

# FTire

The Market-Leading  
Physical Tire Model

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scientific software

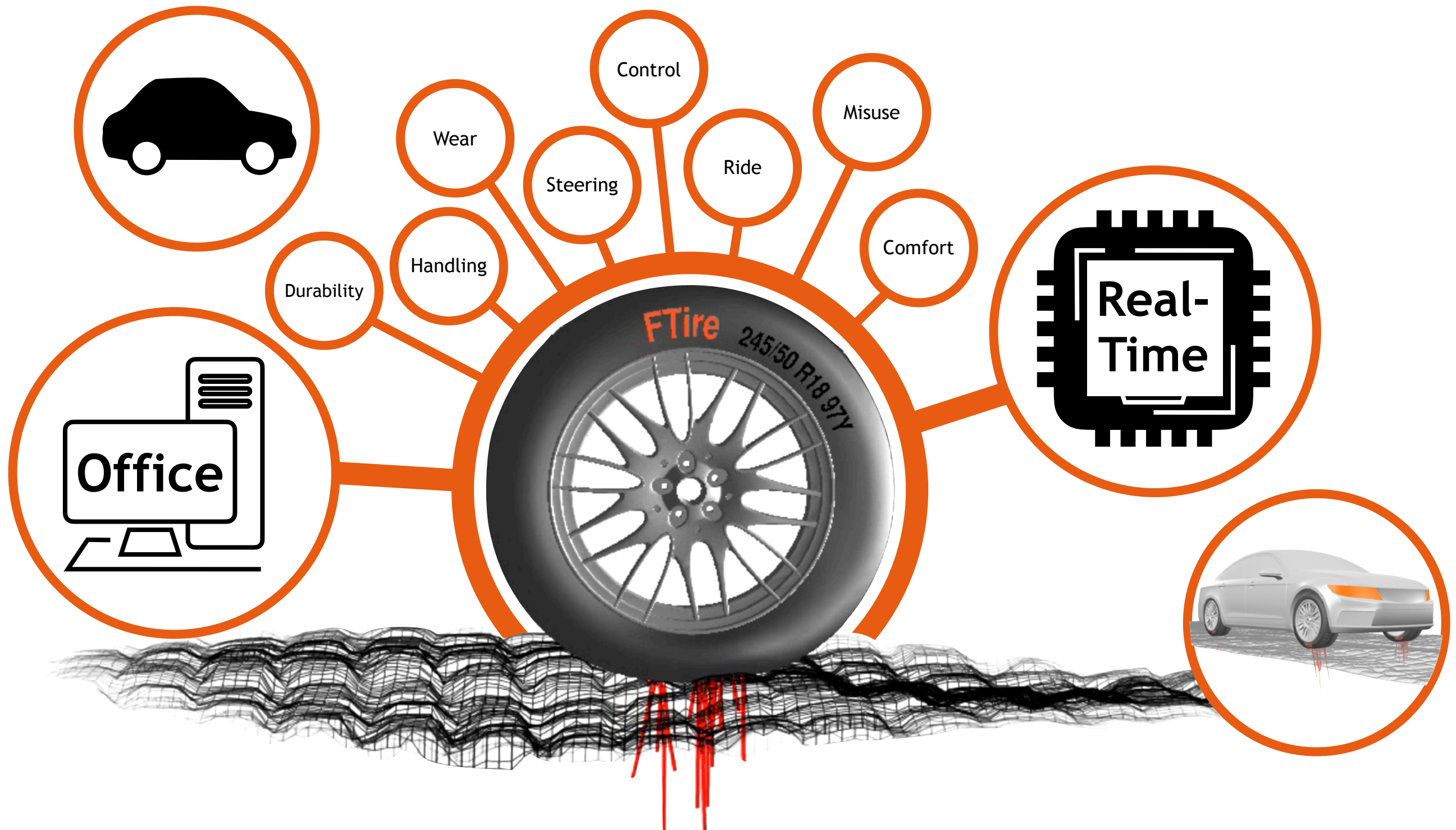


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# FTire/core - The 3D Flexible Structure Tire Model

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One Tool, all Domains. A seamless Approach. Consistent. Trusted. Validated.



# FTire - The Tire Simulation Software

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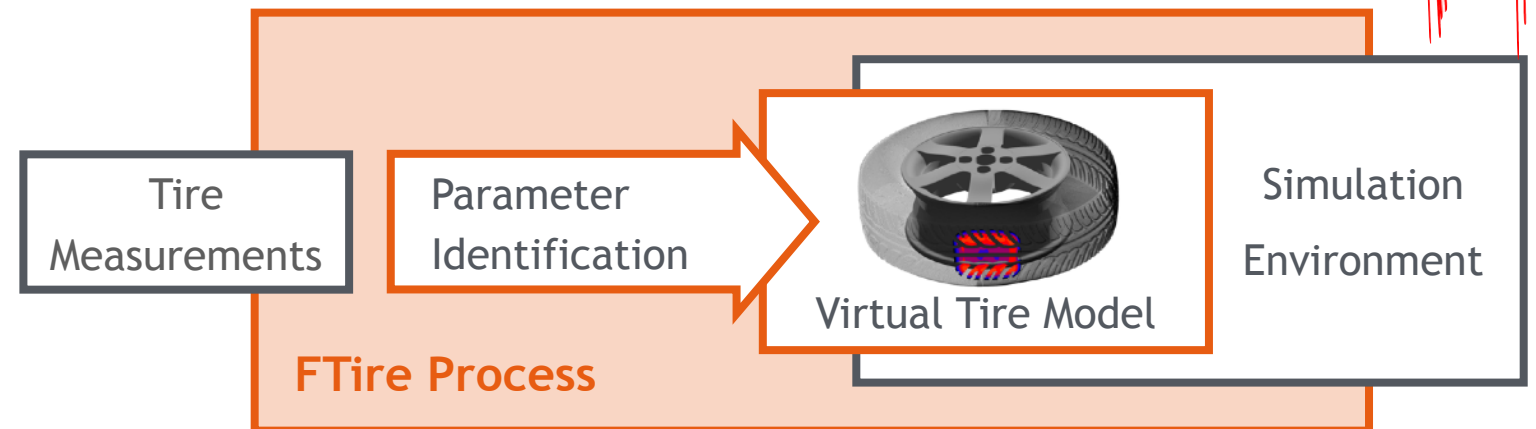


FTire is the most comprehensive simulation software package for advanced tire and road surface modelling on the market.

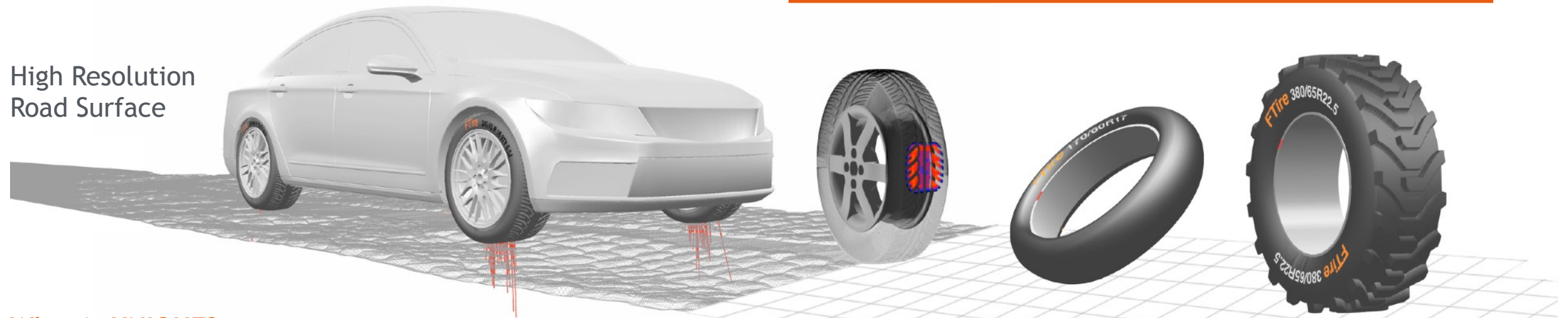
The 3D **Flexible** Structure **Tire** Model (FTire) is the multi purpose virtual tire model designed for applications where tire dynamics have an important effect on the vehicle dynamics simulation.

FTire is applied and supported by vehicle and tire manufacturers in the areas of passenger car, motorcycle, agricultural and aerospace development. Together with several partners worldwide, **cosin** scientific software offers a full range of support for tire data measurement, parameter identification, and road surface measurement.

The FTire software package covers the full process from processing measurement data, over parameter identification, generating the virtual tire simulation model, up to the use in a wide environment of CAE software tools with a huge variety of application cases.



High Resolution  
Road Surface



## What is UNIQUE?

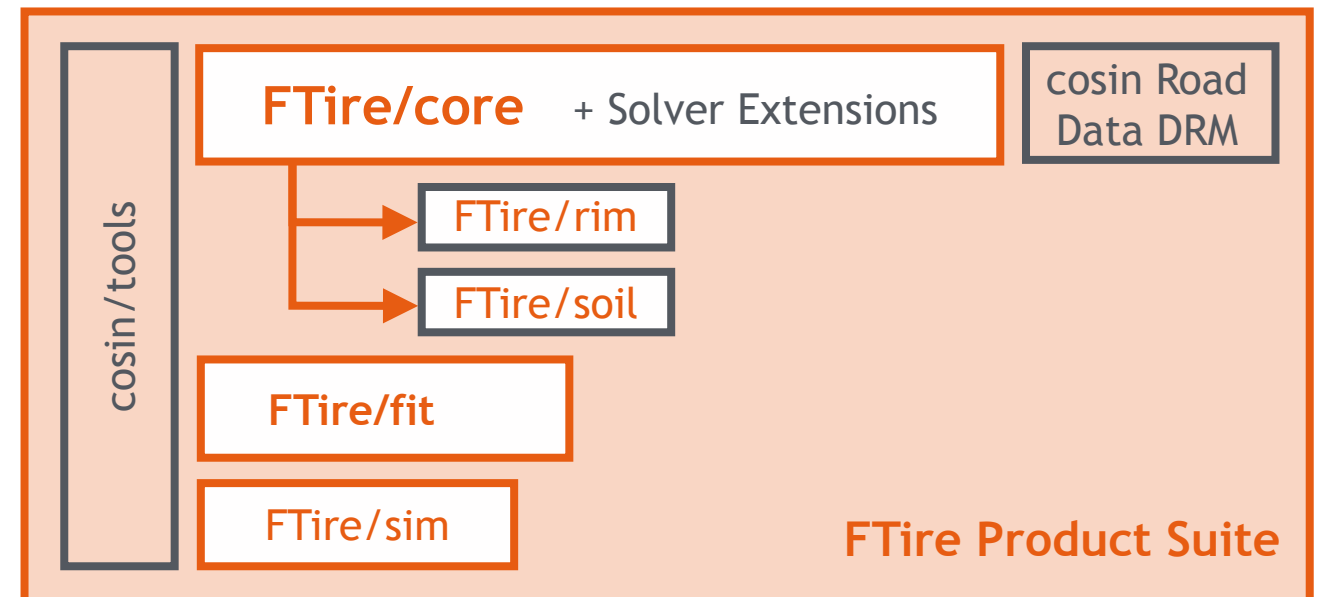
- FTire is the physical tire model, simulating complex tire phenomena on a strictly mechanical and thermo-dynamical basis.

# FTire/core - The 3D Flexible Structure Tire Model

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The tire simulation software **FTire** consists of its main product **FTire/core**, the 3D flexible structure virtual tire with dedicated solver extensions, the standalone product **FTire/fit** for parameter identification out of measurements and **FTire/sim** a fast and efficient tire dynamics and road-related simulation toolkit.

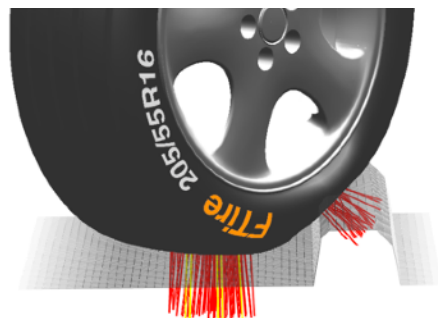
In addition users are provided with the powerful **cosin/tools** to handle **FTire** data and **cosin Road Data DRM** enabling digital rights management and road data encryption.



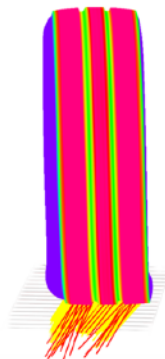
## FTire/core Features

- Physical tire model with fully nonlinear 3D tire structure deformation model covering all frequencies up to 250 Hz and higher
- Extensions for detailed tire temperature and thermal effects, internal air flow and air volume vibrations included
- Tire imperfection models embedding tread gauge variation, imbalance effects, conicity and non-uniformity
- Solver extensions for tread wear, flexible rim, and deformable road
- Optional misuse contact elements like rim-to-belt (bottoming), sidewall-to-road, and rim-to-road
- Dynamic tread-road contact model with a resolution below 1 mm and optional use of geometrical tread patterns
- Wide variety of road data formats including RGR, RDF, CAD formats, OpenCRG, and user-written road models supported
- Unlimited number of tires and roads per simulation model

## FTire/core Extensions



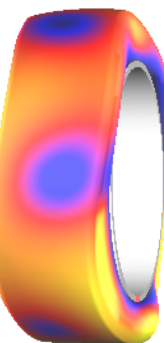
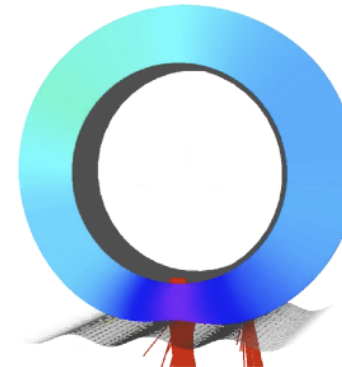
Imperfection & Misuse



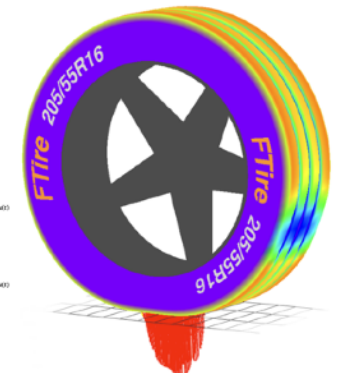
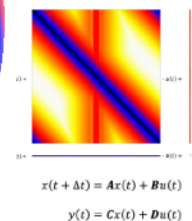
3D Thermo-Dynamic & Heat-Transfer



Air Cavity Vibration



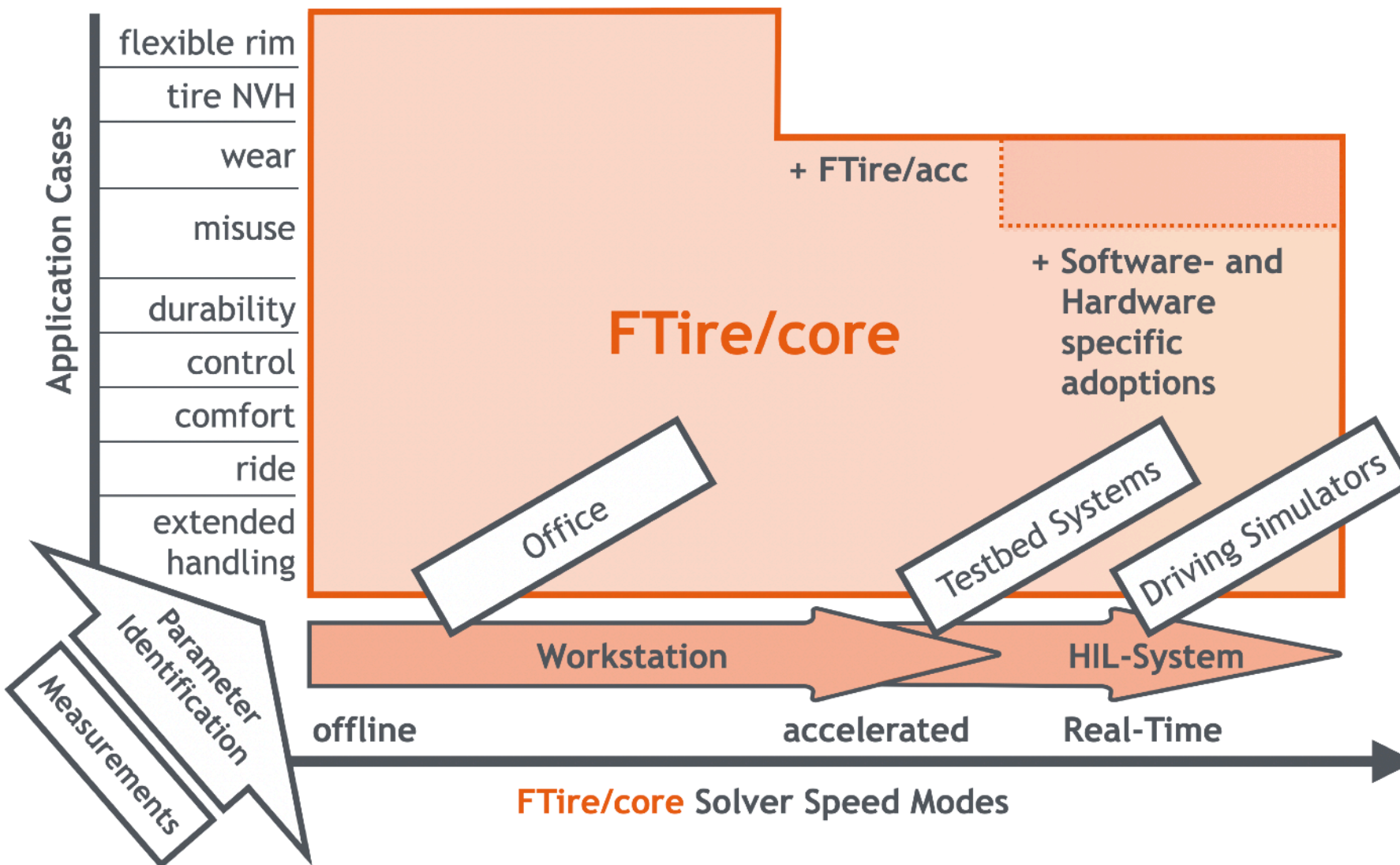
NVH / Linearization



Wear

# FTire/core - The Multi-Purpose Virtual Tire

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## What is UNIQUE?

Seamless modelling approach:

- The identical high-quality virtual tire can be used throughout the entire tool chain and applications across all development departments
- One solver from the office, to HiL SiL and MiL, up to the testbed systems and driving simulators
- No reduction of belt fidelity for higher solver speed modes
- Full level of detail and dynamic range even under hard Real-Time operation conditions
- One product which covers most tire dynamics phenomena
- Interfaces to a large number of CAE software tools

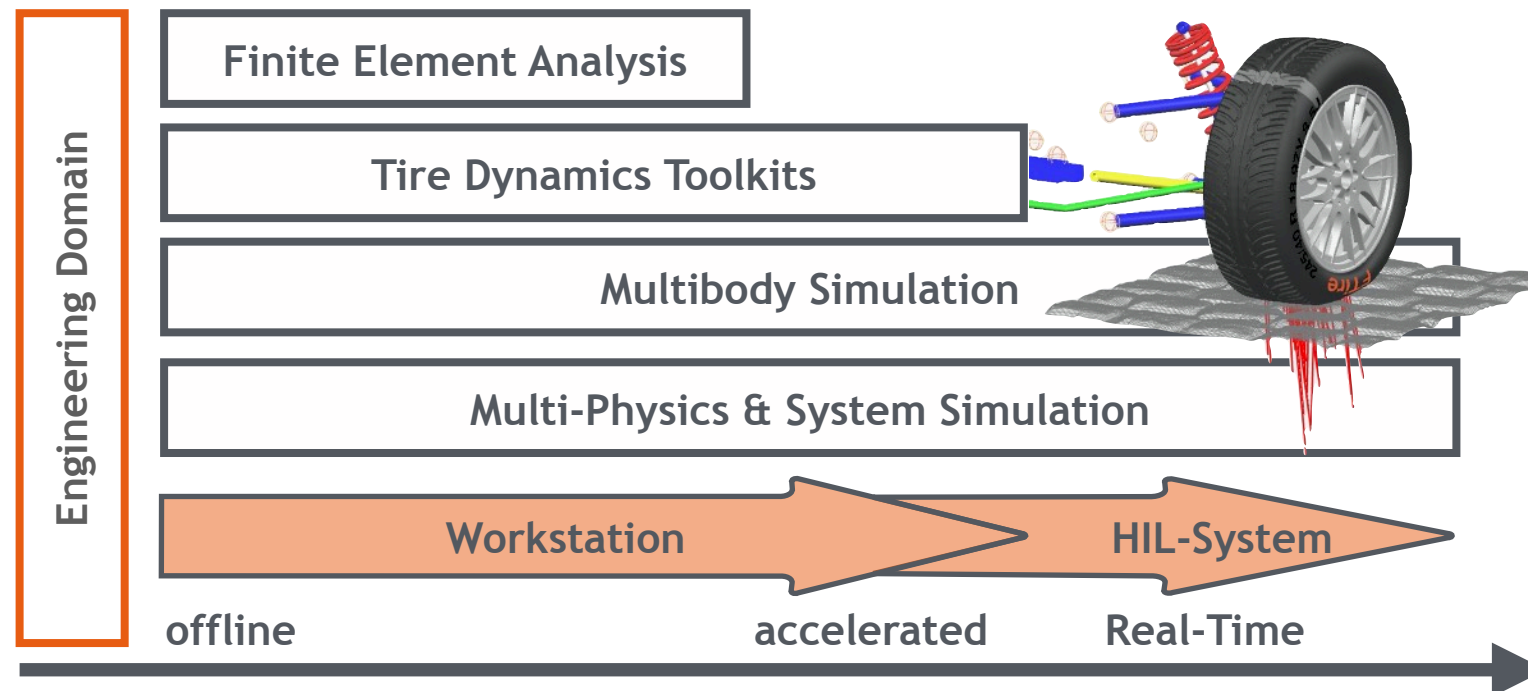
## FTire/core is the multi-purpose virtual Tire Solver

From offline application cases on office workstations up to Hardware-in-the-Loop application cases on specific HiL target systems, the physical 3D nonlinear tire simulation model solves complex tire phenomena on a strictly mechanical and thermo-dynamical basis. The **FTire/core Solver** can run in different speed modes, from standard, to acceleration (**FTire/acc**), up to Real-Time. In order to execute **FTire/core** for Hardware-in-the-Loop Application Cases (**FTire HIL AC**) with hard Real-Time requirements, special packages for the particular target systems are required.



# FTire/core - Engineering Domain & Applications

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## FTire/core Engineering Simulation Domain

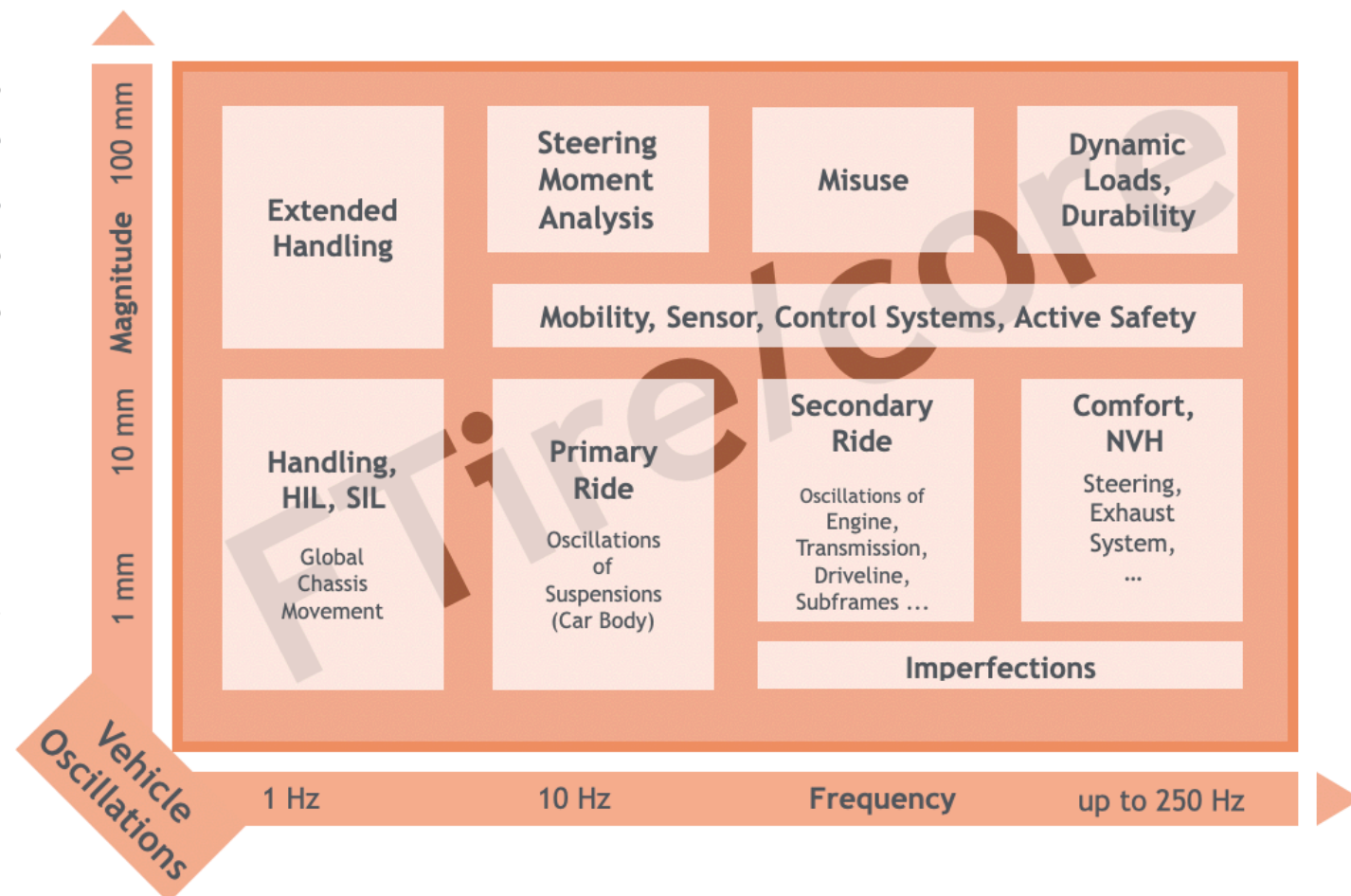
FTire supports about 20 CAE 3rd-party software interfaces. From Finite Element Analysis (FEA) such as Abaqus (Dassault Systèmes) and Tire Dynamics Toolkits, i.e. **FTire/sim**, over Multibody Simulation (MBS) software like Adams (MSC Software), Simpack (Dassault Systèmes), VI-CarRealTime (VI-grade), and others, up to Multi-Physics & System Simulation tools such as ASM (dSPACE), CarMaker (IPG), CarSim (Mechanical Simulation), MATLAB/Simulink (Mathworks), and many more.

## Application Cases

Independent from the simulation domain, **FTire/core** is suitable for all applications from 1 to more than 250 Hz. The highly nonlinear and dynamic tire model **FTire/core** is designed for versatile researches and in-depth studies in the area of extended handling, primary and secondary ride comfort simulation, NVH, and prediction of road loads on road irregularities even with extremely short wave-lengths.

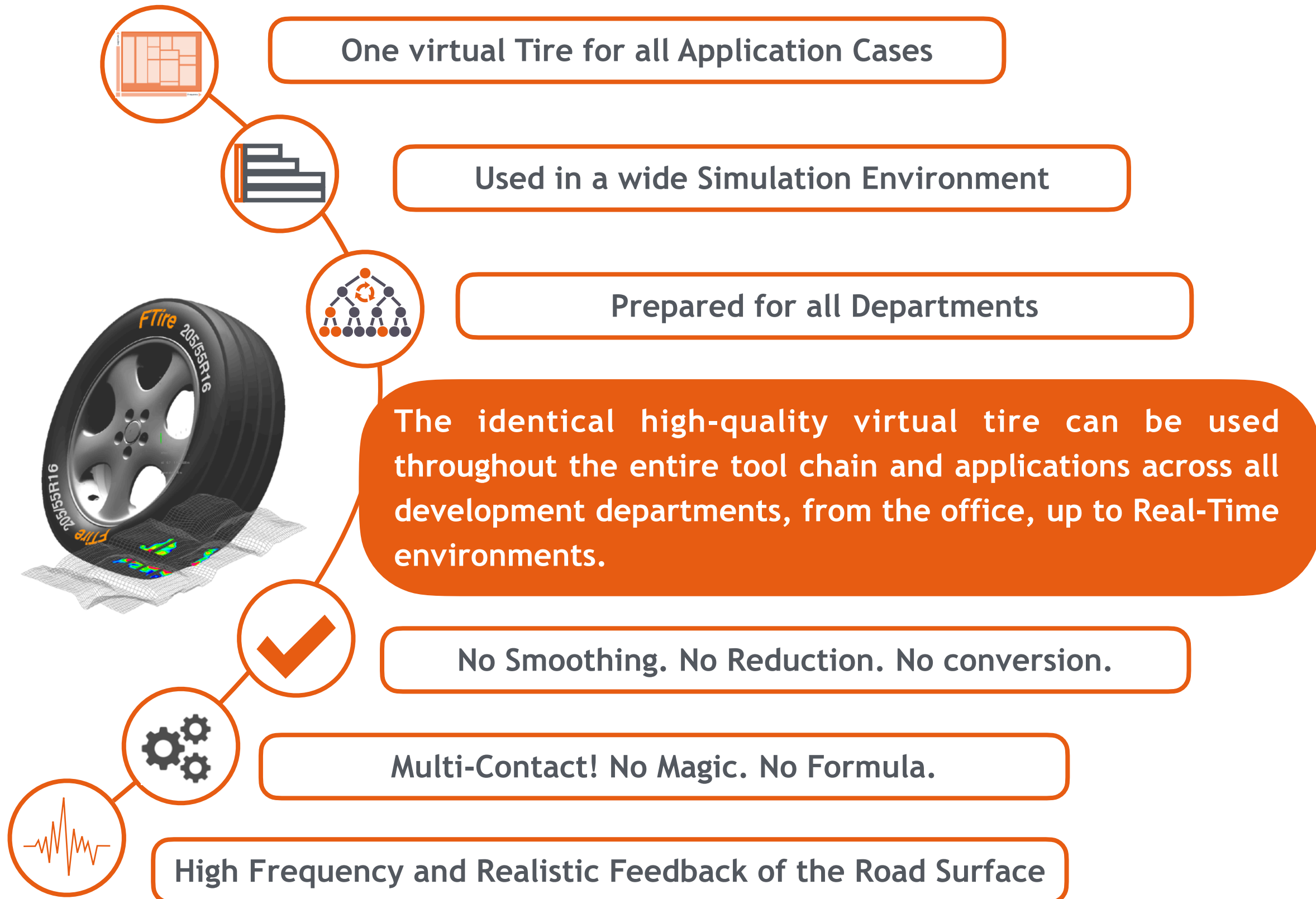
## What is UNIQUE?

- One product which covers most tire dynamics phenomena used throughout the entire tool chain and all application cases
- One solution from Offline to Real-Time



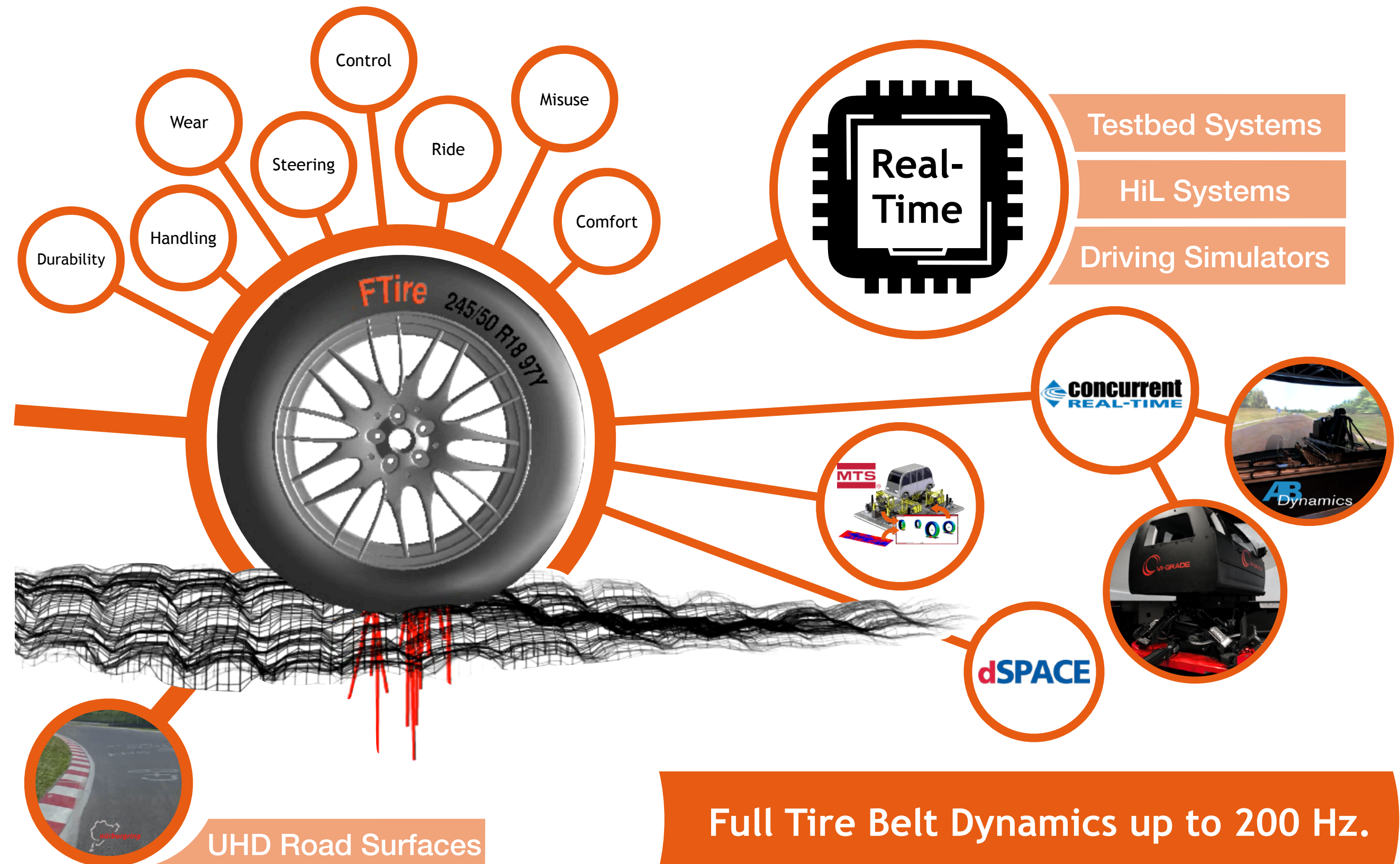
# FTire/core - The Digital Twin

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# FTire/core - Hardware-in-the-Loop Environments

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# FTire/core - Full Tire Dynamics in Real-Time

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## FTire HiL AC

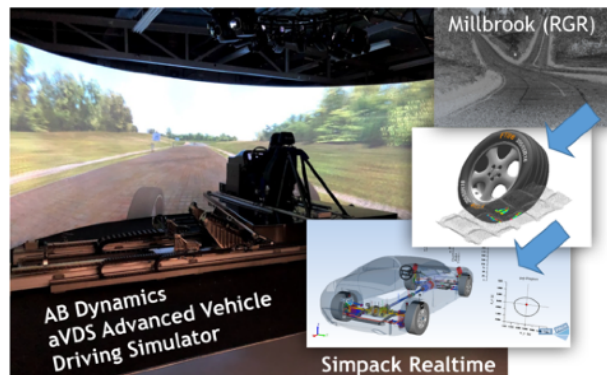
Enables Hardware-in-the-Loop (HiL) Application Cases (AC) executing **FTire/core** on testbed systems, driving simulators and more.

- Guaranteed compatibility to specific target systems
- Hard Real-Time conditions (guaranteed response times)
- High accurate in frequency range up to 200 Hz
- Parallel solver execution for multiple tire instances
- Taking full advantage of multi-core systems
- Suitable for all applications from ride/comfort, extended handling, vibrations, to durability

## Currently Supported Hardware (HiL Systems)

- **FTire HiL AC for HSRC**
- MTS testbed systems (HSRC application case)
- **FTire HiL AC for CCRT** (concurrent REAL-TIME)
- on driving simulator solutions

These packages include hardware glue-code and interfacing components to enable **FTire/core** on the target system.



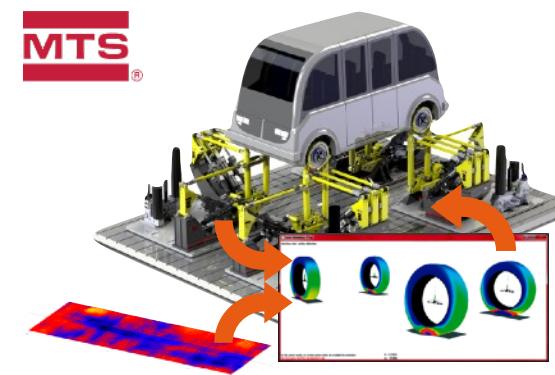
## What is UNIQUE?

- Full featured **FTire/core** model runs under hard Real-Time conditions (full level of detail and dynamic range)
- No changes in tire and road data-sets
- Standard road resolution 5 mm x 5 mm also for **FTire HiL AC**
- Re-use of the same high-quality Digital Twin across all simulations guarantees a seamless workflow



## Benefits at a Glance

- Makes **FTire/core** available to HiL, testbed system and simulator applications under hard Real-Time conditions
- Simulation setup remains unchanged
- Change tire operating conditions at simulation runtime

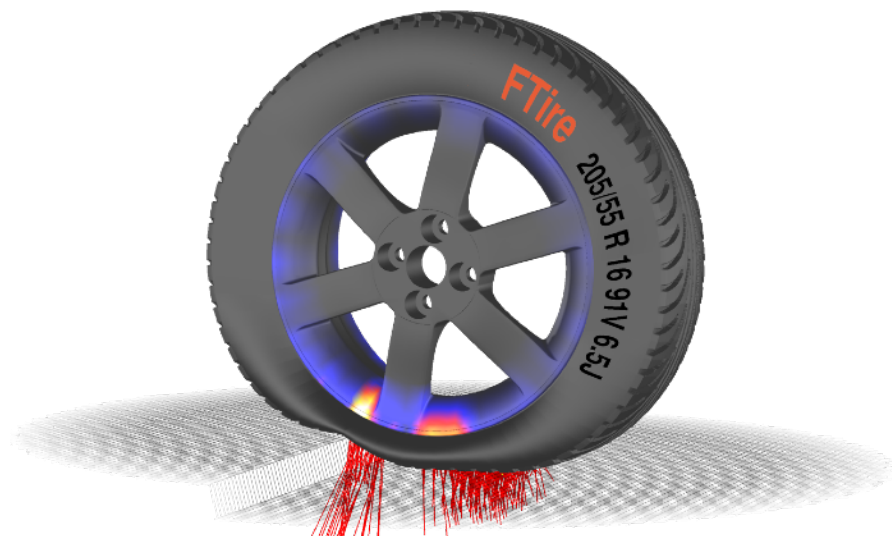


**FTire/soil** and **FTire/rim** extend the modelling capabilities offered through **FTire/core**. These features add a more detailed description to tire and road simulation analysis, which covers all application fields from ride/comfort and extended handling over durability to NVH.

## FTire/rim

Extension to **FTire/core** for flexible and visco-plastic rim modelling

- Internal elastic and plastic rim deformation model on basis of FE load cases import
- Interface to user-defined rim models
- Rim-to-tire friction and slip models



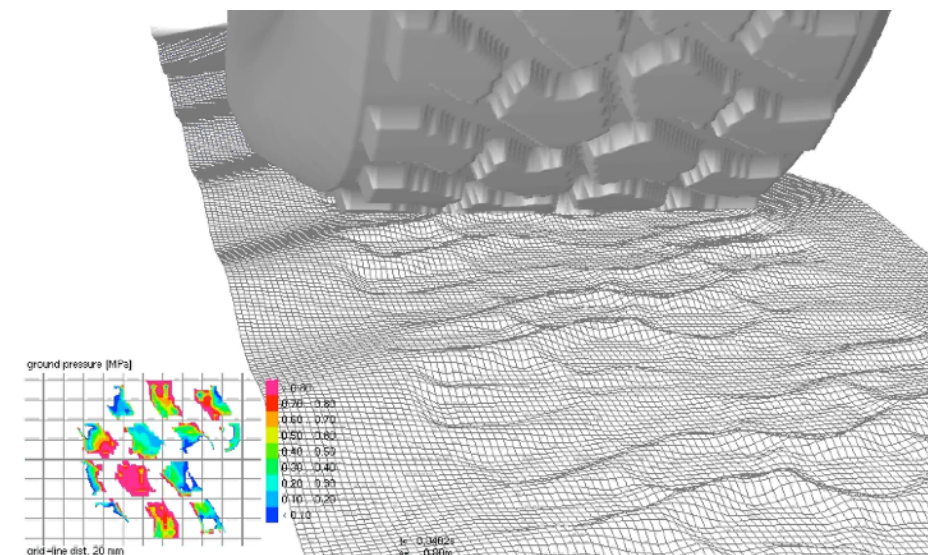
## Benefits at a Glance

- Fast approach for elastically deformable rim
- Enhanced misuse events
- Rim-to-belt and rim-to-road contact
- **FTire** / FEA (finite element analysis) coupling

## FTire/soil

Extension to **FTire/core** for visco-elastic road modelling including the following deformable road surface models:

- cosin soil model
- Bekker/Wong soil model
- interface to user-defined FE-based soil models



## Benefits at a Glance

- Basic approach for elasto-plastically deformable surfaces
- Agricultural tires on soil



# FTire/sim - Tire Dynamics Simulation Tool

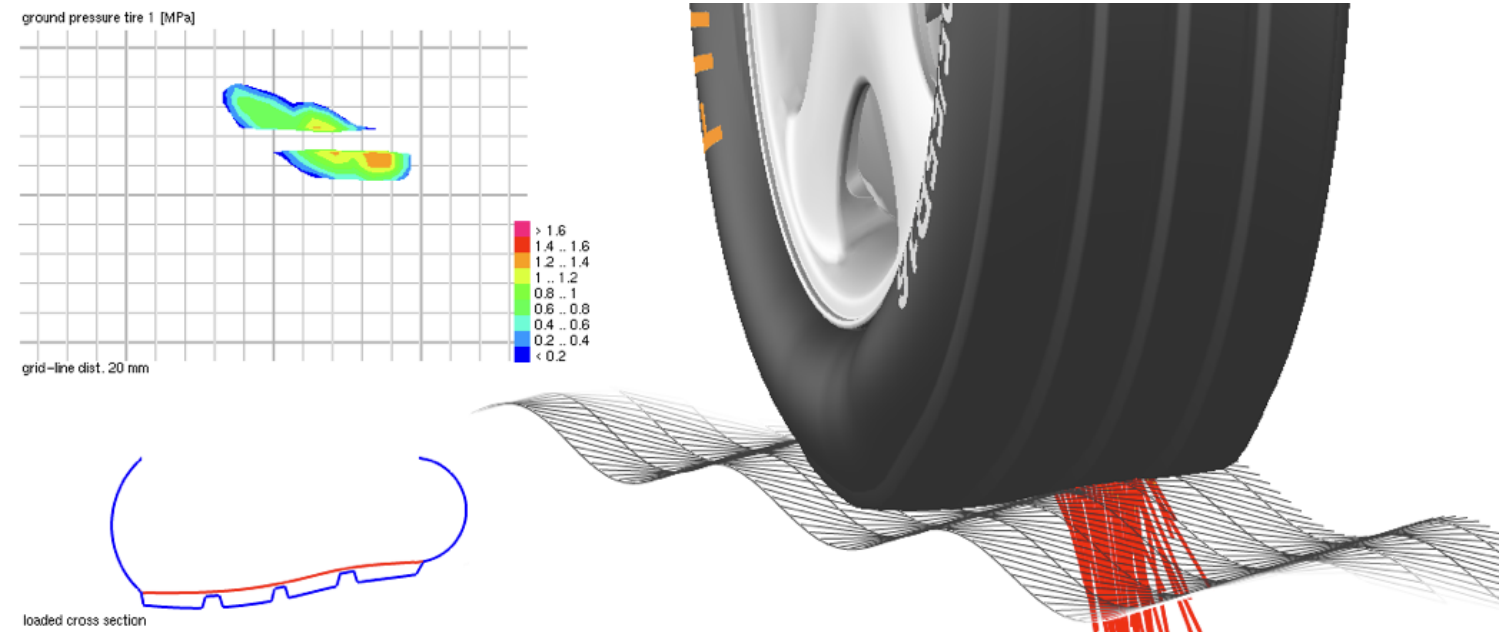
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**FTire/sim** is a standalone tire dynamics and road-related simulation toolbox designed for versatile researches and in-depth studies. It provides a wide variety of tire test-rig and detailed nonlinear suspension simulation models. Tire operating conditions and test-rig controls can be changed interactively. **FTire/sim** assists in developing extensive parameter variations in scripted batch runs, including automated post-processing and helps to gain understanding of complex relationships between all model components. **FTire/sim** enables users to setup models and analysis processes executing the full functionality of **FTire/core**.

The comprehensive time-invariant and time-variant rigid road surfaces library (**cosin/road**) and the powerful **cosin/tools** to handle FTire data are included.

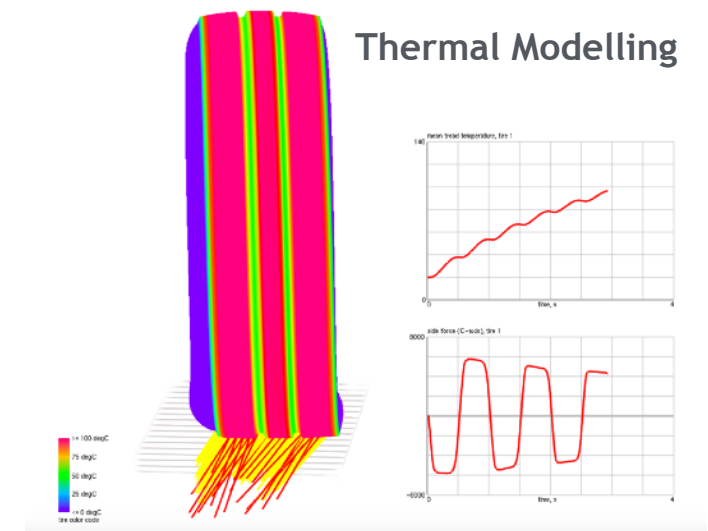
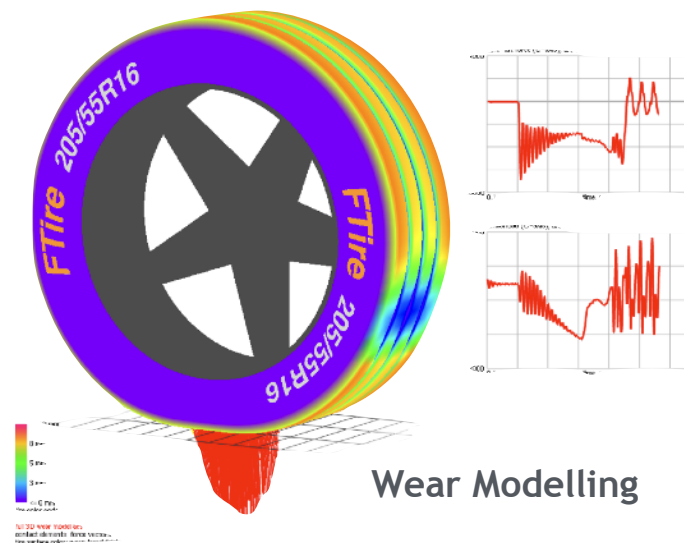
## FTire/sim Features

- Ready to use tire test-rig simulation models
- Detailed nonlinear suspension models
- User-interactive simulation control
- Wide variety of load-case templates
- Multi-dimensional parameter variation
- Automated post-processing
- Detailed road surfaces library (**cosin/road**)



## Benefits at a Glance

- **FTire/sim** is a comprehensive toolbox for multi-dimensional design of experiments (DoE) studies of all tire parameters and connected simulation model components
- Virtual tire test-rig for users with no access to an external multibody dynamics simulation (MBS) software

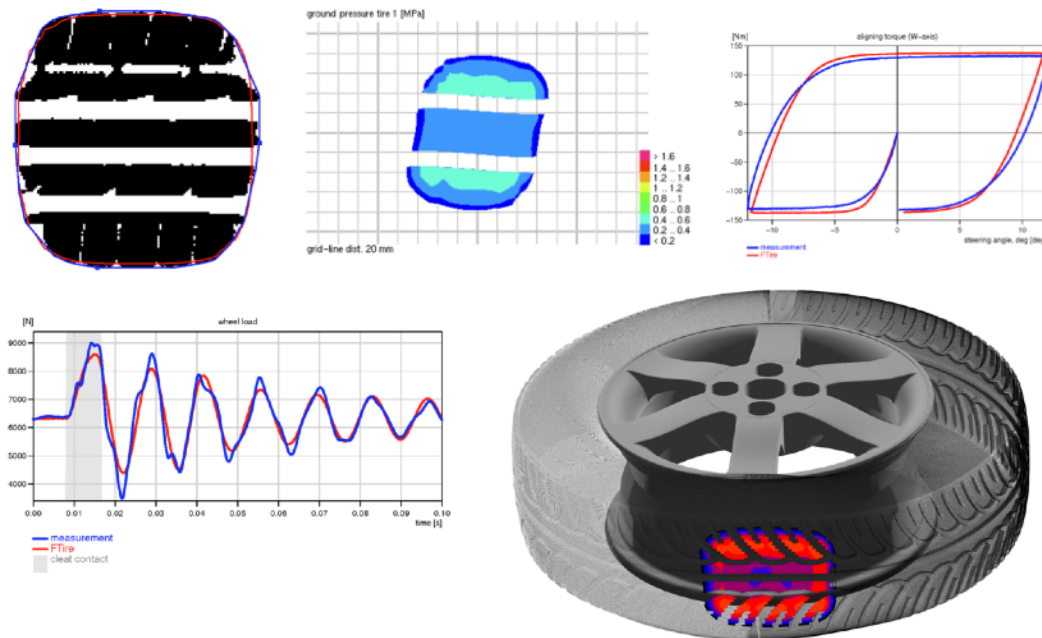
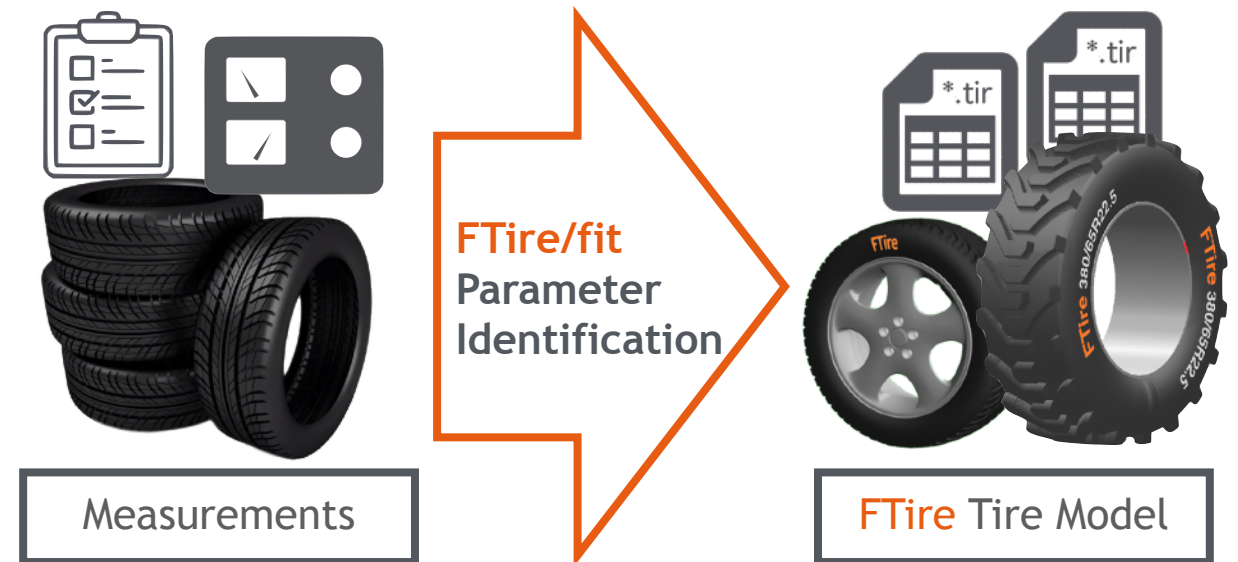


# FTire/fit - Parameter Identification Tool

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**FTire/fit** is the software toolbox designed for parameter identification and optimization of **FTire** data on basis of static and steady-state measurements, footprint geometry, cleat tests and virtual measurements such as finite-element-analysis (FEA) results. The standalone product is developed for tire measurement providers, testing labs, tire manufacturers and automotive OEMs with a high level of in-house testing capabilities.

cosin scientific software provides an extensive consultancy and training for **FTire/fit** users. Parameter identification from physical measurement data is available as a service.



## Benefits at a Glance

- **FTire/fit** is the powerful parameter identification and validation toolbox for **FTire**
- Much more than just a mathematical parameter fitting procedure

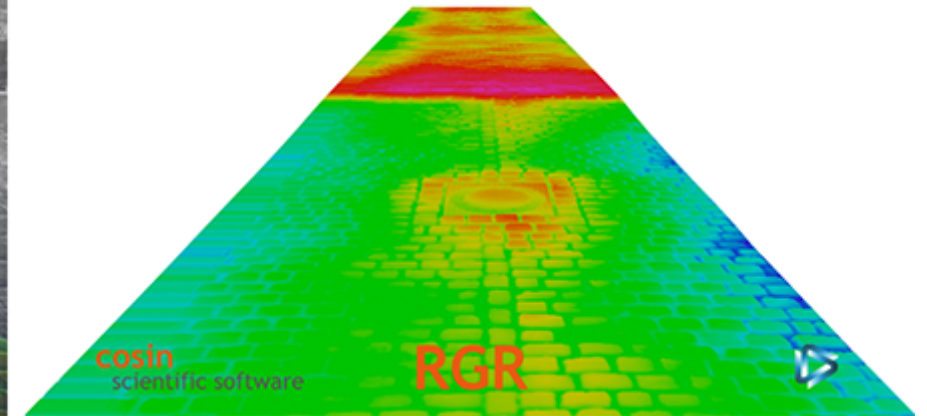
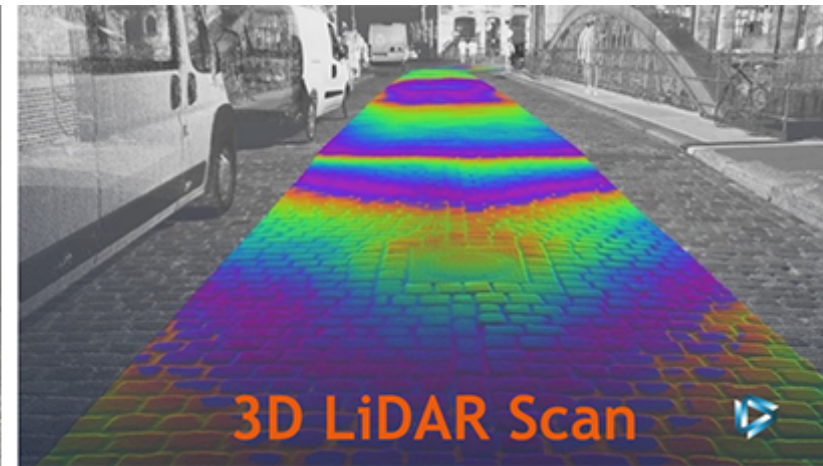
## FTire/fit Features

- Convenient tool for processing, identification, and validation of geometrical, static, steady-state, handling, dynamic, and modal data
- Automatic measurement data format recognition and conversion
- Wide support for input data formats like TYDEX data files, ASCII tables, bitmaps, graphs, MF tire model data, etc.
- Automated footprint comparison and cross-section geometry import
- Automated stiffness determination (radial, longitudinal, lateral, torsion, cornering stiffness, pneumatic trail, and slip stiffness)
- Automated static and steady-state validation by time domain simulation
- Dynamic identification using least squares fits of cleat tests in time and/or frequency domain
- Automated generation of fitting reports
- Fully automatic HTML/PDF-based report creator, including generation and illustration of steady-state and handling simulation results



# cosin - Road Data Marketplace and DRM

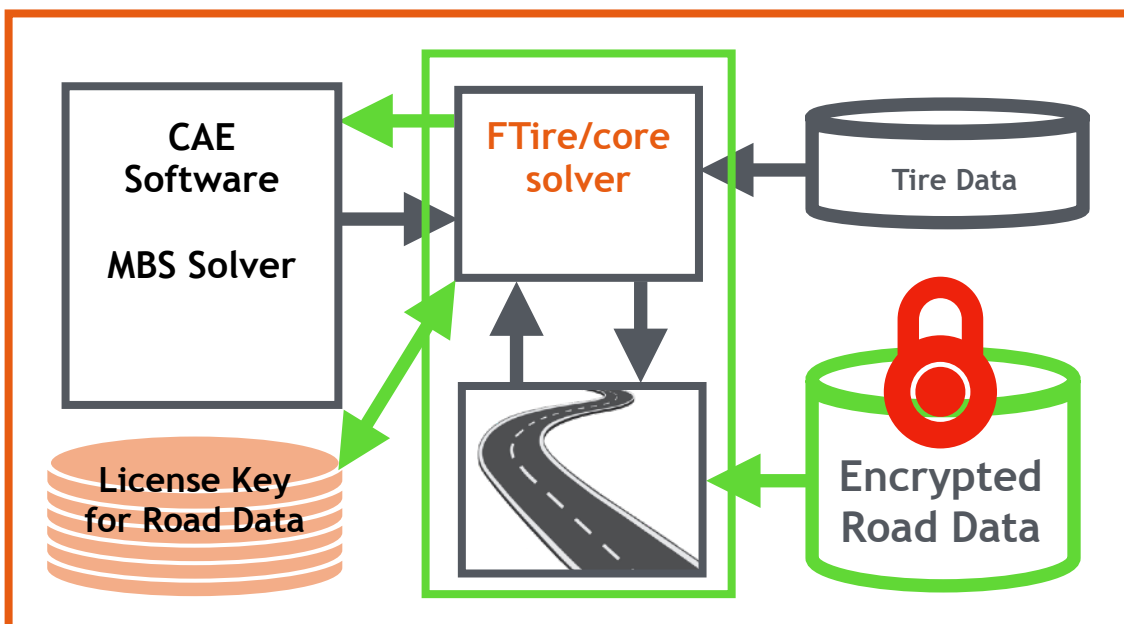
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High quality tire and road models are key to all kinds of virtual prototyping applications. Advanced virtual CAE methods for vehicle performance analysis, durability prediction, ride comfort evaluation, extended handling manoeuvres, ADAS and autonomous control system design require realistic input from the digital twin of the wheels.

Please find more details about **cosin's Road Data Marketplace** on our website: <https://www.cosin.eu/road-data-marketplace/>

## cosin Road Data DRM (digital rights management)



Until now, customers were required to order scanning services as an individual service to purchase digital road data as a proprietary asset. Applying a digital rights management system (DRM) to road data allows users to access encrypted high quality input data in a secure and convenient way. New offerings like restricting data access to particular user groups, short term leasing and publication of proprietary geo data like race tracks or vehicle OEMs proving ground is now possible under the trusted environment provided by the cosin licensing scheme.

*Contact:*

**cosin** scientific software AG

Hans-Stützle-Straße 20  
81249 München  
GERMANY

Tel. +49 89 55288473  
Fax. +49 89 55288474

[sales@cosin.eu](mailto:sales@cosin.eu)  
[www.cosin.eu](http://www.cosin.eu)

