VI-CarRealTime

ONE VEHICLE MODEL FROM CONCEPT TO SIGN-OFF

VI-GRADE

www.vi-grade.com
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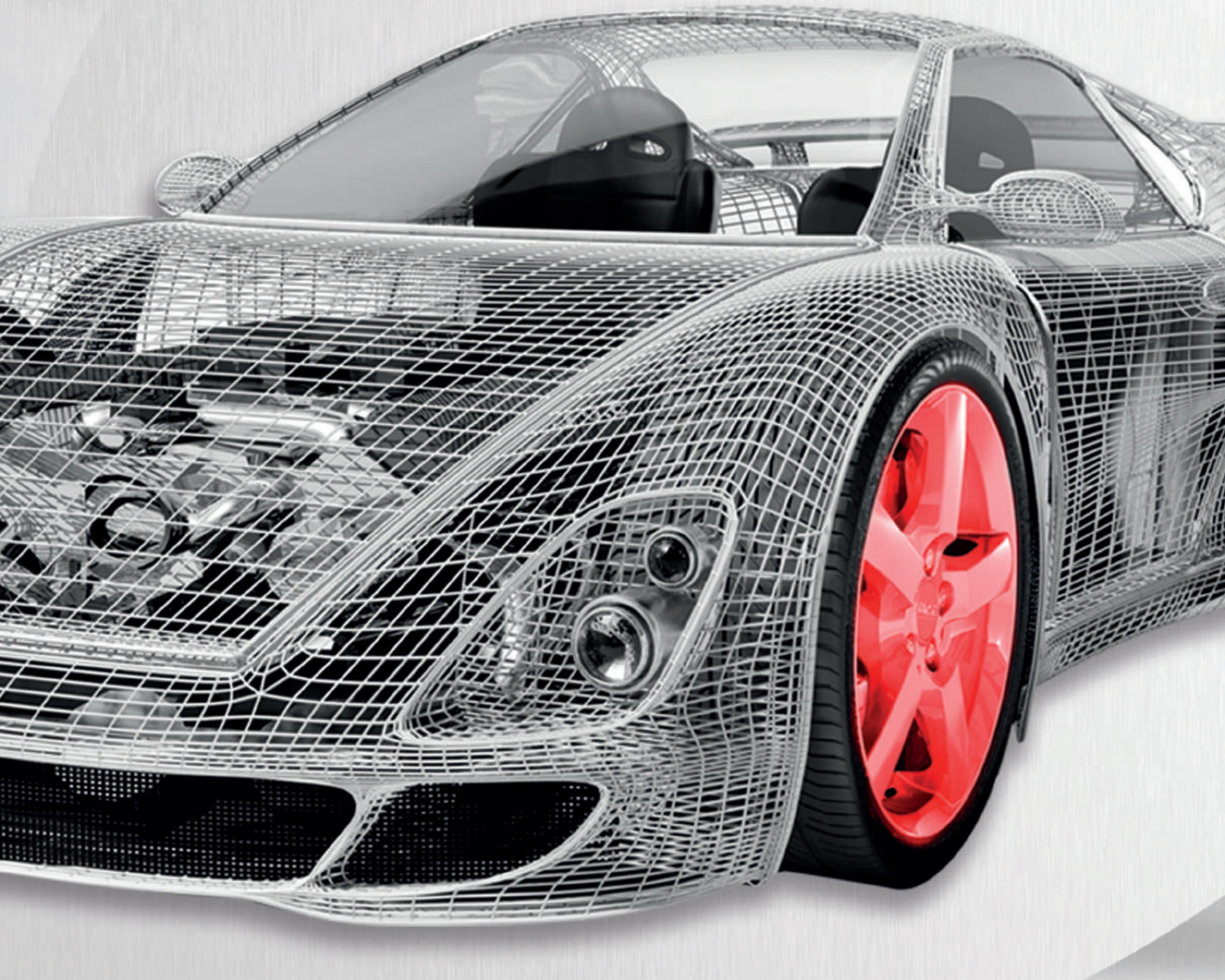
VI-CarRealTime is a real-time vehicle simulation software for engineers who want to quickly evaluate the handling and ride performance of a certain vehicle configuration, develop and adjust vehicle controller and test a prototype or production ECU in a real Hardware-in-the-Loop system.

VI-CarRealTime is based on a faster-than-real-time equation solver, which shares components with and has been validated against the industry standard Adams/Car solution. This ensures high quality and enables an easy exchange of data between engineering teams in all phases of the development process, from conceptual to detailed design, and across the different disciplines, supporting the communication within the organization and with suppliers. The open architecture enables the use of proprietary definition of specific components, when required.

With VI-CarRealTime, the development teams can even experience how a design change affects the vehicle in a more subjective way, by allowing test drivers to get a feeling for the car, while driving the virtual vehicle on a motion base driving simulator. All this with one single model and one single set of data!



Vehicle Dynamics

In the conceptual phase, it is difficult to create detailed virtual models, because the information to create such models is not available. VI-CarRealTime can be used to explore and improve the performance of vehicles at a conceptual level before building a detailed virtual prototype. In this target cascading process, VI-CarRealTime helps to determine the suspension characteristics required to satisfy the vehicle handling performance targets. Those requirements are then used for detailed suspension design within Adams/Car.

During the verification phase, the fast solution times of the VI-CarRealTime model derived from the detailed models enable engineers to run a full stack of handling events including fish hook, lane change, braking in turn, etc. in a much shorter calculation time than ever before, thus allowing for more variations to be studied. The automatic process that generates the VI-CarRealTime model from the detailed Adams/Car model is a matter of seconds. An alternative method for obtaining data, describing the suspension characteristic, is to utilize test data.

Capabilites

VI-CarRealTime is a comprehensive and user friendly environment for modeling and simulating vehicles in real-time. It operates within its own GUI or embedded into a control environment such as MATLAB Simulink.

- Model data automatically derived from detailed models or test
- Shares modeling description for tires, springs, dampers, and driver with Adams/Car
- Advanced driver and road model included
- Advanced steering model for EPS simulation
- Support for trailer and suspended cabin
- VI-Animator as Post Processor
- Export results in RES, CSV, TAB and other data acquisition formats
- Model Extension with Functional MockUp Units (FMUs)
- Interface to traffic simulation environments

Benefits

VI-CarRealTime helps to reduce the time spent in 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.

- No need to validate the model from scratch when derived from detailed assemblies in Adams/Car
- Increase the number of design variations to be studied
- Control engineers and vehicle dynamicists use the same driving tests, tires, and road models
- Easy exchange of data between engineering teams
- No switching between unconnected models while traversing through the design process

The investment pays off because it can be leveraged by many different teams including HIL engineers.

Dynamic Real-Time Simulation

VI-CarRealTime allows to replicate real world tests that are usually conducted in a costly hardware based environment, such as:

- Dynamic open and closed loop events
- Dynamic maximum performance events
- Press Maneuvers
- 4 and 7 post testrig event
- Safety events
- Tire testrig

Users can select from a list of predefined events or create own custom events, including specific GUI. It is also possible to automate and organize event test suites for different vehicles with fingerprints.

Dynamic Events with VI-Driver

VI-CarRealTime takes advantage of the most advanced driver technology in the market. It is fast, robust, easy to tune and takes the vehicle to the limit without a cumbersome learning procedure, which other driver codes may require. With VI-Driver both open and closed loop maneuvers are allowed.

Users may freely create events combining different mini maneuvers, defining steering, throttle/brake and shift control behavior. The product comes with a large library of canned events, including the associated road files.

For an improved user experience, special GUIs are available to setup the most common maneuvers:

- Constant Radius Cornering
- Braking in a Turn
- Impulse, Sine, Step and Swept Steer
- Straight Line Acceleration and Braking

Steering release option is available for most of the canned events.

VI-Driver MaxPerformance

VI-Driver MaxPerformance combines the VI-SpeedGen and VI-CarRealTime modules to automatically detect the maximum speed of a car on a given driverline. An online check of the speed profile feasibility is performed and local recursive corrections of the speed profile on individual track segments are determined. VI-Driver Max Performance pushes the vehicle dynamically to the limit while considering the:

- Path distance
- Yaw rate limits
- Longitudinal speed threshold
- Wheel Locking

VI-Driver Press Maneuvers

The VI-Driver Press Maneuvers toolkit allows VI-Driver users to use VI-CarRealTime to easily optimize vehicle performances on following maneuvers: ISO Lane Change, ISO Lane Change (Consumer Report), Obstacle Avoidance, Slalom.

The user needs to select the vehicle model, the maneuver, the initial speed and few other parameters; VI- Driver, in conjunction with VI-CarRealTime, will determine the maximum velocity allowed for a given vehicle for the specified maneuvers using an automatic cone-hitting detection algorithm.

This very advanced toolkit allows in a short time to automatically evaluate vehicle performance on very demanding maneuvers, without time-consuming and error-prone manual iterations.

Safety Toolkit

Roll over maneuvers are becoming more and more important to study and ensure vehicle stability and to obtain homologation, especially in some countries. For this reason, a new VI-CarRealTime Safety toolkit has been developed. The toolkit has been designed in order to allow users to setup and perform specific type of simulations related to safety scenarios:

- Straight line rollover
- Straight line misuse events
- Curb trip rollover

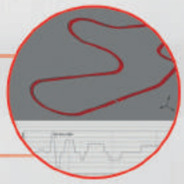
In order to exploit the full set of functionalities, models can be instrumented using a specific set of sensors, generating the relevant outputs that can be used to evaluate event results

Advanced Steering Model

With electronic systems becoming more and more common, EPS is the power steering system that will be progressively utilized in the automotive industry. Unlike its conventional counterpart, EPS is active only during the actual steering process, eliminates maintenance needs on steering hydraulics and considerably reduces fuel consumption.

VI-CarRealTime gives now the possibility to include a detailed EPS (Electric Power Steering) model, developed in collaboration with Prof. Pfeffer of Technical University of Munich, into full-vehicle simulations. The EPS model available in VI-CarRealTime includes both mechanical and servo characteristics, which enables to design, analyse and optimize EPS models in one single environment.

Users have the possibility to define and take into account parameters like friction, hooke joints orientation, e-motor characteristic and many others. If needed, a ECU controller can be also modeled in MATLAB Simulink and interfaced with the VI-CarRealTime model for Software-in-the-Loop applications. The EPS model can also work on Hardware-in-the-Loop applications and driving simulators. VI-Driver can be interfaced with the advanced steering model, supporting open or closed loop maneuvers.



3D Road and Path

The road profiles are generated with VI-Road. There are a number of predefined tracks and speedways available in the database delivered with the product.
To create your own road you can assemble a complete profile with different sections based on measured data, analytical descriptions, extruded profiles or generic polygonal surfaces. The OpenCRG standard is also supported.

A common problem to address in simulation preparation is the proper generation of reference trajectories to feed driving algorithm: VI-Road features a comprehensive toolbox designed to generate, manipulate and clean trajectory data, including ones imported from telemetry.

Tires

The tire is one of the key components of the vehicle as it represents the interface between the road and the vehicle and it has a significant impact on performance. To capture the complex dynamic behavior of the tires, a number of numerical models have been developed in the industry. VI-grade has developed interfaces to the widely adopted one such as:

- Pacejka
- MF-Tyre
- MF-Swift
- FTire

All models run on 3D roads and allow investigation of curb crossings and variable friction surfaces.
For more specific needs, VI-CarRealTime supports coding of user defined tire models.

Interface to K&C

VI-CarRealTime Interface to K&C enables automotive OEMs to automatically use K&C data in a real-time vehicle model. The K&C analysis is a simple and widespread methodology to generate a suspension model through physical testing performed on existing vehicles and can be used in case a detailed multibody model is not available in order to determine suspension curves and other global vehicle data.

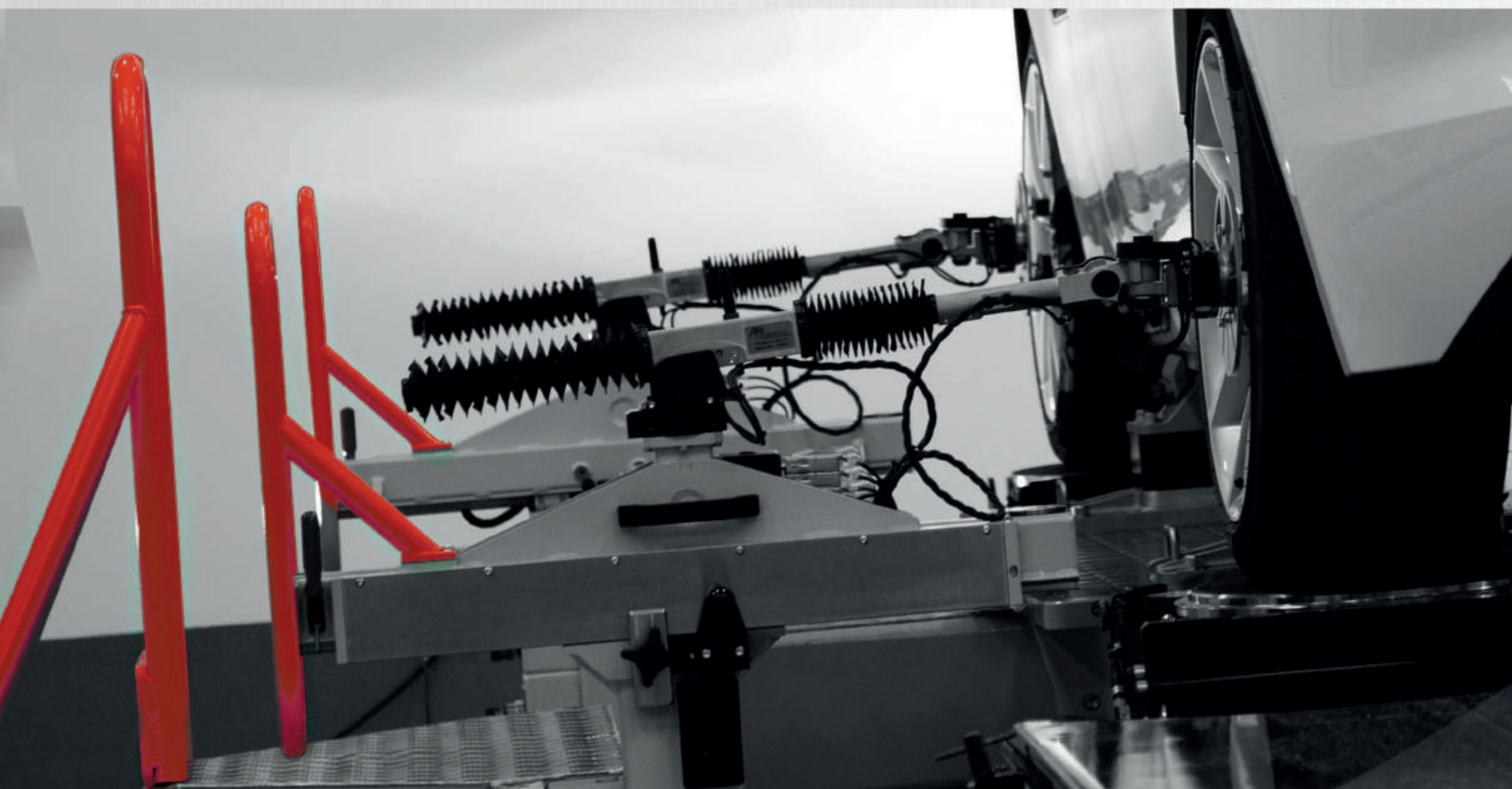
The VI-CarRealTime Interface to K&C, available as plugin, accepts as inputs a configuration file along with other parameters such as the unsprung mass, the damper, tire, brakes and powertrain data and enables to automatically generate a report including all fitting plots, a log file report and all calls to fitting utilities.

The VI-CarRealTime Interface to K&C is an alternative method to populate the vehicle database and a convenient way to create models of competitive vehicles. The toolkit closes the gap between experimental results and simulations.

FMI Interface

Functional Mockup Units (FMUs), compliant to co-simulation mode version 1.0 and 2.0, can be easily integrated into a VI-CarRealTime model using the VI-CarRealTime FMI Master module: build complex systems importing custom or commercial components offered as FMUs.

FMU generation is supported by most Modelica based modeling environment like MapleSim and Dymola. The VI-CarRealTime FMI Master streamlines user simulation process since integrated system can be simulated directly in the VI-CarRealTime framework instead of moving to the Matlab/Simulink environment.



Automatic Model Validation

An automatic validation procedure, implemented in Adams/ Car and in VI-CarRealTime, involves both suspension and full-vehicle analyses and is based on the evaluation of the following parameters:

- Suspension parameters (curves, antiroll bar properties)
- Vehicle parameters
- CG location
- Understeer gradient
- Longitudinal and lateral weight transfer
- Powertrain and brakes data
- Plots and report created automatically

Included into Adams/Car interface are the following validation criteria: Design, Static mass distribution, CG Location, Suspension Kinematics, Compliance, Steering, Kinematics, Full vehicle dynamics, Longitudinal, Lateral.

Key Topics of v17 Release

- FMI master update with full support for co-simulation including static analysis
- Interface with the SCANeR traffic environment by Oktal
- Vehicle data obfuscation
- Introduced additional effects on suspension components steering dependency
- Enhanced advanced steering model with new type of friction and servo gear
- Definition of external suspension models using FMI
- Skidplate component to compute chassis-to-road plane impact forces
- Support of user defined events including custom GUI and pre- events
- PressManeuver event for Matlab/Simulink
- Canned ramp steer event
- Availability of external inputs from Simulink, allowing straight- forward integration with ADAS controllers
- Suspension adjustments now supported for all full-vehicle events including suspension testrig
- VI-SpeedGen event now supports a more accurate tire slip formulation
- External road models can now be coupled to built-in tire models through the Simulink interface
- Improvement of VI-Driver behavior in low-speed driving conditions
- Support of xPC Target

Controls Design and Software-in-the-Loop (SIL)

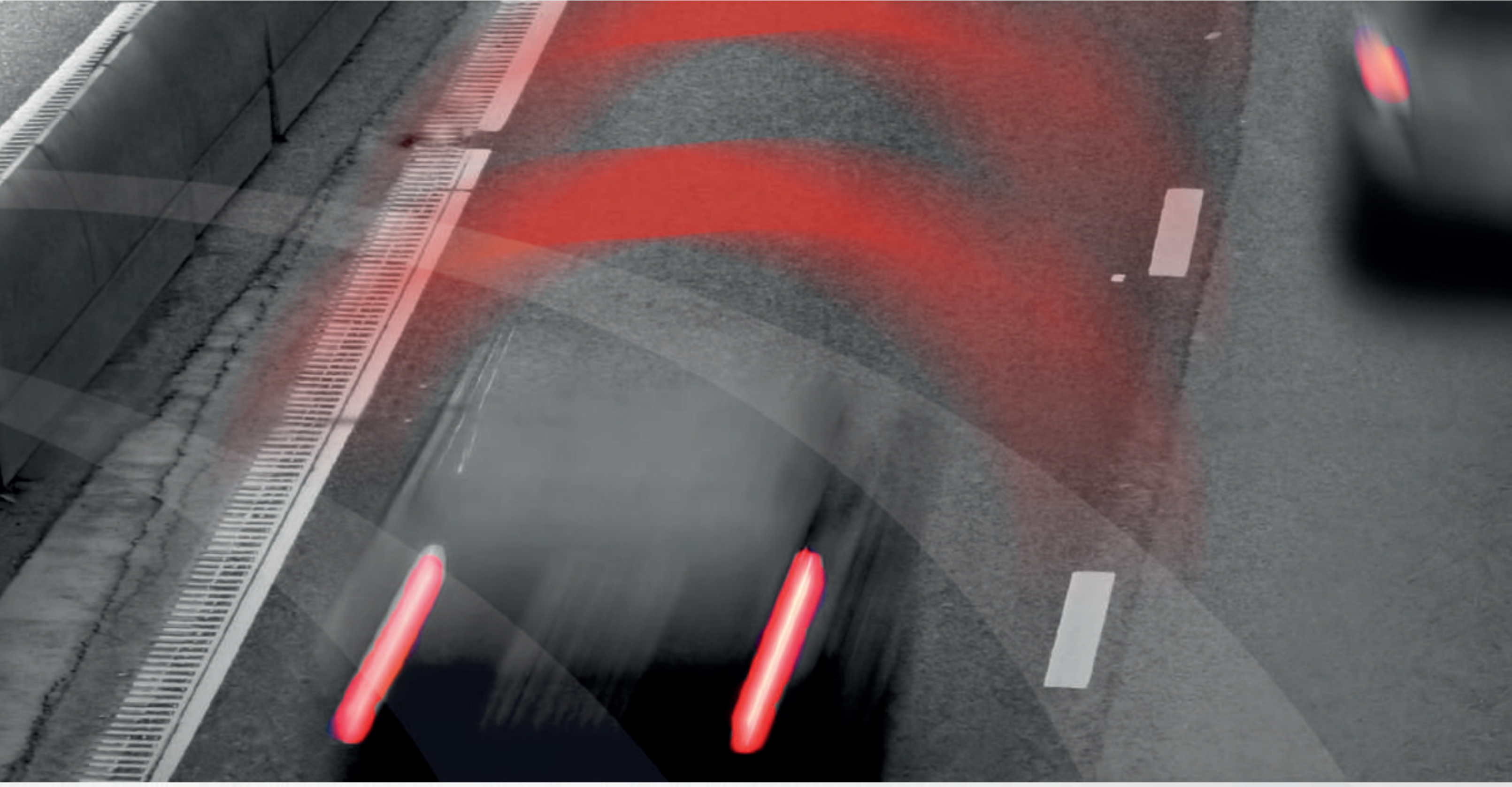
Often, vehicle control engineers cannot reuse the same models used by vehicle dynamicists to test their control systems, because they are too complex.
For controls design, it is possible to include the VI-CarRealTime model as an S-Function or User Defined Block in a controls environment such as MATLAB Simulink. The VI-CarRealTime GUI broadcasts the model input in terms of vehicle date (e.g. spring rates, tire properties, roads,...) and in terms of event control for the virtual driver model via sockets. Another option is to feed all data thru files into MATLAB Simulink, so that the user can fully control the simulation from there.
On top of that, it is possible to group all events in so called "fingerprints" for a high level of automation. You may submit simulations with the VI-CarRealTime S-Function in Simulink directly or in batch mode.
You can also animate the motion of the models during the simulation with the included post processing utility called VI-Animator. In that same utility you can plot the responses of the vehicle, such as yaw rate or lateral acceleration and internal model states, such as aerody- namic forces or brake pressure.
The Matlab API toolkit grants the possibility to query/ modify the VI-CarRealTime model within the Matlab environment in order to easily integrate the VI-CarRealTime suite into larger simulation processes.

Hardware-in-the-Loop (HIL)

Vehicle OEMs and suppliers are being required to perform failure and field warranty analyses of the embedded control system prior to a vehicle being released. This requires the use of virtual models running in real time in conjunction with the controls hardware.
After embedding your VI-CarRealTime model into the controls environment, you can automatically generate the code for the most common platforms of HIL systems.With VI-CarRealTime, you can validate the embedded control system on a battery of tests even before the vehicle is available. The validation of vehicle designs is difficult and time consuming: with VI-CarRealTime, you can sidestep questions about the accuracy of the model and intellectual property rights by using the actual hardware itself.This functionality is compatible with the following platforms:

- Concurrent Computer
- dSPACE
- National Instruments
- Mathworks xPC Target

Since VI-CarRealTime is developed using software standards such as ANSI-C, porting to new hardware and operating systems is easily possible.



ADAS (Advanced Driver Assistance Systems)

Advanced Driver Assistance Systems (ADAS) are devices developed to automate, adapt and enhance vehicle systems for safety and better driving.
Safety features are designed to avoid collisions and accidents by offering technologies that alert the driver to potential problems, or to avoid collisions by implementing safeguards and taking over control of the vehicle.
Adaptive features may provide adaptive cruise control, automate braking, alert driver to other cars or dangers, keep the driver in the correct lane, automate lighting, incorporate GPS/traffic warnings, connect to smartphones or show what is in blind spots.

Advanced Driver Assistance Systems are one of the fastestgrowing segments in automotive electronics. In all the applications listed below, vehicle, controls and external environment are interacting with each other and therefore all elements of the system need to be modelled accurately:

- Adaptive Cruise control
- Lane Keeping
- V2V communication
- Blind Spot Detection
- Collision Avoidance
- Pedestrian Avoidance
- Emergency Maneuvers

VI-grade has implemented interfaces, partnerships and tools to make it possible to develop ADAS systems using exactly the same accurate real-time vehicle model used for vehicle dynamics and ride studies.
VI-grade created a collaborative environment in which its own vehicle technology (based on VI-CarRealTime), state-of-the-art software solutions for control system design (MATLAB Simulink, MapleSim, etc) and traffic simulation software are connected with each other.

To do so, partnerships have been established with all major companies providing traffic and sensors modelling environment: we provide highly reliable vehicle models and our partners provide ADAS and Traffic features.
Thanks to this joint offering, three different ADAS simulation environments are available:

- Software-in-the-loop, typically the first application when new active control systems are developed: this is the environment in which new control strategies are developed and tested with virtual real-time vehicle models.
- Hardware-in-the-loop, typically the environment in which active control strategies are verified against all possible working conditions: in this phase, robustness of the control strategy, possible failure scenarios and safety aspects are becoming very important.
- Driver-in-the-loop, the new way of developing vehicles and active control systems: through driving simulators, it is possible to frontload activities in the development cycle when prototypes are not yet available.
  SIL and HIL applications are meeting each other when a driving simulator is used in the vehicle development process.

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