ADDING HIL TO A MOTORCYCLE MODEL: ECUs, ADAS AND TEST RIGS IN THE-LOOP

VI-grade's XiL solution
powered by Concurrent Real-Time
for Automotive Applications

NOT ONE, BUT MULTIPLE CHALLENGES

New Vehicle Architectures & Powertrains

EV, H2

Rider Safety

ADAS
Headlights
M2Car

Change of Legislations

Euro 5+

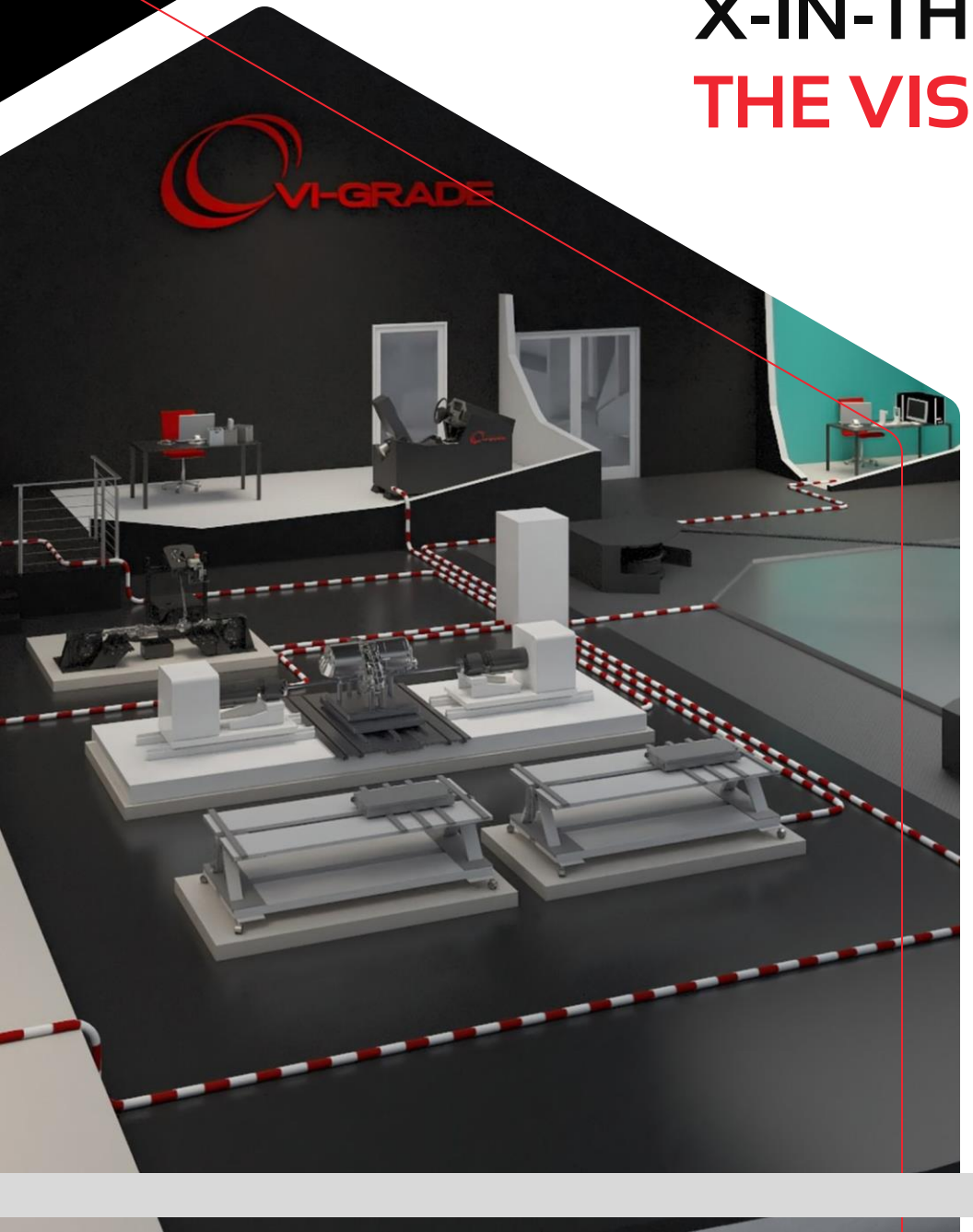
Software-Driven Development

Motorcycles are now computers with wheels

Some Disciplines Getting More Relevant

NVH for EVs

X-IN-THE-LOOP:
THE VISION



AUTOHAWK
Powered by concurrent REAL-TIME

- Enables an integrated virtual test approach, including driving simulators
- Decreases the number of physical prototypes throughout the development cycle, achieving virtual sign-off
- Allows to take into account the effect of controllers and hardware components in simulator testing activities, as soon as they become available
- Allows to use the same real-time tool stack for different simulation activities (MiL, SiL, HiL, on-Sim, on-vehicle test)

AutoHawk
Powered by concurrent REAL-TIME

INTRODUCING...

AutoHawk

AutoHawk is the VI-grade XiL solution (powered by Concurrent Real-Time) for automotive applications.

AutoHawk consists of real-time hardware, real-time OS, real-time software and I/O cards. It is highly configurable. VI-grade real-time software (or software from 3rd party) can be installed on it. In the same configuration, it can work as a stand-alone Linux based, high power computer, as a HiL system or in combination with a driving simulator or on a real vehicle.

AutoHawk is a flexible XiL platform that can be used across the entire product development cycle, from concept to sign-off.

THREE MAIN APPLICATION AREAS

AUTOHAWK
Powered by concurrent REAL-TIME

ADAS / AV / UX-UI

RADAR
LIDAR
ViL
V2X
HMI/UI

CHASSIS

DAMPERS
BRAKE
CONTROLLERS

POWERTRAIN / DRIVELINE

ENGINE
E-MOTORS
INVERTERS
E-AXLES
BATTERIES

AUTOHAWK FROM CONCEPT TO SIGN-OFF

AutoHawk Powered by concurrent REAL-TIME

01 Desktop (Offline + SiL + MiL)
AutoHawk is used for off-line simulations, DoE, optimization loops

02 In-lab (HiL + SiL + MiL)
These are the typical HiL applications in which a device under test (DUT) is connected to AutoHawk running real-time software

03 On-sim (HiL + DiL + SiL + MiL)
These are HiL applications in which the driver sends inputs to AutoHawk through the simulator - useful to test corner cases and where the closed-loop inputs are essential

04 On-board (HiL + ViL + SiL + MiL)
These are HiL applications where virtual motorcycle model runs on the real vehicle with mutual influence

05 Digital Twins (HiL + DiL + ViL + SiL + MiL)
Driving simulator and real motorcycle are fully synchronized and they affect each other

AUTOHAWK

POSSIBLE INSTALLATIONS:
- DESKTOP,
- RACK,

AUTOHAWK 8

8-CORE
3.6 GHz Xeon Gold 6244
REDHAWK OS
P400 CARD
48 Gb MEMORY
4 TB DISK
CAN/CAN-FD/LIN,
FPGA
SimWB

- Real-time offline simulations with VI-CarRealTime
- DoE, Optimization
- ECU testing with VI-CarRealTime and tires
- Chassis HiL (dampers, brake)

AUTOHAWK 16

16-CORE
Two 3.9 GHz Xeon Gold 6250
REDHAWK OS
P400 CARD
96 Gb MEMORY
4 TB DISK
CAN/CAN-FD/LIN,
FPGA
SimWB

- Advanced tires (FTire, CDTire, Swift)
- ADAS HiL w/ VI-WorldSim
- Powertrain / Driveline apps

AUTOHAWK X

Fully Custom Product

SIMULATORS

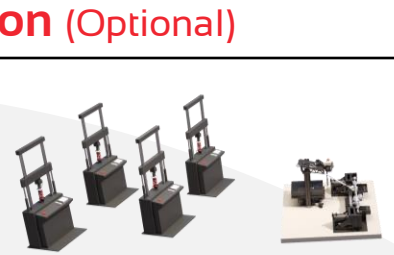
REAL VEHICLE

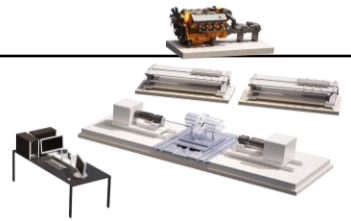
AUTOHAWK
Powered by concurrent REAL-TIME

Software	VI-DriveSim	SIMulation Workbench	iHawk	Hardware
	Vehicle (VI-BikeRealTime) Environment (VI-WorldSim) Traffic (VI-WorldSim) Sensors (VI-WorldSim) Driver (VI-BikeRealTime) Scenarios (VI-WorldSim) SiL FMU/FMI 3rd party software		Signal Conditioning & Fault Insertion (Optional) I/O Cards FPGA CAN EtherCat Ethernet LIN FlexRay Graphic cards	Power Supply (optional)

Test Automation (Optional)

DEVICE UNDER TEST



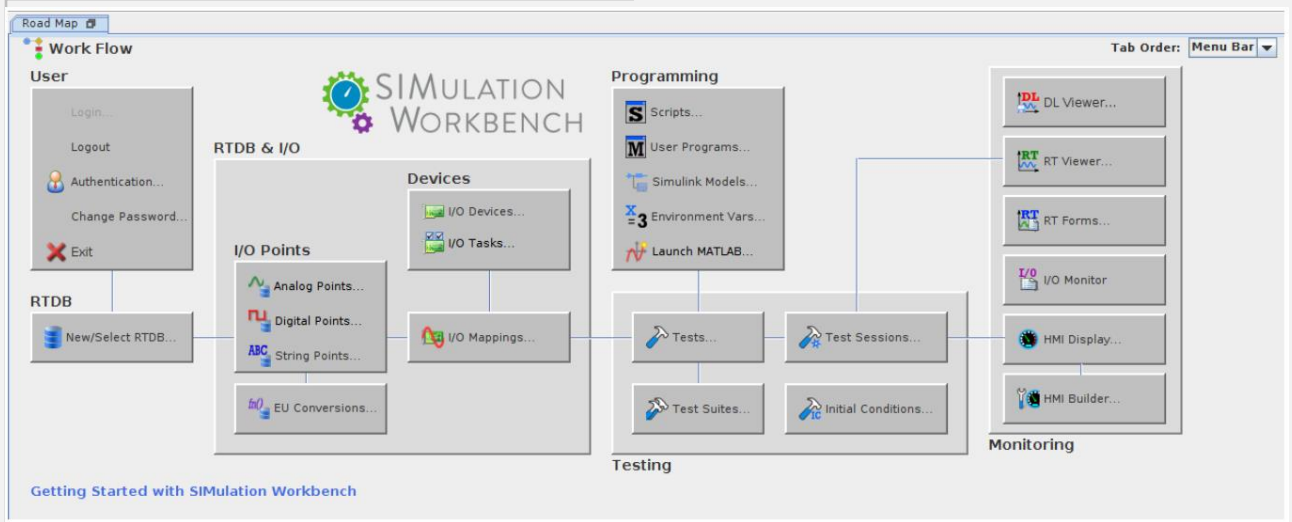


SIMULATION WORKBENCH

THE WORKFLOW

Powered by AUTOHAWK / concurrent REAL-TIME

SimWB - WORKFLOW



RealTimeDataBase (RTDB)

- Scripts
- Matlab/User Models
- Data Structures

Programming

- Model Variables
- Signal IO / IO Mapping
- Data Bus Protocols

Testing

- Initial conditions
- Add and configure models
- Distribute workload on CPUs
- Model execution scheduling

Monitoring

- Real-Time Viewer
- Scheduling Info
- I/O Monitor
- Data Logger

VI-GRADE Software Ecosystem

AUTOHAWK
Powered by concurrent REAL-TIME

VI-DRIVESIM

Compatibility with:

- Software Modeling Tools
- Software Visualization Tools

MOTION CUEING
TELEMETRY
BIO TELEMETRY
GRAPHICS
FORCE FEEDBACK
SOUND

REAL-TIME DATABASE

OPEN API

VEHICLE
TIRE
SCENARIO
DRIVER
SENSOR
CONTROLLERS

VI-WORLDSIM

VI-grade AND 3rd PARTY PLUG-INS

AUTOHAWK

VI-BIKEREALTIME

HEXAGON DYMOLA MODELICA Modelon IPG

cosin scientific software
Fraunhofer ITWM
MEGARIDE APPLIED VEHICLE RESEARCH
SIEMENS Ingenuity for life

MATLAB & SIMULINK
dSPACE
VECTOR

USE CASES

AUTOHAWK
Powered by concurrent REAL-TIME

CHASSIS

DAMPERS
BRAKE
CONTROLLERS

HiL APPLICATIONS

CHASSIS | BRAKE RIG

BRAKE RIG

Equipment

- Brake rig (brake system not included)
- Connection to the Driving Simulator

Applications

- Brake system integration & calibration
- Fault injection
- X-by-wire redundancy validation
- Benchmark
- ADAS development

HiL APPLICATIONS

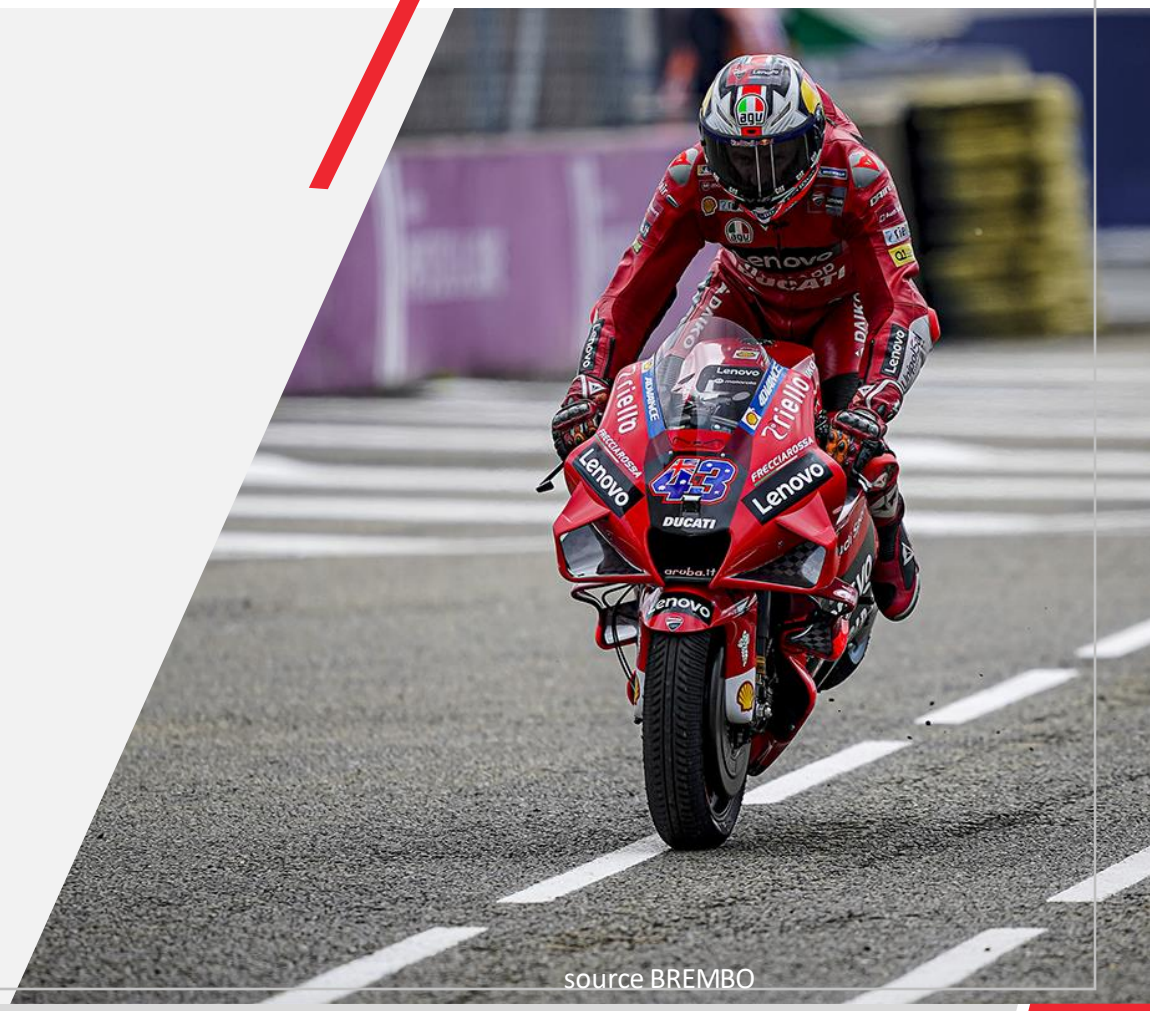
CHASSIS | BRAKE RIG

Powered by AUTOHAWK concurrent REAL-TIME

BRAKE RIG

Applications – in dept

- Brake system integration & calibration
- Brake feedback
- Driver feeling
- Braking system dynamics (friction, pipings length, ECU) for brake friction optimization, lower energy consumption, anti-lock brake
- Target setting and calibration performed together
- Coupling/validation of stability control system, traction control
- Fault controllability (different users, targets) with higher safety conditions.
- ADAS integration in conjunction with Dampers, Camera, Radar



source BREMBO

HiL APPLICATIONS

CHASSIS | DAMPER RIG

Powered by AUTOHAWK concurrent REAL-TIME

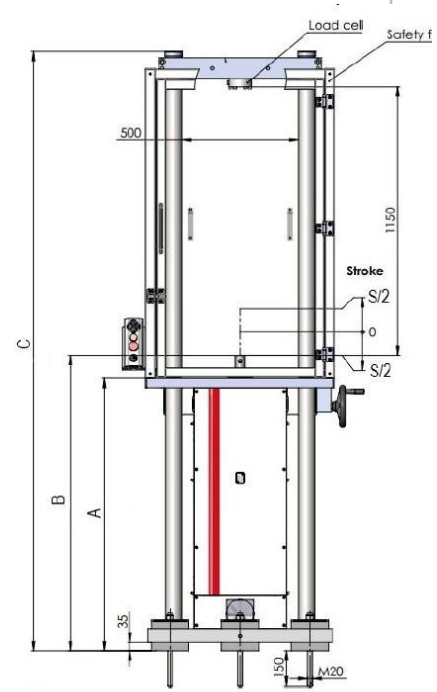
DAMPER RIG

Equipment

- Damper test rig (damper not included)
- Connection to the Driving Simulator

Applications

- Damper systems integration & calibration
- Fault injection
- X-by-wire redundancy validation
- Benchmark
- Performance
- Calibration
- Validation



S = 200 mm
A =1120 mm
B = 1310 mm
C = 2610 mm

HiL APPLICATIONS

CHASSIS | DAMPER RIG

Powered by AUTOHAWK concurrent REAL-TIME

DAMPER RIG

Specifications – in dept

- Max peak force : 21 kN (max speed at peak load 1,6m/s)
- Max static force (without additional static load actuators): 8 kN
- Max dynamic force: 6 kN
- Max speed: 4 m/s
- Stroke: 200 mm
- Built-in anti-rotation feature
- Electric supply: 400V 50Hz (3P+N+E)
- Safety brake: activated by mechanical spring, deactivated by pressure – required 6.0 (+2.0/-0.0) bar
- Max frequency: 125 Hz
- Cooling: Air

source Getty Images

HiL APPLICATIONS

CHASSIS / POWETRAIN | HiL INTEGRATON

COMPLEX XIL SYSTEM

Equipment

- Powertrain Model
- HiL ECU and real subsystems
- Connection to the Driving Simulator

Applications

- DiM and Offline environment
- Powertrain calibration
- Controller calibration
- ECUs calibration
- Quick switch between SiL and HiL

USE CASES

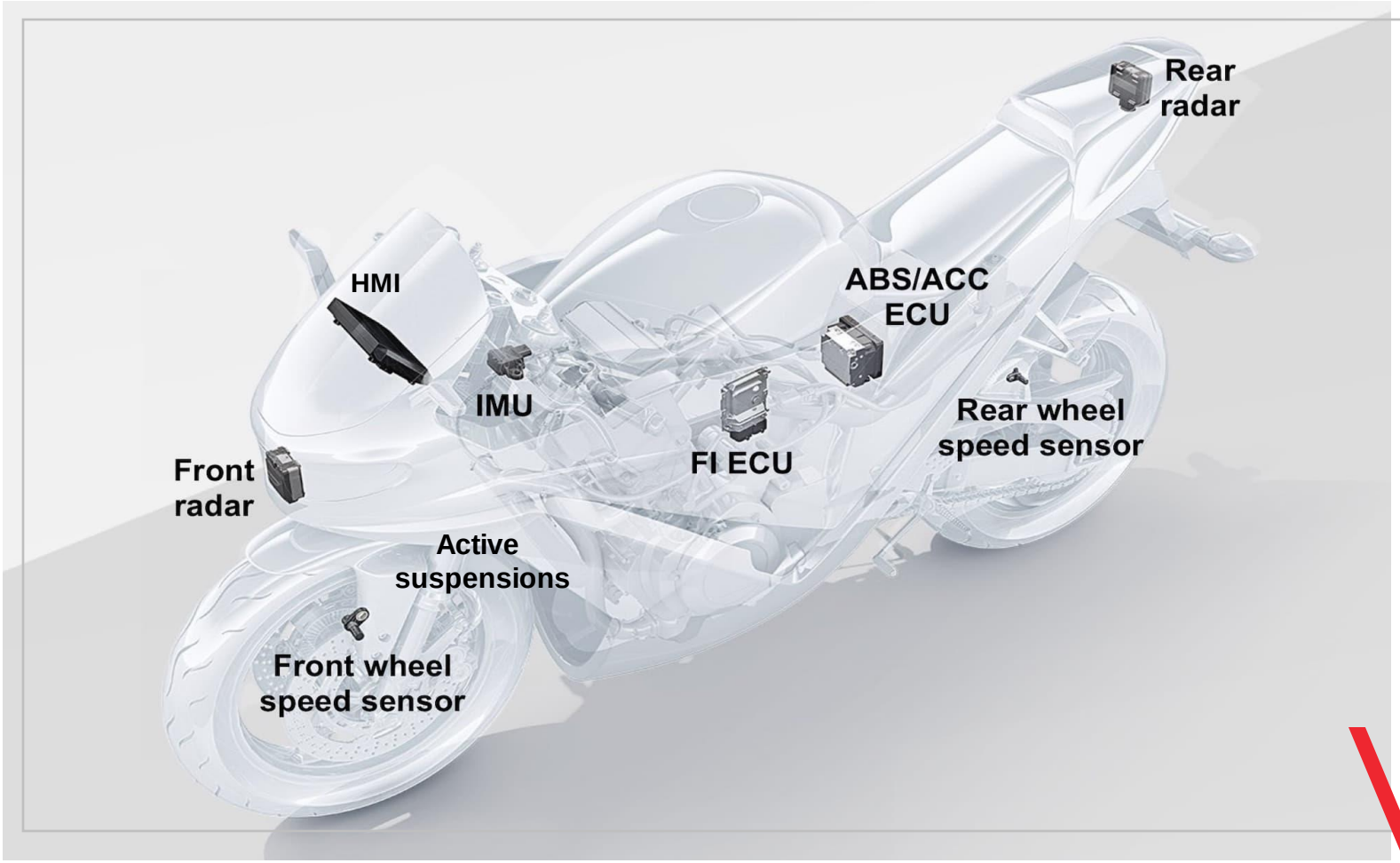
AutoHawk
Powered by concurrent REAL-TIME

ADAS / HMI

CAMERA
RADAR
ViL
V2X
HMI

HiL APPLICATIONS

ADAS | HIL SYSTEMS

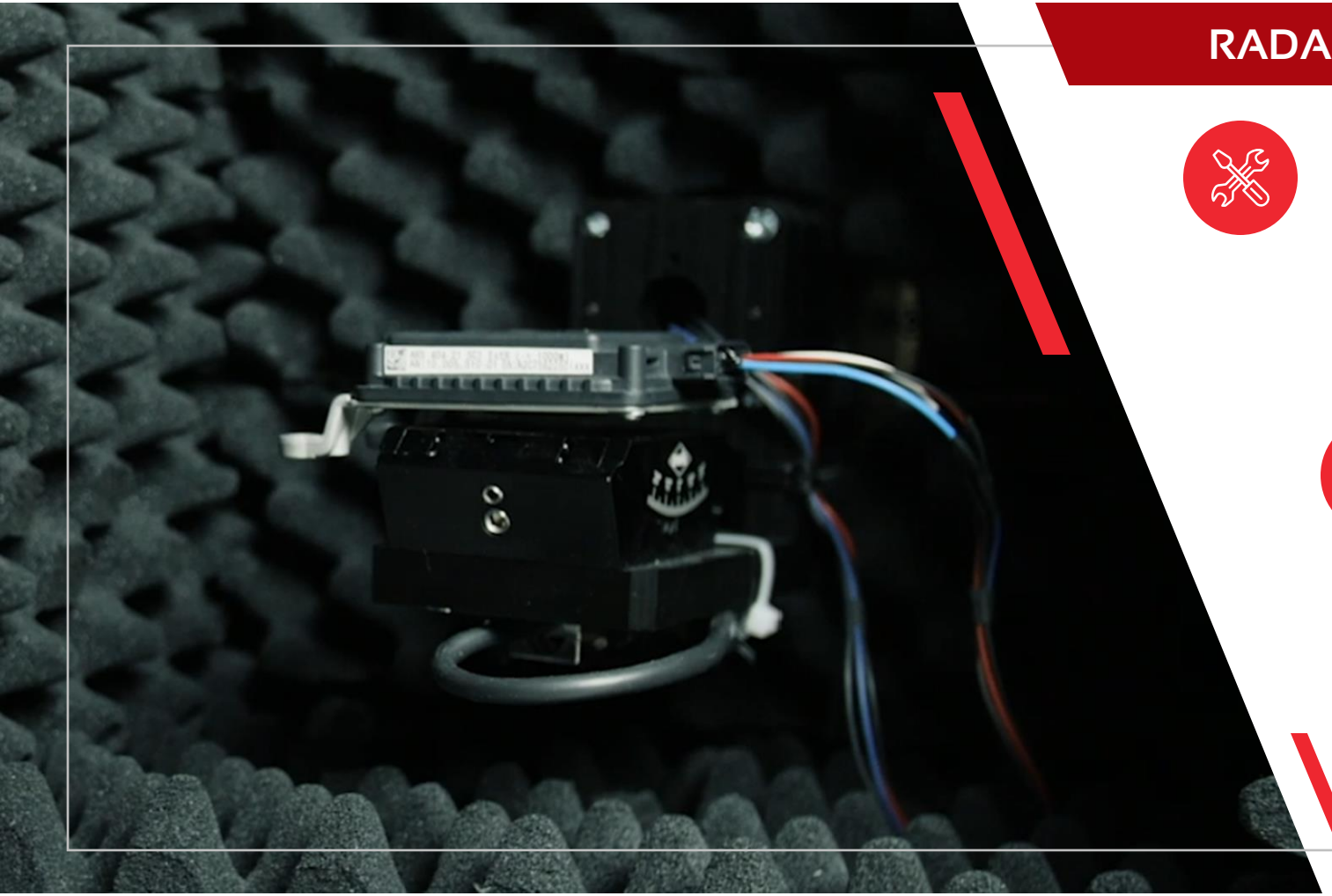


HiL ADAS Subsystems

- Radar
- Camera
- HMI
- ECUs

HiL APPLICATIONS

ADAS | RADAR RIG



RADAR RIG

Equipment

- Radar chamber
- Radar sensor fixture
- Software
- Connection to the Driving Simulator

Applications

- Lane Keeping
- Emergency braking
- Blind spot detection
- Possibility to run in off-line mode with pre-defined Scenarios (road, traffic, maneuvers, weather)
- Connection to the Driving Simulator for tuning and verification

HiL APPLICATIONS

ADAS | CAMERA RIG

AutoHawk Powered by concurrent REAL-TIME

CAMERA RIG

Equipment

- Camera fixture
- Lens
- Monitor
- Connection to Real Time PC (Desktop or Driving simulator)

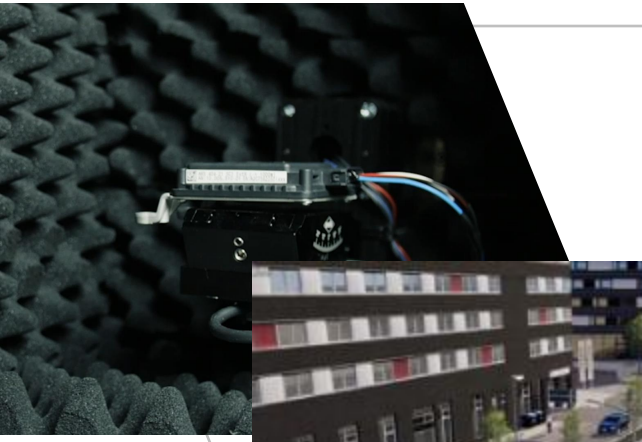
Applications

- Lane Keeping
- Emergency braking
- Blind spot detection
- Traffic sign recognition
- Possibility to run in off-line mode with pre-defined Scenarios (road, traffic, maneuvers, weather)
- Connection to the Driving Simulator for tuning and verification

HiL APPLICATIONS

ADAS | CAMERA RIG, RADAR RIG

Powered by AUTOHAWK concurrent REAL-TIME



APPLICATIONS

PRIMARY

OFF LINE

DESKTOP SIMULATOR

SECONDARY

RIDING SIMULATOR

HiL APPLICATIONS

UX-UI | HMI + DRIVING SIMULATOR

Powered by AUTOHAWK concurrent REAL-TIME

HMI - DASHBOARD

Equipment

- HMI / UX actuators
- Connection to the Driving Simulator

Applications

- HMI development and validation
- Ergonomics assessment in real driving conditions
- UI / ADAS development and validation
- Possibility of connection with ADAS HiL Systems and eye tracking device
- Possibility of connection with NVH/Sound devices for Sound Design activities

HiL APPLICATIONS

POWERTRAIN DRIVELINE | POWERTRAIN TEST BENCH

SiL Cluster

Riding Simulator

DriveTrain Test Bench

POWERTRAIN TEST BENCH

Equipment

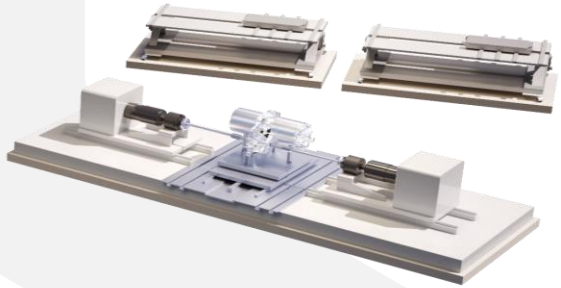
- Powertrain Test Bench (third party supplier)
- Connection to the Driving Simulator
- SiL Cluster (third party supplier)

Applications

- Subsystems integration
- Vehicle Calibration
- Real Driving conditions
- Fault injection
- X-by-wire redundancy validation
- ADAS development

Possibility of connection with Engine, Transmission, E-axle, Battery pack test benches

CONCLUSIONS



- HiL applications complement offline and driving simulator activities and help to achieve virtual sign-off
- More complex use cases demand for high performance, open, extendable HiL solution
- Linux based open architecture enables integration of custom solutions as well as 3rd party products
- AutoHawk is a complete and open solution made of hardware, software and integration services