotational lidar spins around on its axis scanning all the points a few times a seconds, rereferred to by rotational rate (usually in Hz). A scanning lidar uses a steerable mirror to direct the beam to scan the world.

Lidar sensors are exceptionally important for self driving cars and are now becoming important for advanced driver assistance systems.

"Our customers get accurate results for the tests that matter most. If a sensor parameterization model doesn't meet their needs, it's easy to accurately extend the functionality of our platform. Moreover, with VI-WorldSim, changes to experiments are instant, without need for recollection, re-test, empirical inference. This leads to higher flexibility and lower cost of testing for all variances that may be encountered."

Warren Ahner

CEO, RightHook (part of VI-grade)

EURO NCAP TESTS

When preparing for the certification of ADAS and Autonomous driving algorithms, we must make sure that all EuroNCAP tests can be fully simulated. We made sure that all 2020 and 2021 EuroNCAP test are fully implemented in the VI-WorldSim environment as ready-to-use environments from the shared database:

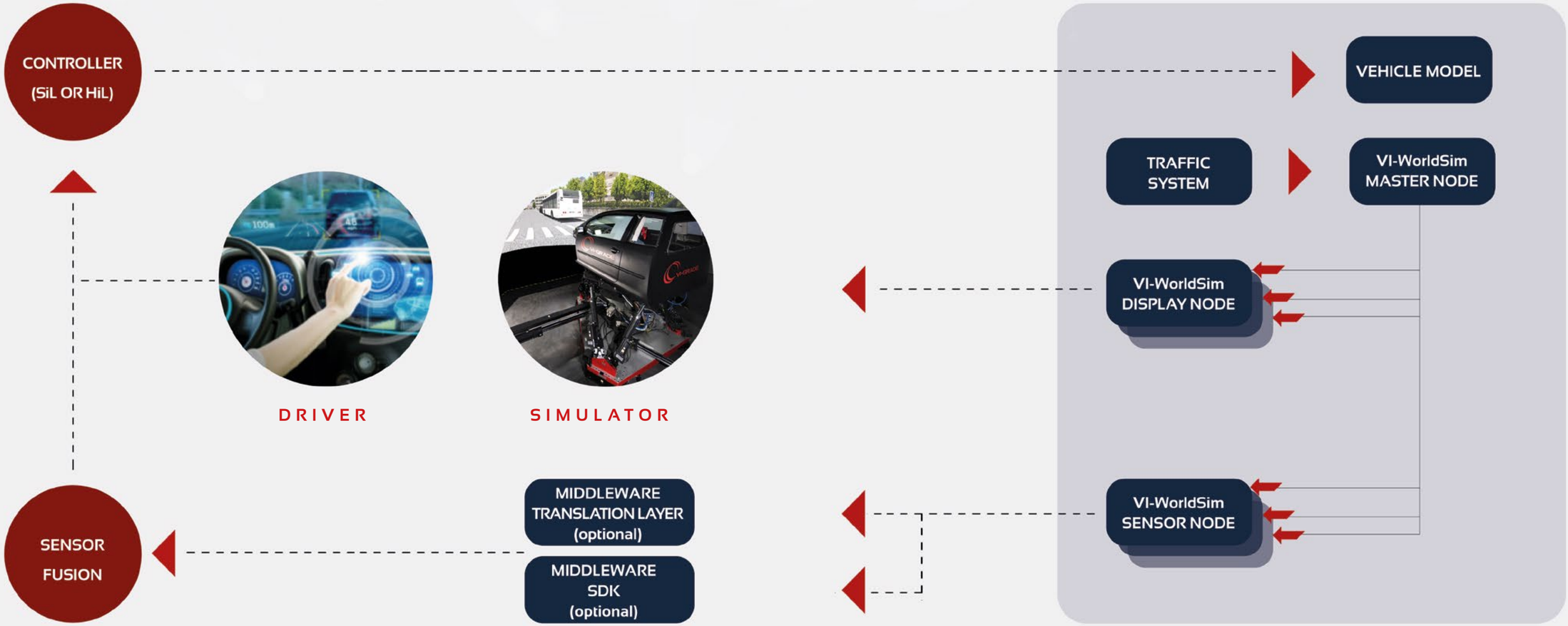
- *2020 & 2021 Tests implemented*
- *AEB systems (C2C)*
- *AEB VRU systems*
- *Lane support systems (emergency LKA (ELK), LKA, lane departure warning)*
- *Speed assist systems*

MULTI SIMULATORS MODE

When testing ADAS and Autonomous driving algorithms, it is important to evaluate how these algorithms react to unpredictable traffic situations. Sometimes the easiest way to create those conditions, to push the controller to the limit, is to generate such unpredictable traffic situations through the intervention of a human driver. For this reason, VI-WorldSim gives the possibility of supporting a multisimulator set-up which enables to test all kinds of interactions:

- *Human-to-AI*
- *AI-to-Human*
- *Human-to-Human*

VI-WORLDSIM ONLINE



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Germany
VI-grade GmbH
Im Tiefen See 45
64293 Darmstadt Germany
Tel: +49 6151 8702834
info@vi-grade.com

Italy
VI-grade srl
Via Galileo Galilei 42
I-33010 Tavagnacco (UD) Italy
Tel. +39 0432 68 91 51
info_italy@vi-grade.com

UK
VI-grade Ltd
Heritage House - Church Road
Egham TW20 9QD UK
Tel: +44 1784 470470
info_uk@vi-grade.com

USA
VI-grade, Inc.
6855 Commerce Boulevard
Canton, MI 48187
Phone: +1 734 604 7559
info_us@vi-grade.com

Japan
VI-grade Japan Ltd
Nittochi Kameido Bldg. 6F
6-26-5 Kameido, Koto-ku,
Tokyo, 1360071
Tel. + 81 3 6457 8503
info_japan@vi-grade.com

China
VI-grade China (c/o Spectris China)
Unit 1102, XinMao Plaza, Building 9, No.99
Tianzhou Road, Shanghai 200233 P.R.C.
Tel +86 137 8899 9689
info_prc@vi-grade.com

vi-grade.com

VI-GRADE

BRIDGING THE GAP
BETWEEN TESTING AND SIMULATION

VI-CARREALTIME | VI-WORLDSIM