VIRES Virtual Test Drive

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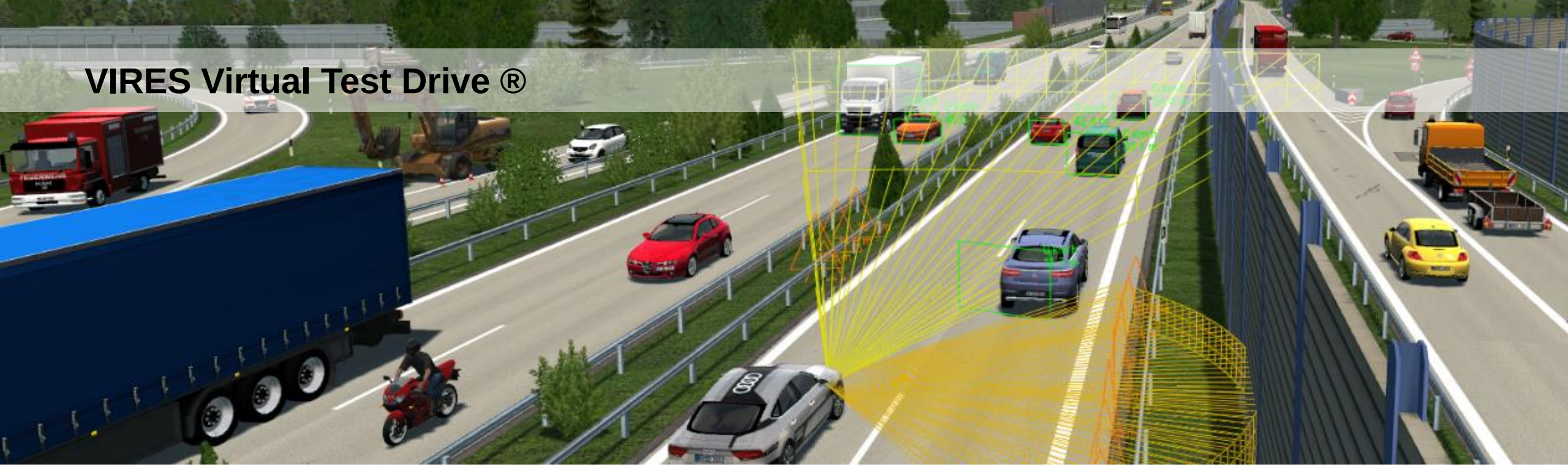
June 2020

VIRES Virtual Test Drive ®



- Over 20 years' experience of virtual test driving and ADAS development
- Center of excellence near Munich, Germany
- 50 employees
- Part of MSC Software, a company of Hexagon AB

Numerous synergies within Hexagon AB :

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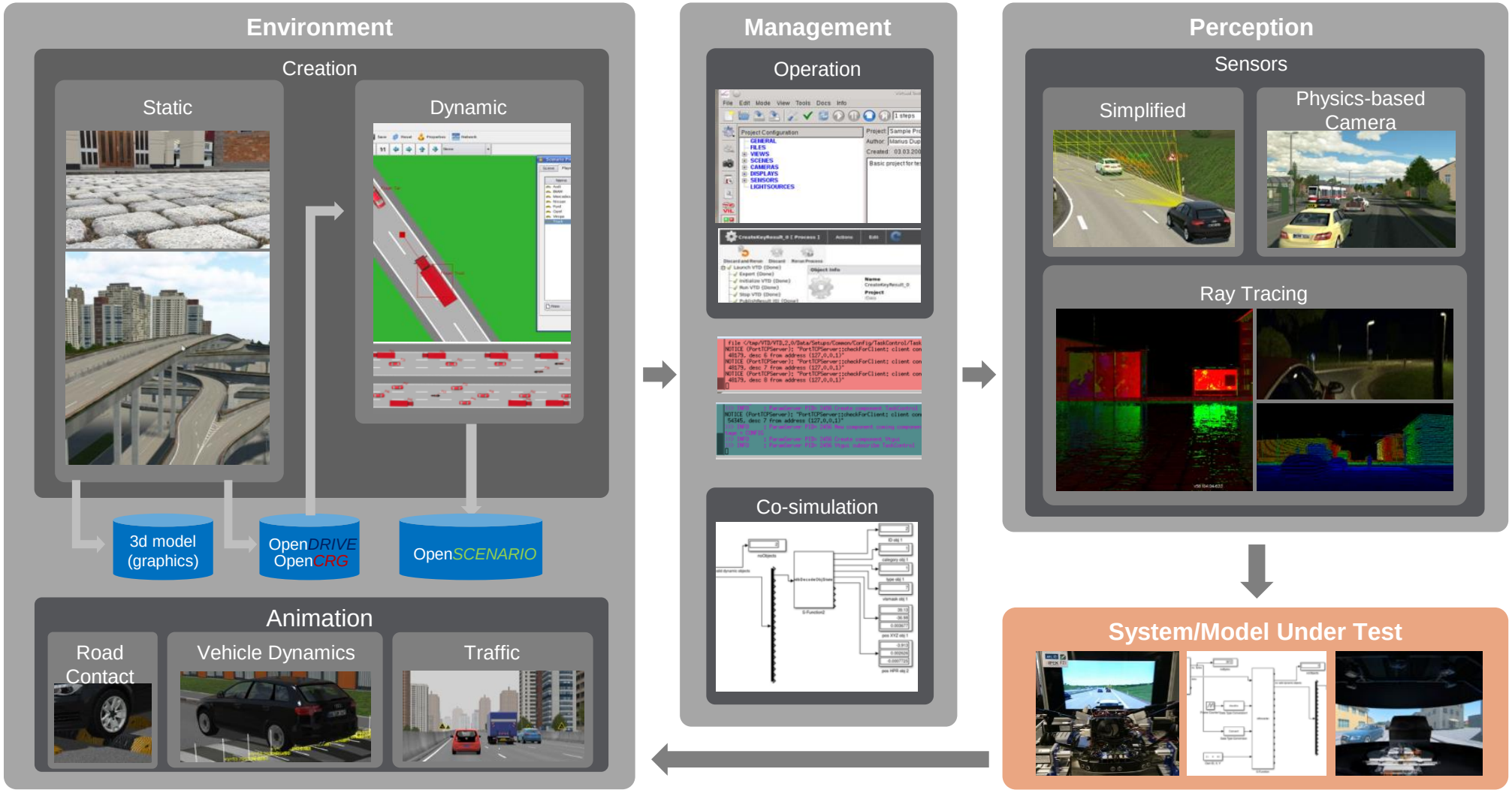
1. Simulation Workflow


VTD
1. Create
2. Animate
3. Perceive
Control

VTD Simplified Simulation Workflow



2. Create

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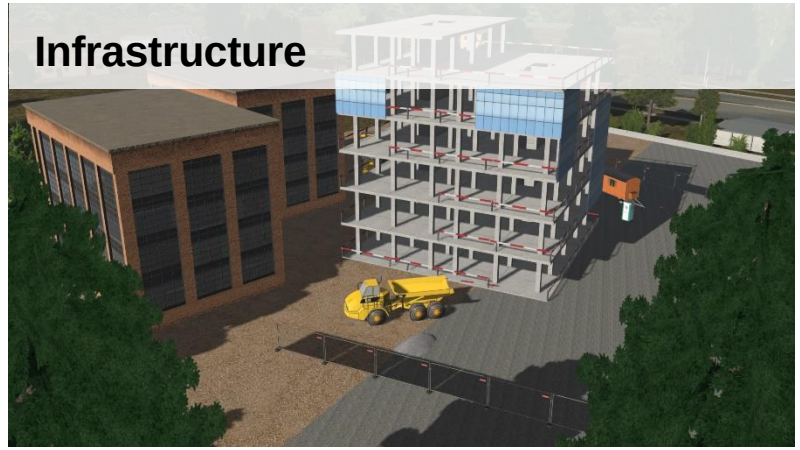
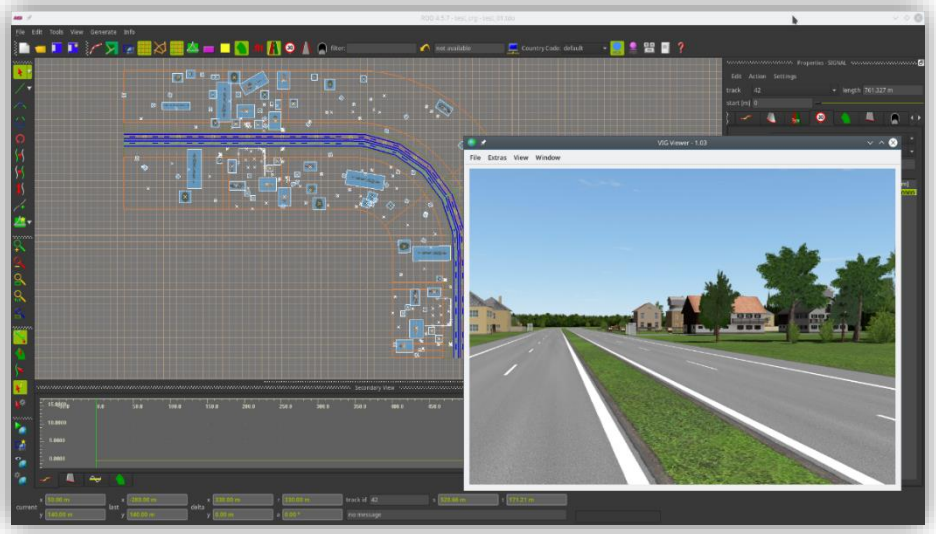
Create the Static Environment





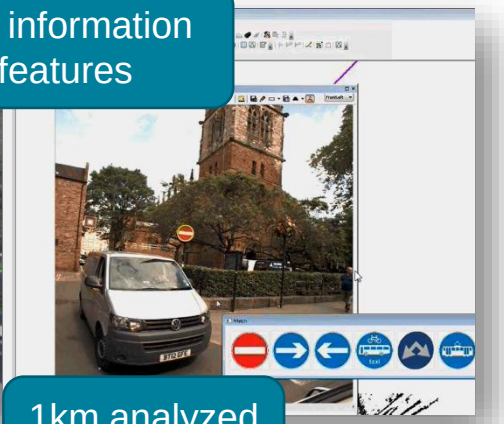
Generate your static environment with our graphical interface Road Designer

- Native support of OpenDRIVE and OpenCRG
- Support of OpenStreetMap
- Large country-specific database available

Scan Roads with LEICA Pegasus Hardware

Measure at 50-100 km/h

Sensor fusion: LiDAR, Cameras, GNSS + IMU



Extract road information and identify features

1km analyzed in 60”

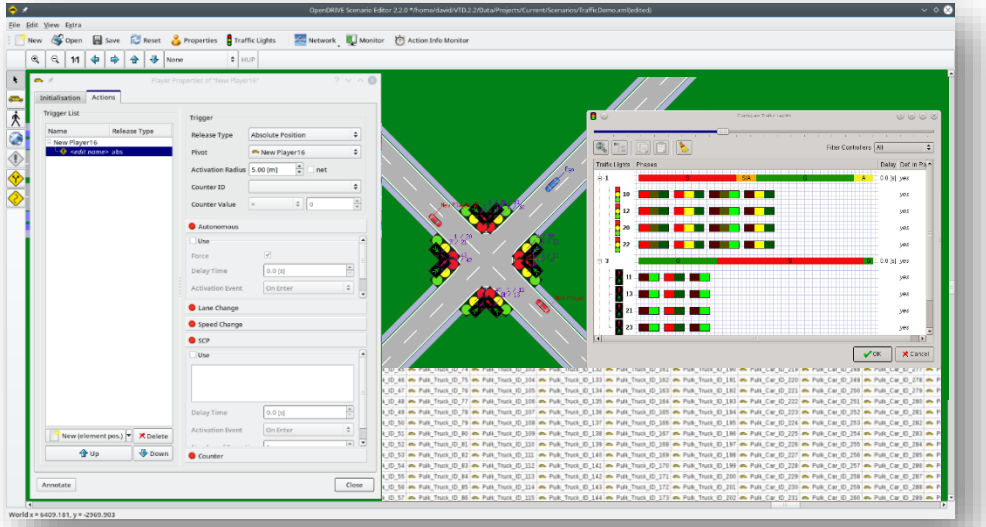
Export OpenDRIVE file

Create the Dynamic Environment

Vehicles

Pedestrians

Traffic lights



Generate your scenario with our graphical interface Scenario Editor

- Native support of OpenSCENARIO
- Path definition + swarm traffic with over 200 concurrent vehicles
- Scripting capabilities and numerous trigger options

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3. Animate

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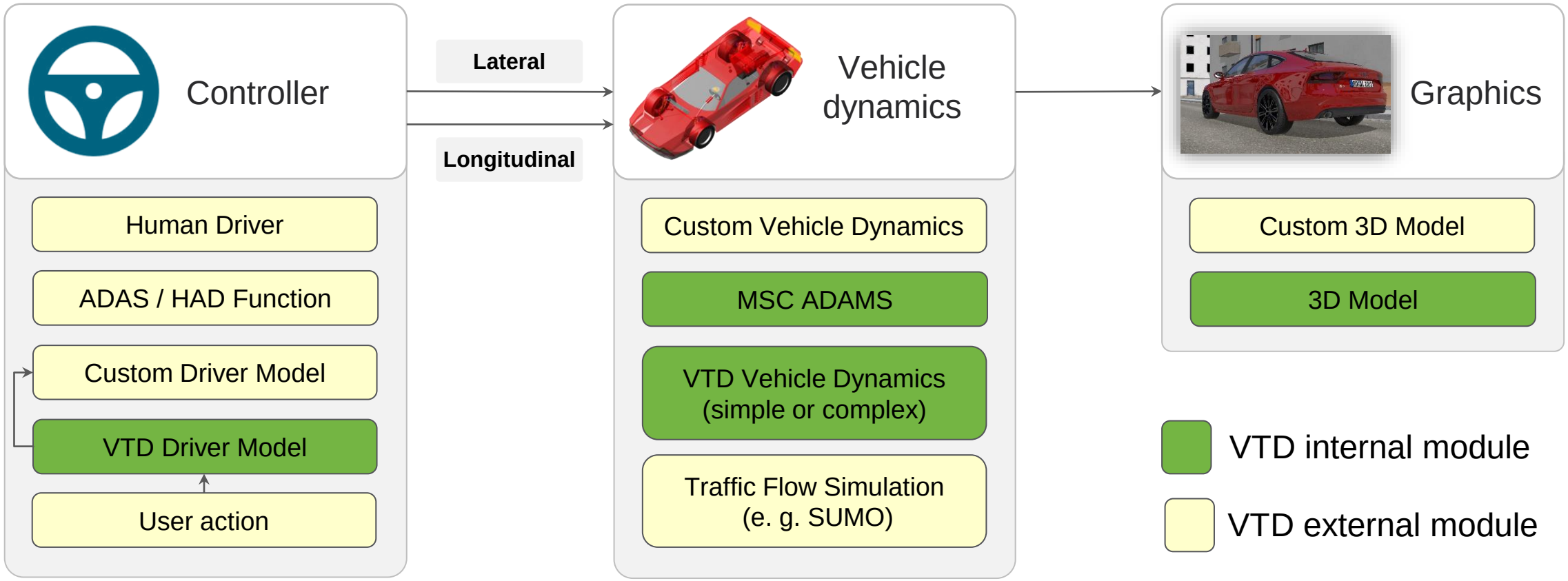
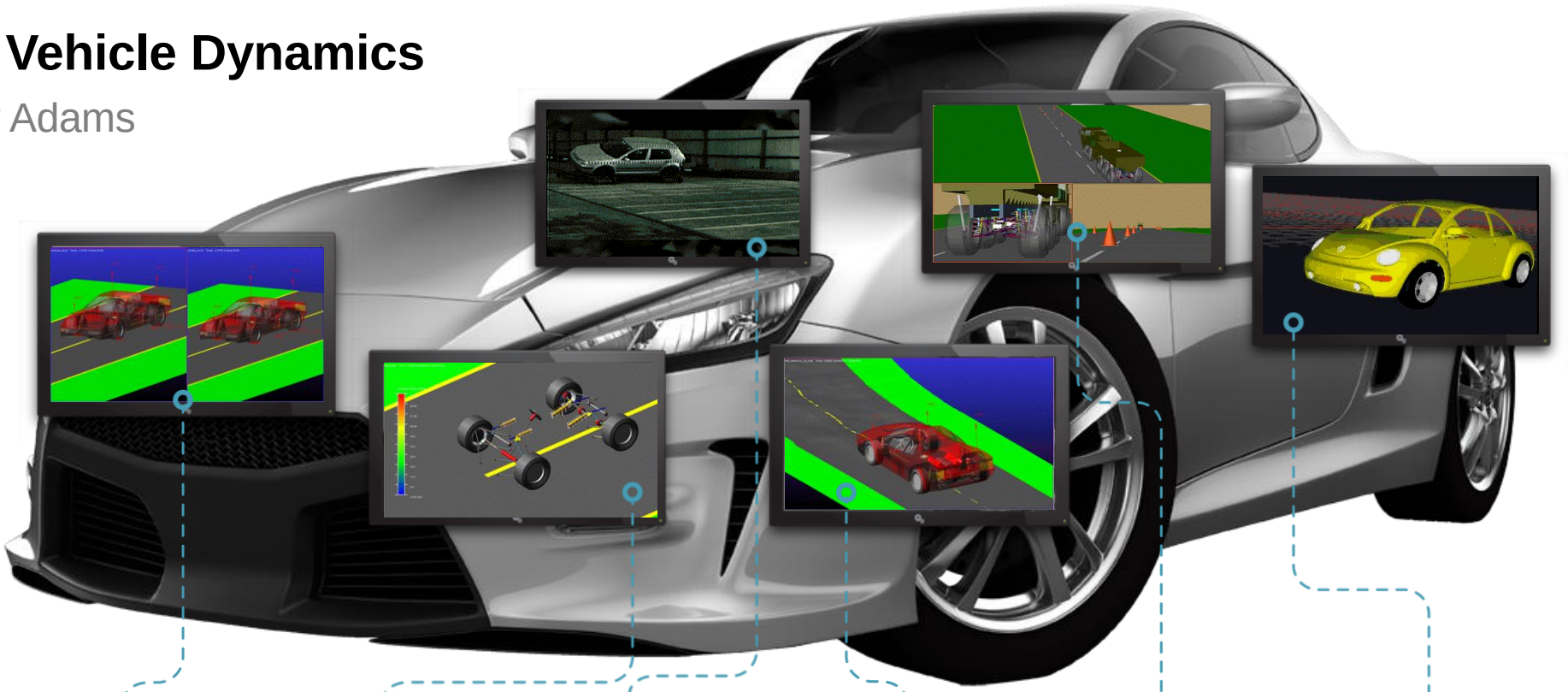
Animate your scenario

Customizable solution



Realistic Vehicle Dynamics

Powered by Adams



POWERTRAIN

Perform dynamic analysis on vehicle powertrain systems.

DURABILITY

Perform accurate load-history prediction for durability analysis.

SAFETY

Perform roll-over prediction and loss of control simulations.

NVH/RIDE

Perform vehicle ride tests on rough roads.

HANDLING

Analyze how the vehicle maneuvers quickly without losing traction.

DRIVETRAIN

Understand how driveline performance effects features like shift quality.

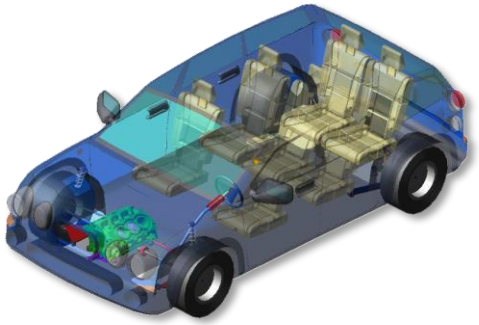
Realistic Vehicle Dynamics

Powered by Adams

x, y, z, rotation angle, steering angle, slip value for each wheel part and optionally yaw, pitch, roll for each defined part (tractor chassis, cab trailer...)

Road height and friction coefficient for each wheel, steering, brake and throttle signals

Library of Models :



Brake Maneuver on Highway with Traffic

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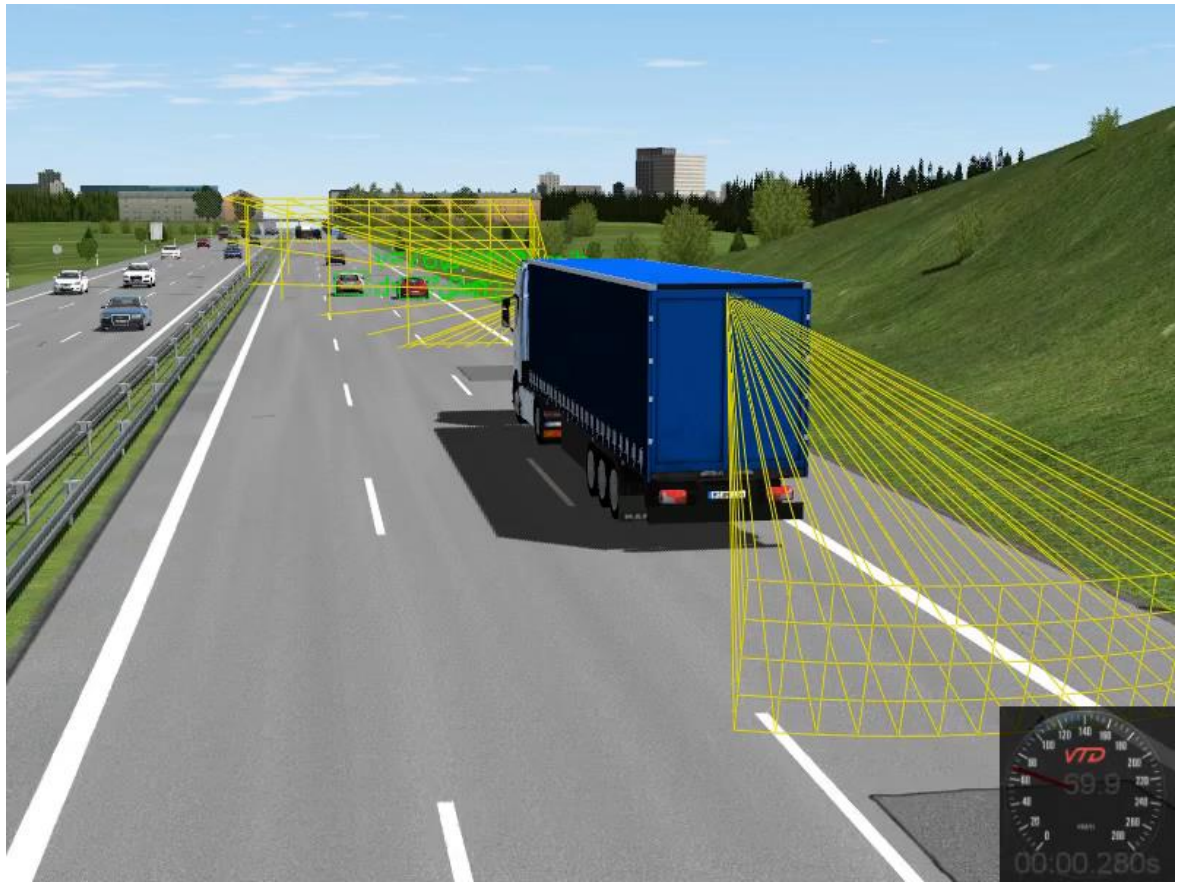
Animate a complex Multibody Dynamics System

Lane Change Maneuver at 70 kph



Animate a complex Multibody Dynamics System

Driving on Speed Bumps

Animate a complex Multibody Dynamics System

Driving on an icy road

Animate Animals and Pedestrians

Realistic

Behaviors

4. Perceive

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Perceive the Virtual Environment

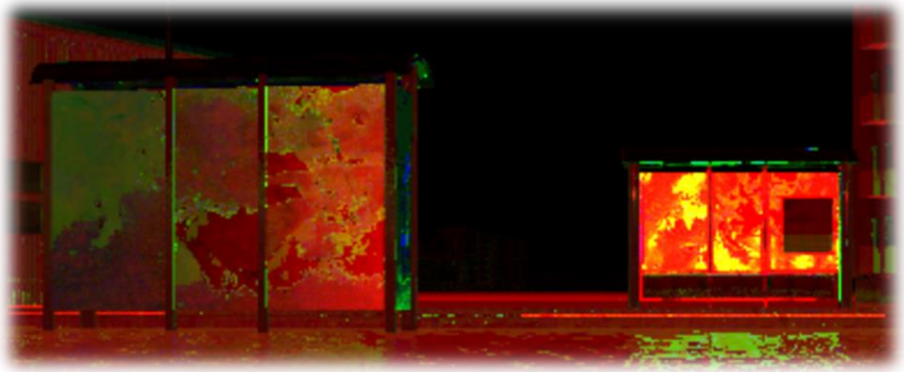
What is your system under test?

Perception Algorithms

Control Algorithms

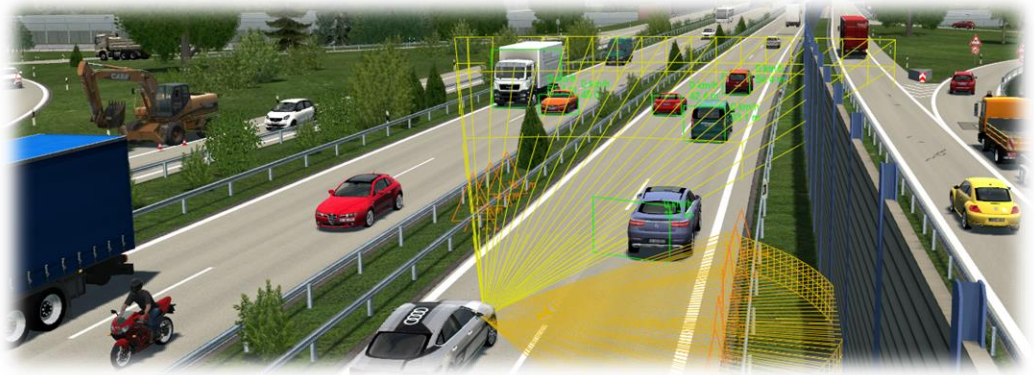
Physics-Based Sensor

→ Information per pixel (Intensity, RGB, coordinates,…)



Simplified Sensor

→ Annotated object list (type, distance, speed,…)



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Physics based Camera Sensor

Scalable Solution with OpenGL & Ray Tracing

Example with 1920 x 1080 pixels resolution

OpenGL – 60 FPS

Ray Tracing – 0.5 FPS

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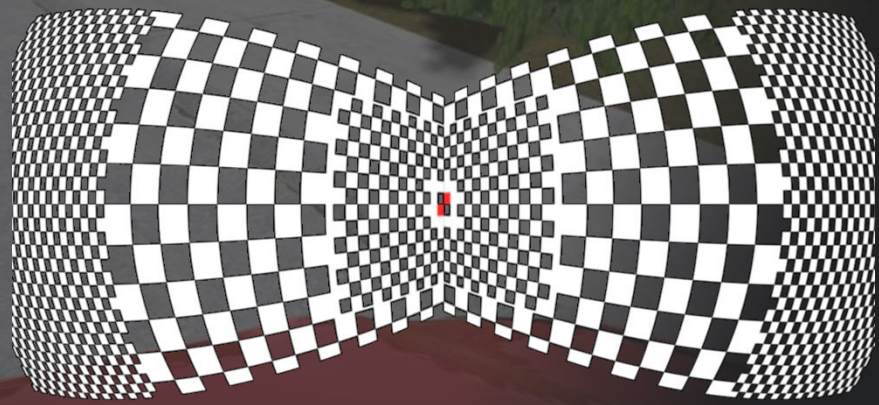
Physics based Camera Sensor

Different Climate Conditions

Rain drops on the windscreen

Pinhole Camera

Fisheye Camera – up to 360 degrees FOV



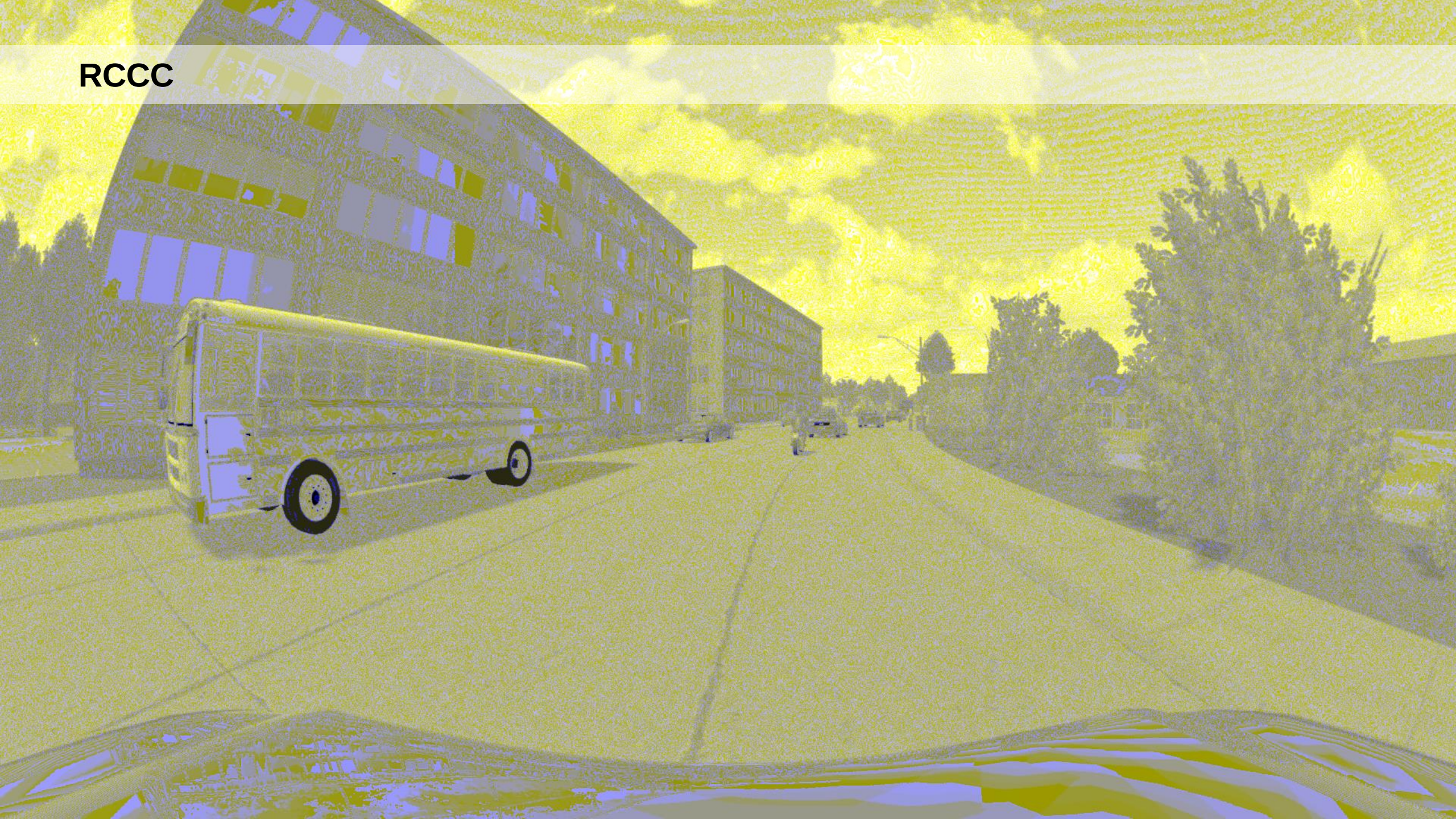
Interactive “Lens creator” tool

Statistical noise on pixel level

Lens failure (e.g. Chromatic Aberration)


YUV Pattern

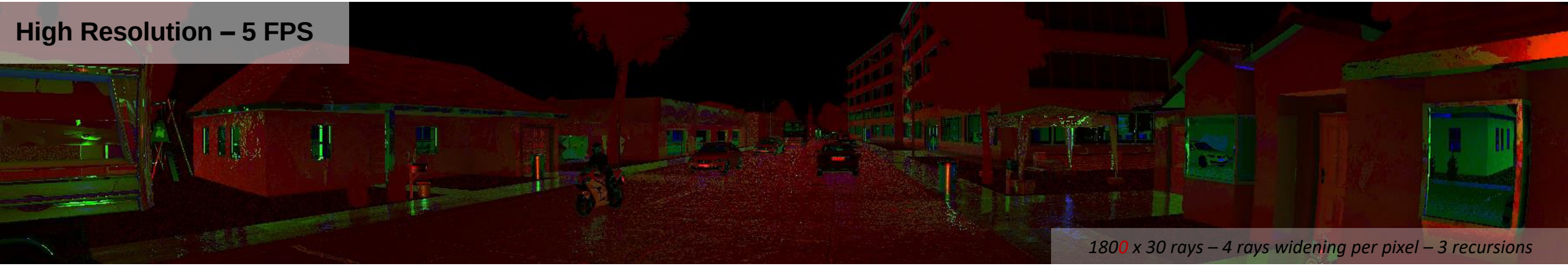
RCCC



Physics based LiDAR Sensor with Ray Tracing

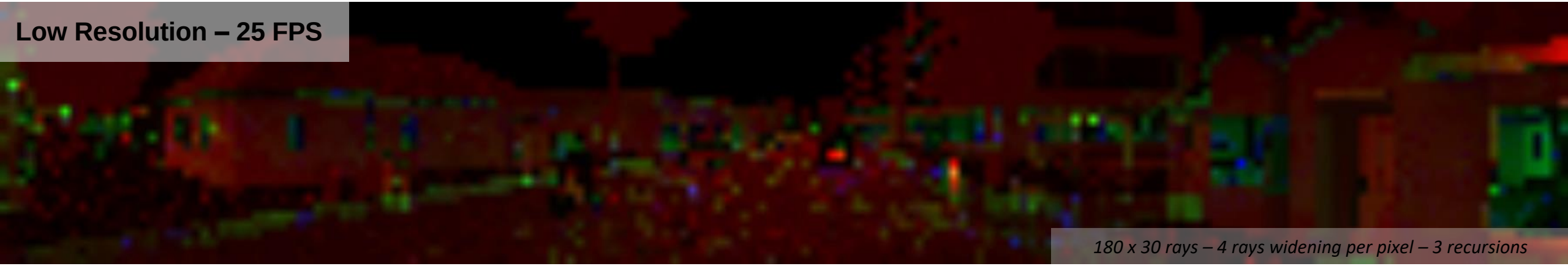
Scalable Solution

High Resolution – 5 FPS



1800 x 30 rays – 4 rays widening per pixel – 3 recursions

Low Resolution – 25 FPS



180 x 30 rays – 4 rays widening per pixel – 3 recursions

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Physics based LiDAR Sensor with Ray Tracing

Configurable Parameters

Standard parameters

- Number of rays (resolution) + FOV (linear interpolation)
- Number of rays (resolution) + Look up table per pixel for direction and intensity
- Maximum distance (also allows better performance)
- Maximum reflection depth
- Signal attenuation (Constant, linear, quadratic)
- Offset rays with configurable degree to simulate ray widening (ex: 4 rays to generate a widening pyramid)

New Bidirectional Reflectance Distribution Function (BRDF):

- Albedo
- Material chart (Metals, mirror Glass, water, cloth…)
- Metallic
- IOR / reflectivity
- Roughness
- Surface Normal Mapping
- Occlusion

Large database for PBR LiDAR available

Physics based LiDAR Sensor with Ray Tracing

Configurable Outputs

Each pixel contains:

- Distance, Elevation, Azimuth of hit

- Signal rest-intensity in %:
    - how much energy came back to emitter
    - Red – % of first hit
    - Green - % of first bounce hit
    - Blue - % of second bounce hit

- XYZ relative coordinates to emitter
- XYZ absolute world coordinates

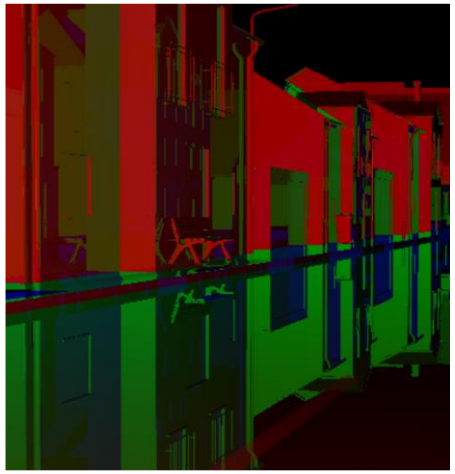
Extra optional information:

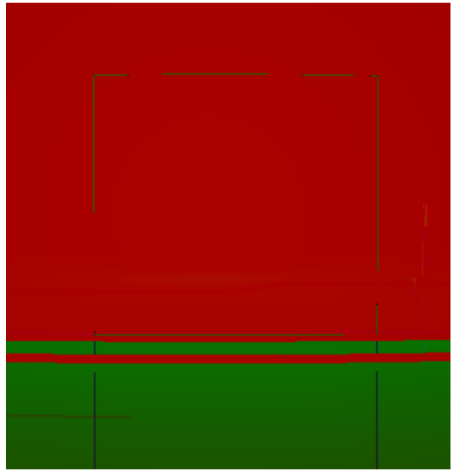
- Time of signal return
- Material Information
- Dynamic / Static object
- Relative object speed to emitter
- Spherical Coordinates

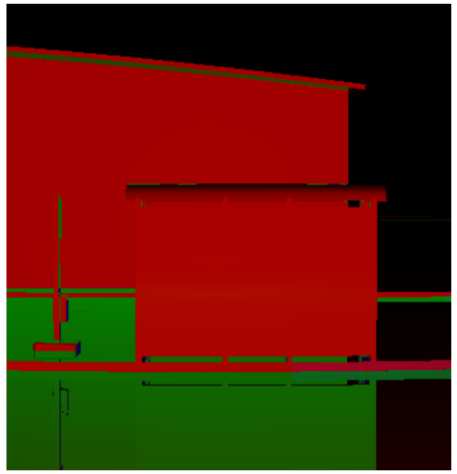
Physics based LiDAR Sensor with Ray Tracing

Importance of the Material Properties

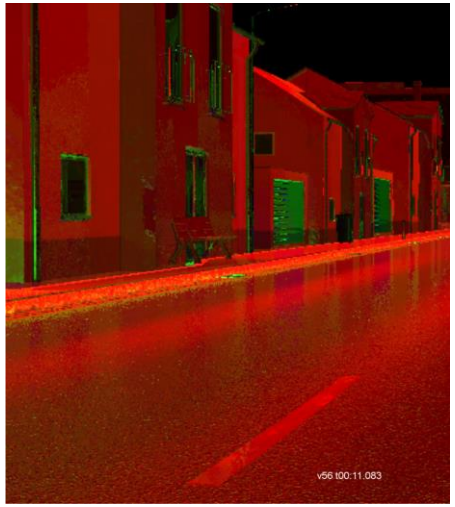
Basic

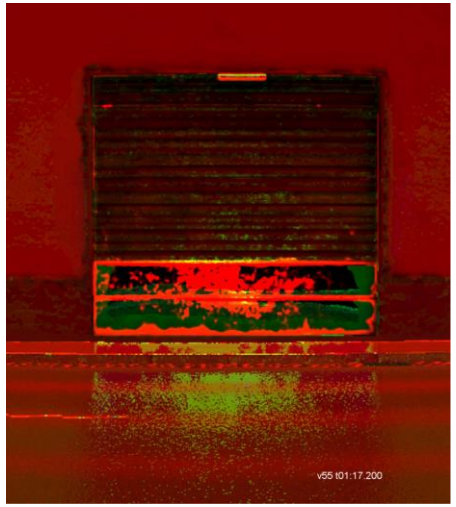


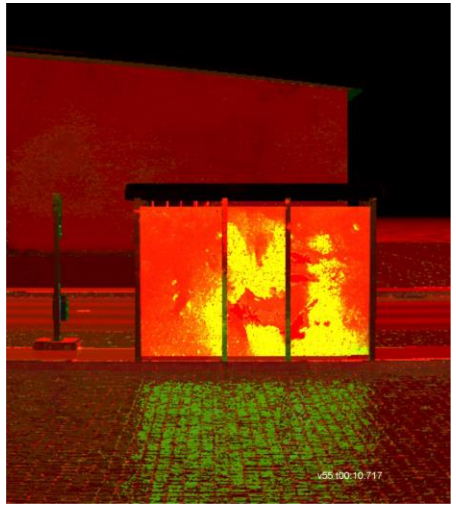




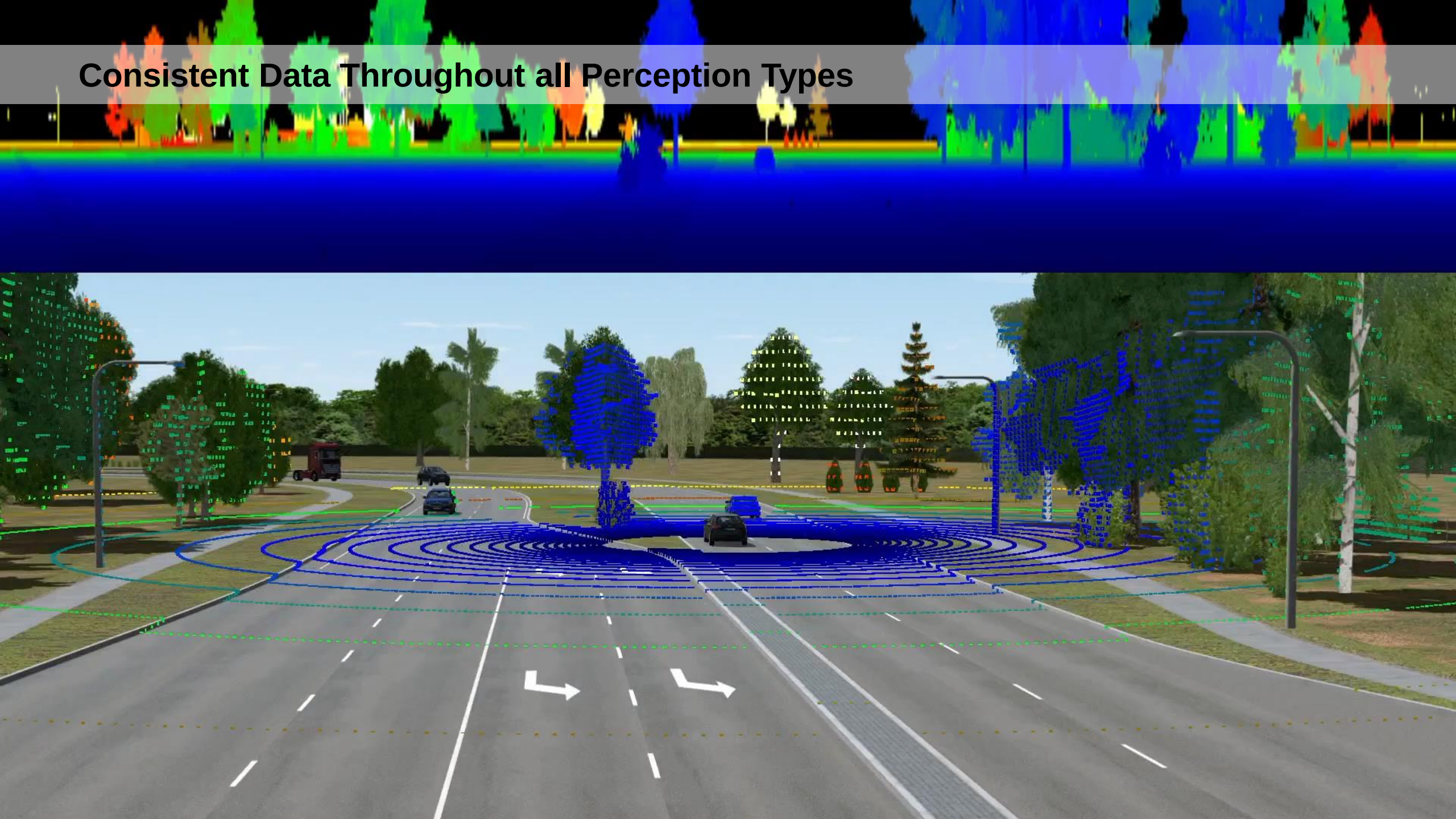
PBR







Consistent Data Throughout all Perception Types



5. XiL Environments

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XiL Environments

Portability

MiL
SiL

DiL

ViL

HiL

Integration

Feedback

Virtual

Real

Driver
Dynamics
Sensors
Systems
Traffic

Portability

Modules
Configuration
Record data
Scenarios

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XiL Environments

Hardware-in-the-Loop Testing of Camera

XiL Environments

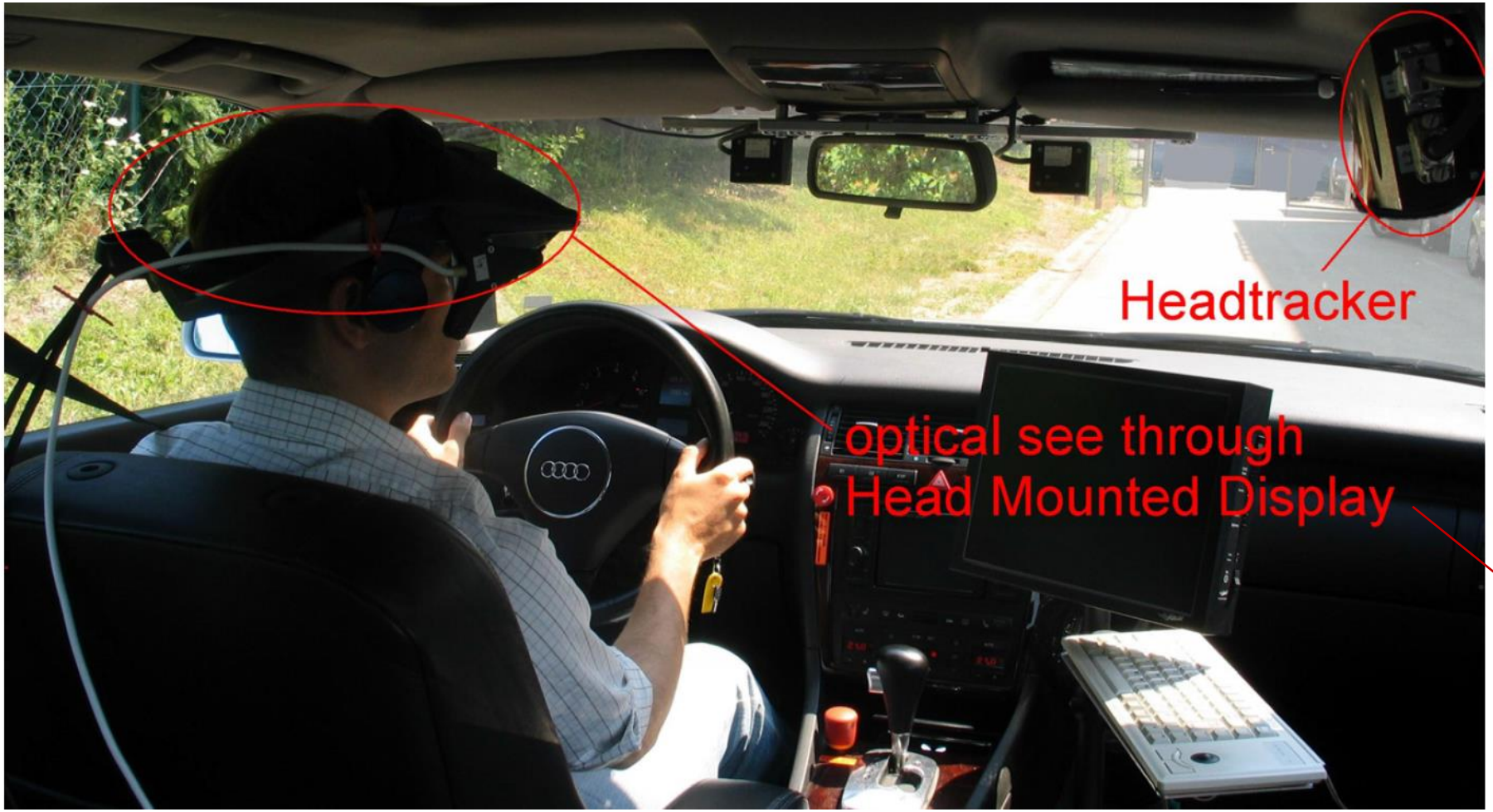
Driver-in-the-Loop References

XiL Environments

Co-Operative Driver-in-the-Loop

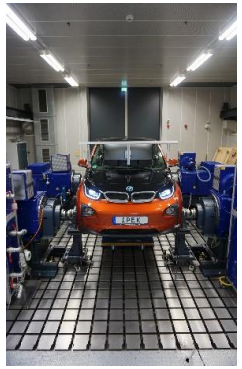
XiL Environments

Vehicle-in-the-loop on the Proving Ground



XiL Environments

Vehicle-in-the-loop on the Test Bed



In cooperation with

AVL

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6. Massive Simulation

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Run and re-run thousands of scenarios in parallel

New product scaling VTD and taking it into the cloud

- Cloud Native Architecture

powered by aws Azure

- Enable the execution 1000’s of VTD simulation in parallel
- Support all MiL / SiL setups available with VTD
- VTD Scale capabilities:
  - Flexible parameterization of all aspects of the simulation, including the SUT
  - Incorporation of any sampling methodology (open loop / close loop)
  - Execution millions of VTD simulations in a robust and deterministic manner
  - Integration of any data analytics framework to analyze simulation results
- Seamlessly integrated into the Continuous Integration / Continuous Deployment (CI/CD) process

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7. Synergies within Hexagon

Unique Hexagon Simulation & Testing Expertise

Agriculture

Smart agriculture solutions that boost productivity, reduce waste and optimise processes and resources for maximum yield.

Geospatial

Geospatial data management solutions that leverage the power of mapping to promote a holistic understanding of smart change.

Geosystems

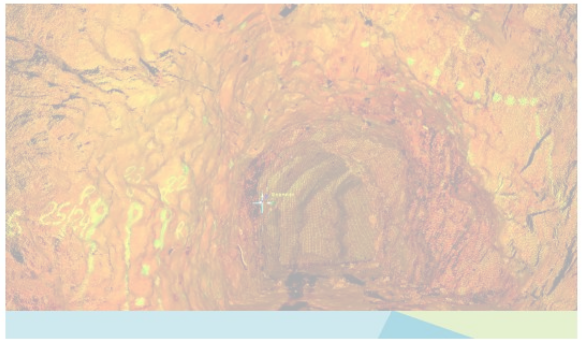
Reality-capture solutions that create 3D digital worlds, providing actionable information for insight, planning & execution.

PPM

Smart solutions that transform data into actionable information for design, construction & operation of industrial projects.

Manufacturing Intelligence

Manufacturing solutions that integrate technologies for sensing, thinking and acting, to optimise productivity and quality



Mining

Integrated solutions that bridge the gap between planning, operations and safety for smarter, safer, more productive mines.

Positioning Intelligence

Satellite positioning and correction solutions for land, sea and air.

Safety and Infrastructure

Geospatial solutions that deliver insight and optimise resources for government, public safety, utilities and transportation.

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Unique Hexagon Simulation & Testing Expertise

Road Testing and Data Acquisition

HEXAGON
POSITIONING INTELLIGENCE

NovAtel

HEXAGON
GEOSYSTEMS

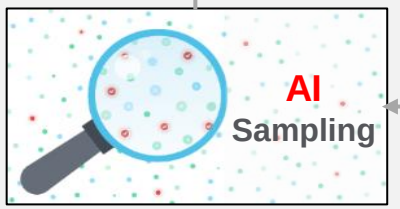
Leica

Virtual Testing and Analysis

MSC Software
Simulating Reality, Delivering Certainty

Vehicle Model
AI Driver
Traffic
Sensors
3D Environment

Data
Management



8. VTD Case Studies

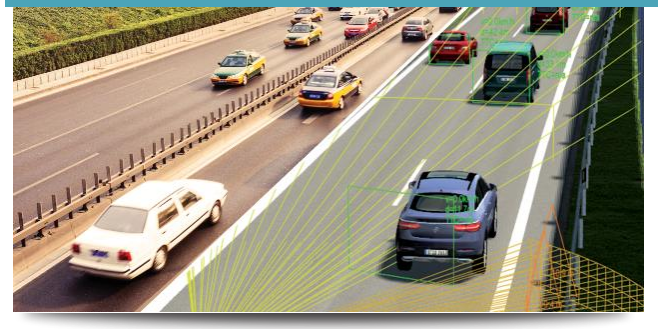
VTD Case Studies

VW: Leveraging VTD to Design a Cooperative Driver Assistance System

The Challenge

- The high degree of connectivity and interactions between vehicles prevent the development and validation of a Cooperative Driving system in a virtual environment

MSC Simulation Solution



- A combination of ADTF (from Volkswagen group), VTD's simulation tool-chain, and OMNet++ (network simulator) allowed VW to do a host of experiments to test and validate cooperative driver assistance systems

Value Realized

- The new simulation framework accurately models the perception communication, and controlling of several vehicles in a virtual environment.
- It speeds up the deployment of the first cooperative driver assistance systems on our public streets

"A combination of ADTF (the application prototyping framework within the Volkswagen group), VTD's simulation tool-chain *and OMNet++ (an open-source network simulator) allows a host of experiments to test and validate cooperative driver assistance systems."*

– Dr. Kai Franke, Development Online Driver Assistance Systems, Volkswagen AG

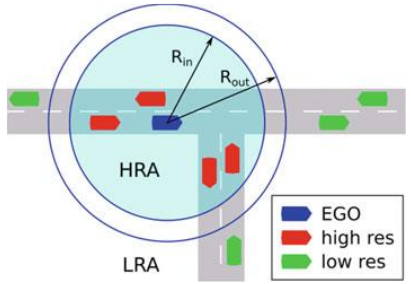
VTD Case Studies

Audi: Multi-Resolution Traffic V2V Simulation for VANETS with the help of VTD

The Challenge

- To perform large-scale and extensive testing of vehicular networks is too expensive and dangerous
- Trade-off is required between accuracy and scalability for virtual testing

MSC Simulation Solution



- Leveraging VIRES VTD to simulate high-resolution vehicles and traffics
- Coupling nanoscopic simulation VTD with microscopic simulation SUMO to achieve a multi-resolution traffic simulation to reach a balance between accuracy and speed

Value Realized

- The evaluation shows a dramatic reduction in computation time
- The new strategy enables accurate, realistic and large-scale virtual testing and validation of vehicular networks

"We employ the nanoscopic traffic and vehicle simulator VTD for the simulation of the high-resolution vehicles. VTD's focus lies on interactive high-realism simulation of driver behavior, vehicle dynamics and sensors."

– Andreas Kern, Software Development for Virtual Environment, Tools and Frameworks, AUDI AG

VTD Case Studies

AVL: Using VTD for Validation of X-in-the-Loop Automated Driving Functions

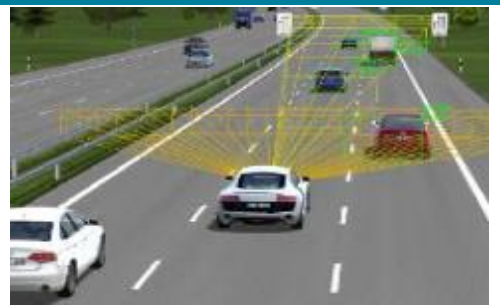
The Challenge

- Development towards automated driving would require billions of kilometers of testing which can only be achieved through simulation
- A method to validate the simulation against the physical testing is required

MSC Simulation Solution

- Leveraging VIRES VTD to simulate the exact testing conditions from the proving ground
- Compare the results from physical proving ground against the results from virtual proving ground with 3 automated driving scenarios

Value Realized



- First results show a promising correlation regarding multiple repetitions on the test bed and regarding the validation of both X-in-the-Loop approaches for a future virtual homologation of automated driving functions

“The measured data is transferred to the environment simulation VIRES Virtual Test Drive to re-simulate the exact testing conditions from the proving ground. First results show a promising correlation regarding multiple repetitions on the test bed and regarding the validation of both X-in-the-Loop approaches. ”

– Dr.-Ing. Tobias DÜSER, Department Manager Advanced Solution Lab, AVL

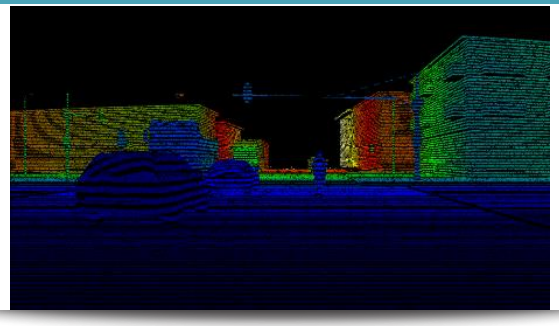
VTD Case Studies

BMW: Leveraging VTD to Generate and Validate Sensor Models

The Challenge

- Ensuring and validating the safe conduct of the automated driving systems for public use
- A proper choice of scenarios as well as the generation of virtual sensor data that closely matches reality

MSC Simulation Solution



- The virtual environment for the proposed sensor model is provided by the VIRES VTD driving simulation software, which offers a ray tracing framework based on the Nvidia OptiX ray tracing engine

Value Realized

- The model was employed to faithfully recreate the full sensor processing chain in a virtual environment with the help of VIRES VTD
- The results show a high correlation between real and synthetic data

"The virtual environment for the proposed sensor model is provided by the VIRES VTD driving simulation software. The results show a high correlation between real and synthetic data."

– Alexander Schaermann, Data Engineer, BMW Group

Thank you

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