Physics Based Sensor simulation
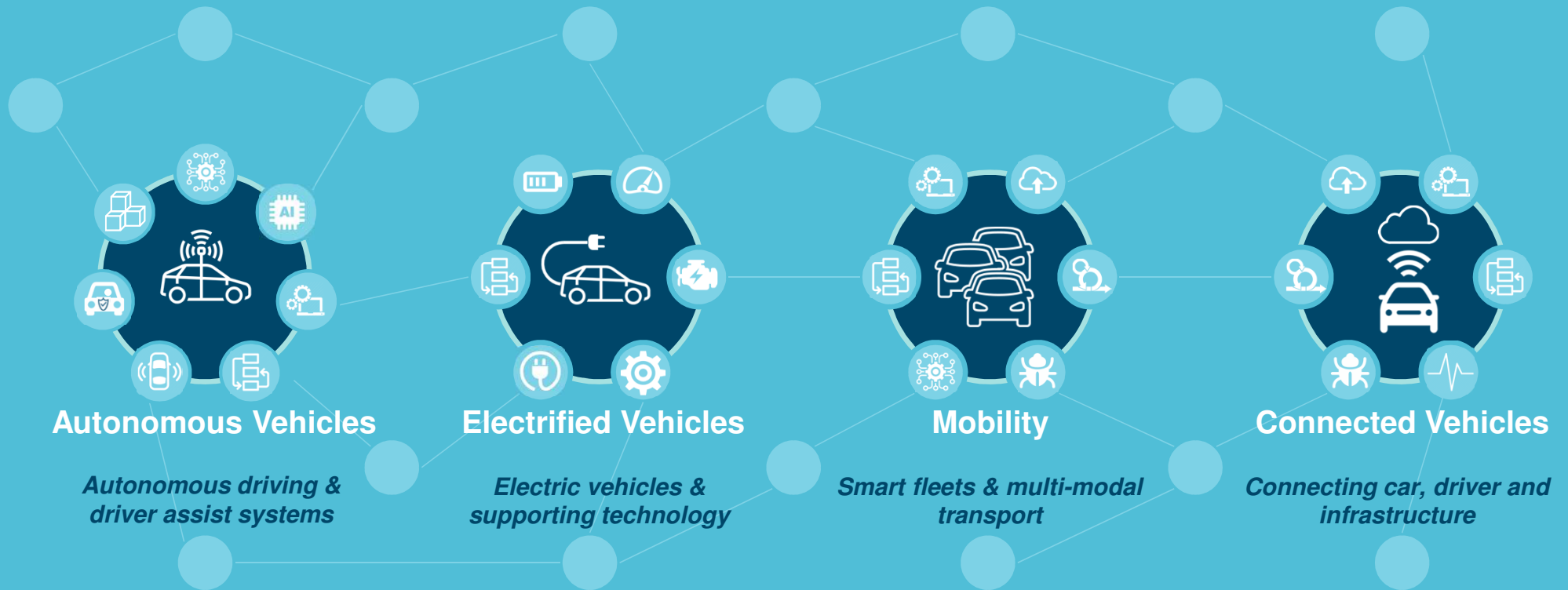
Jordan Gorrochotegui - Product Manager Software and Services
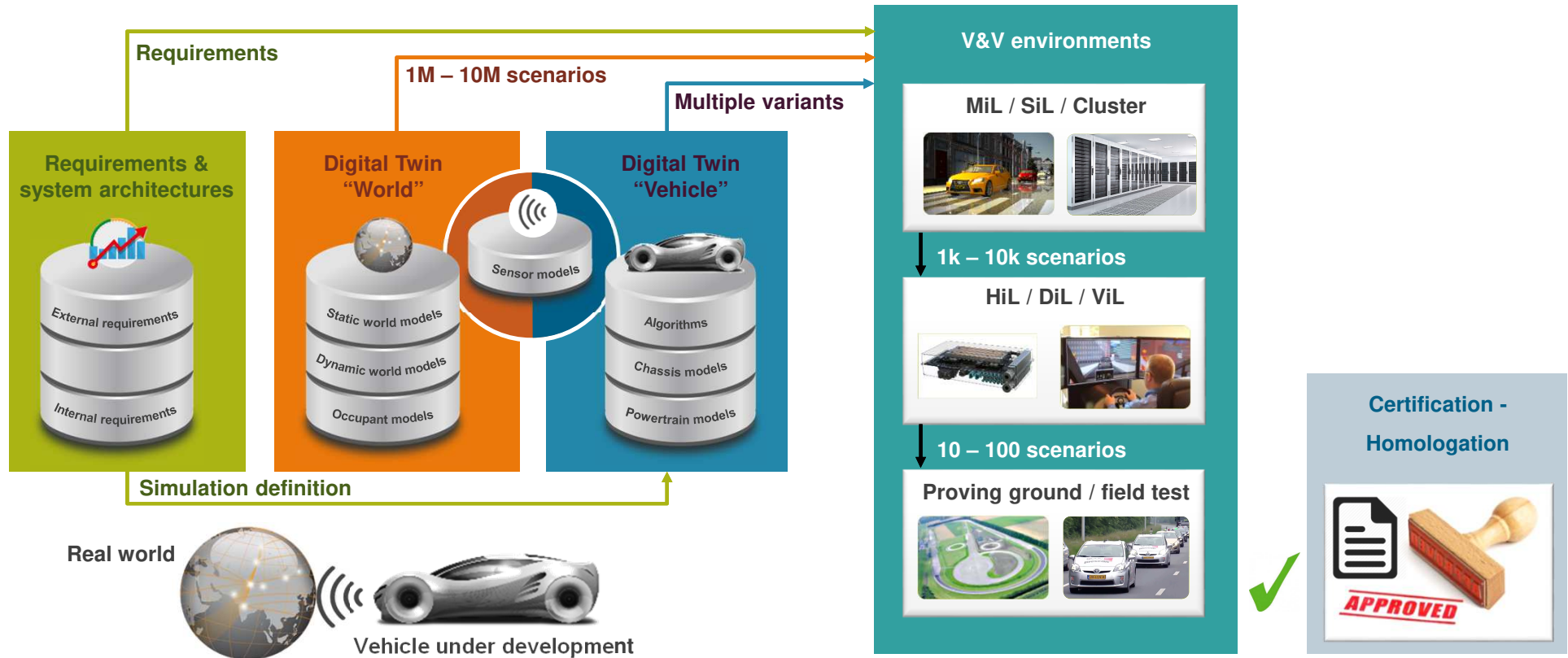
Mike Phillips – Software Engineer

Realize innovation.

Siemens offers solutions across all automotive mega trends

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Autonomous Vehicles

Autonomous driving & driver assist systems

Electrified Vehicles

Electric vehicles & supporting technology

Mobility

Smart fleets & multi-modal transport
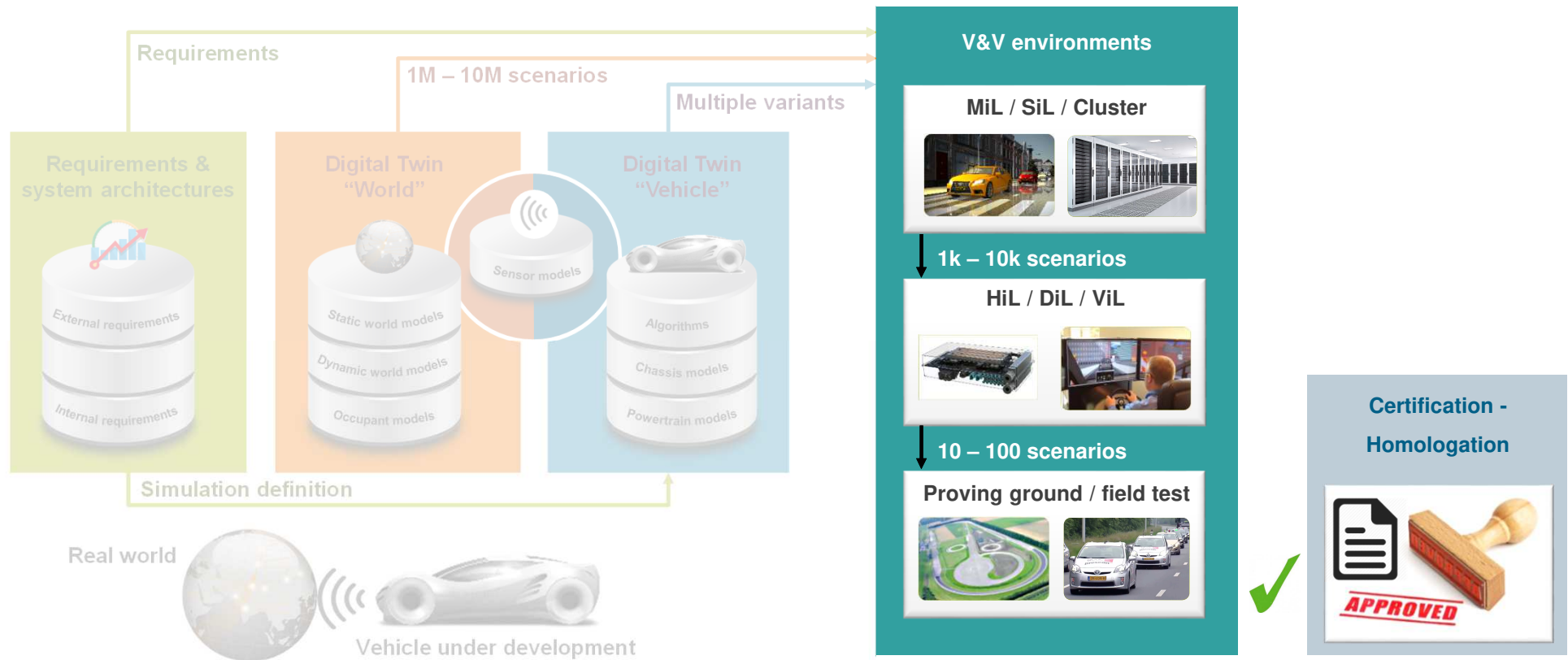
Connected Vehicles

Connecting car, driver and infrastructure

Engineering the **next** product not just the best product for the future

Validation and Verification framework for AVs

Requirements

1M – 10M scenarios

Multiple variants

V&V environments

Requirements & system architectures

External requirements

Internal requirements

Digital Twin "World"

Static world models

Dynamic world models

Occupant models

Sensor models

Digital Twin "Vehicle"

Algorithms

Chassis models

Powertrain models

MiL / SiL / Cluster

1k – 10k scenarios

HiL / DiL / ViL

10 – 100 scenarios

Proving ground / field test

Certification - Homologation

APPROVED

Simulation definition

Real world

Vehicle under development

Validation and Verification framework for AVs

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APPROVED

Example #1: MiL / SiL / Cluster

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V&V Environments

MiL / SiL / Cluster

...arios

HiL / DiL / ViL

10 – 100 scenarios

Laboratories / proving grounds / public roads

Run massive amounts of Prescan scenarios for Automated Vehicle development and optimization
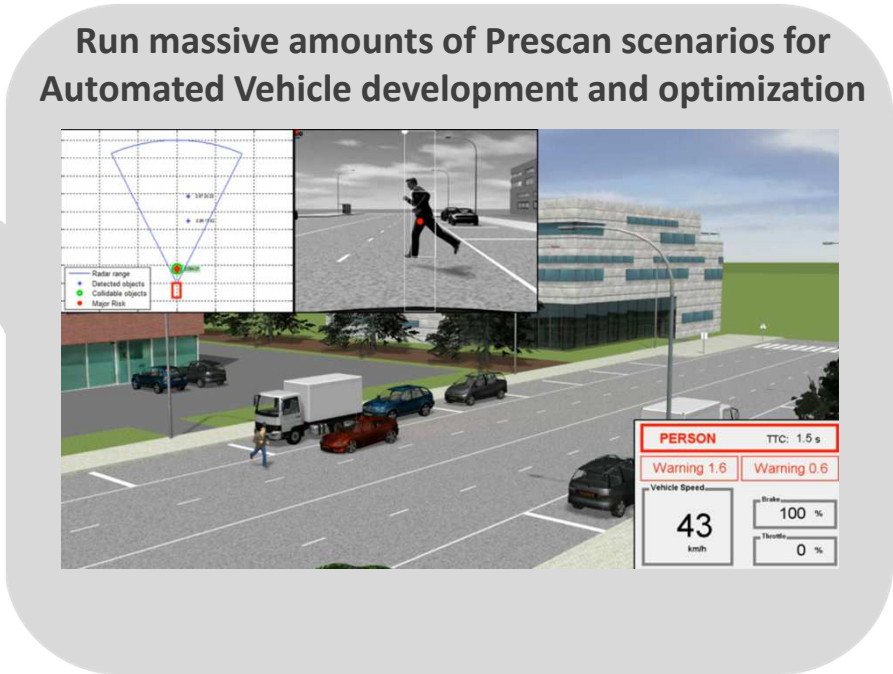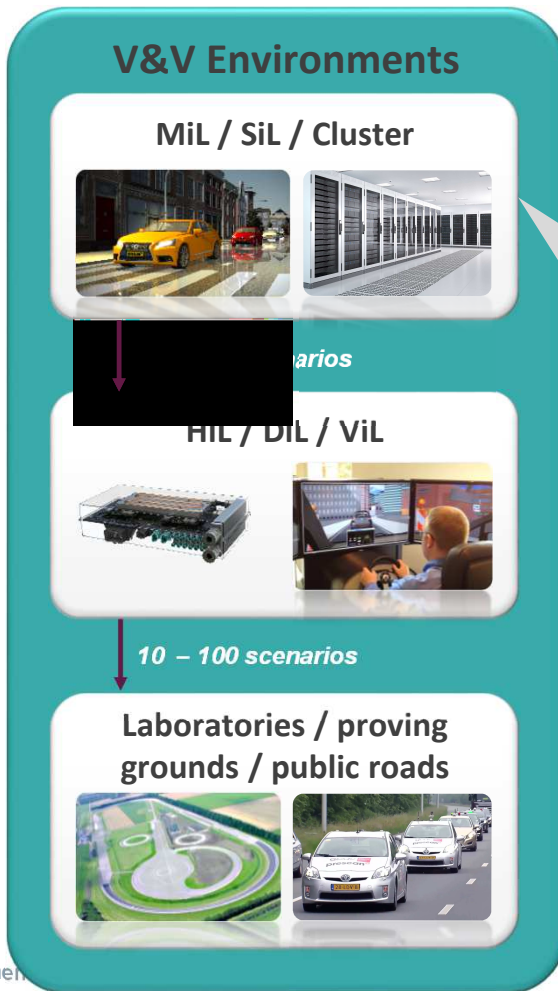
- Design space exploration using large scenario databases
- Virtual development, verification and robustness testing
- Optimized automated vehicle designs

Example #2: HiL testing of central AD processing unit
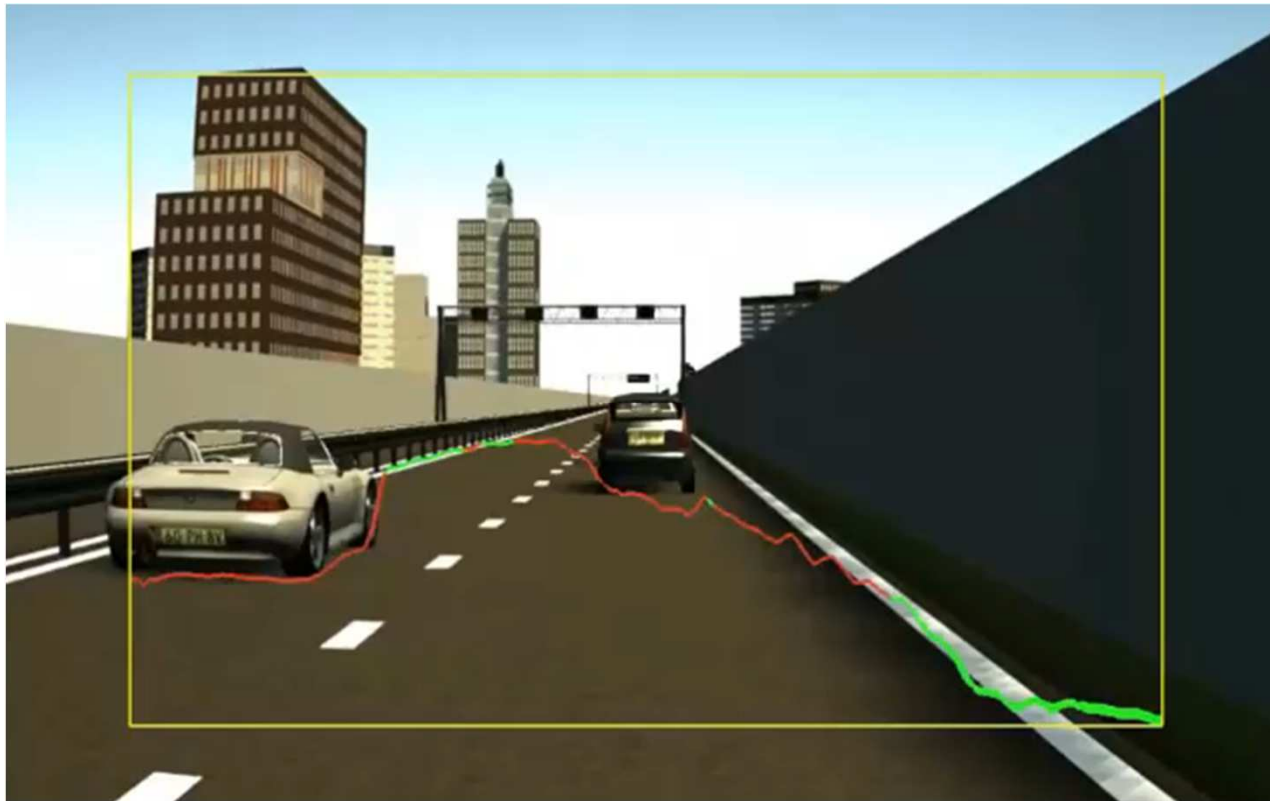
Free space detection on Nvidia Drive PX2

Example #2: HiL testing of central AD processing unit
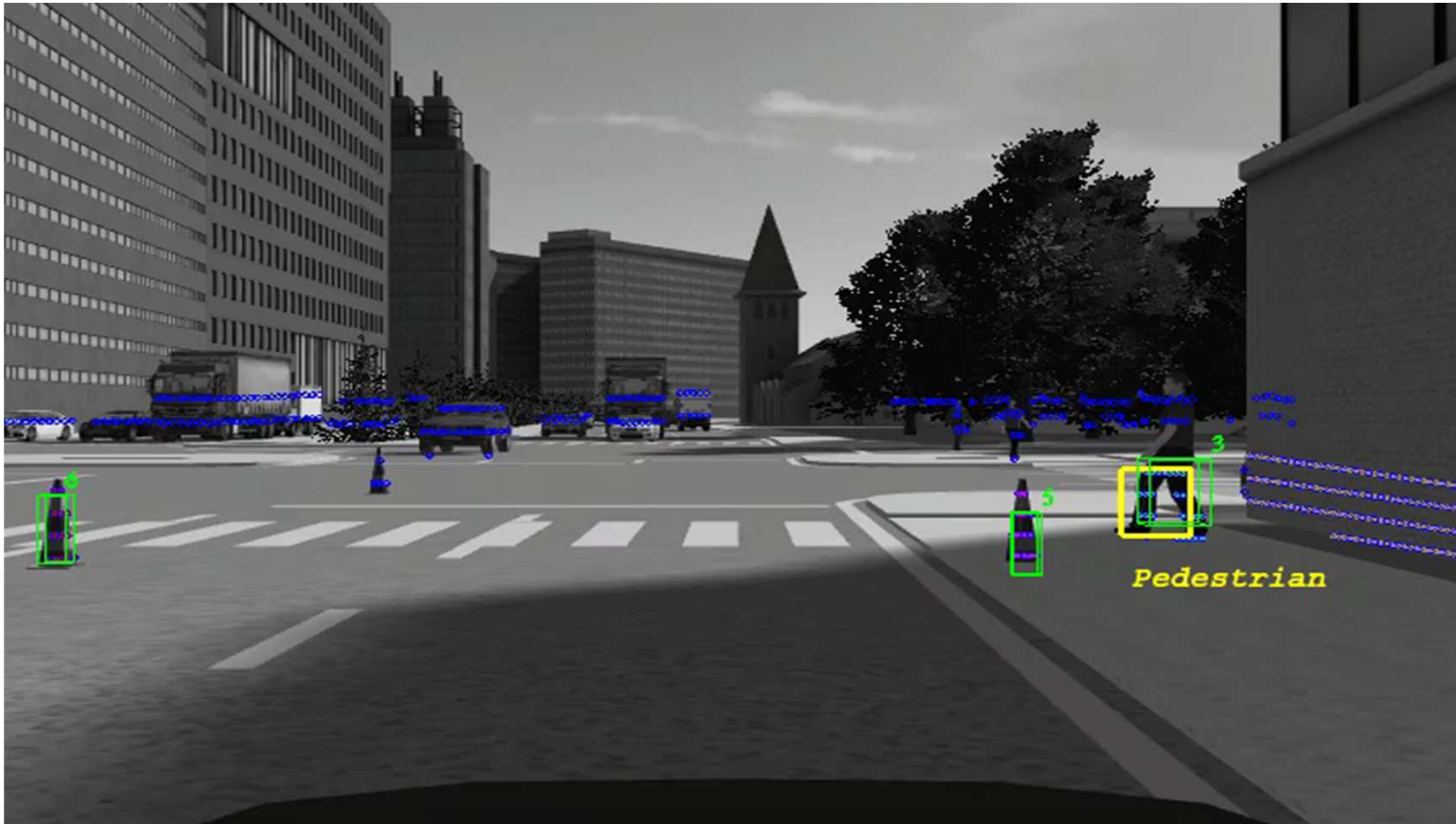
Object detection on Mentor DRS360

PreScan – HIL application examples

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V&V Environments

MiL / SiL / Cluster

...arios

HIL / DIL / ViL

10 – 100 scenarios

Laboratories / proving grounds / public roads

Hardware in the Loop setup
running PreScan™ on Real Time
including the NVIDIA DRIVE PX 2
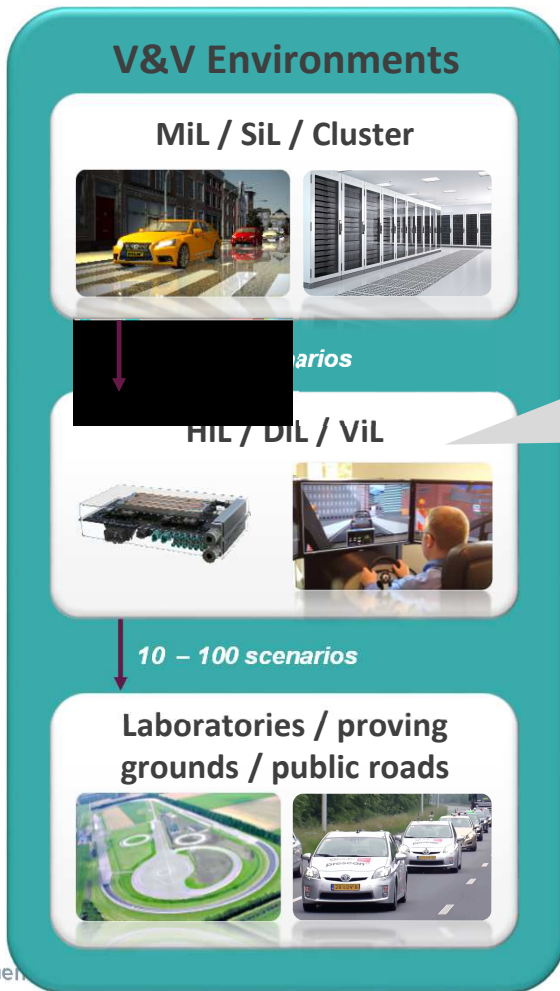
Example #3: Automated Driving physical validation

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V&V Environments

MiL / SiL / Cluster

...arios

HiL / DiL / ViL

10 – 100 scenarios

Laboratories / proving grounds / public roads
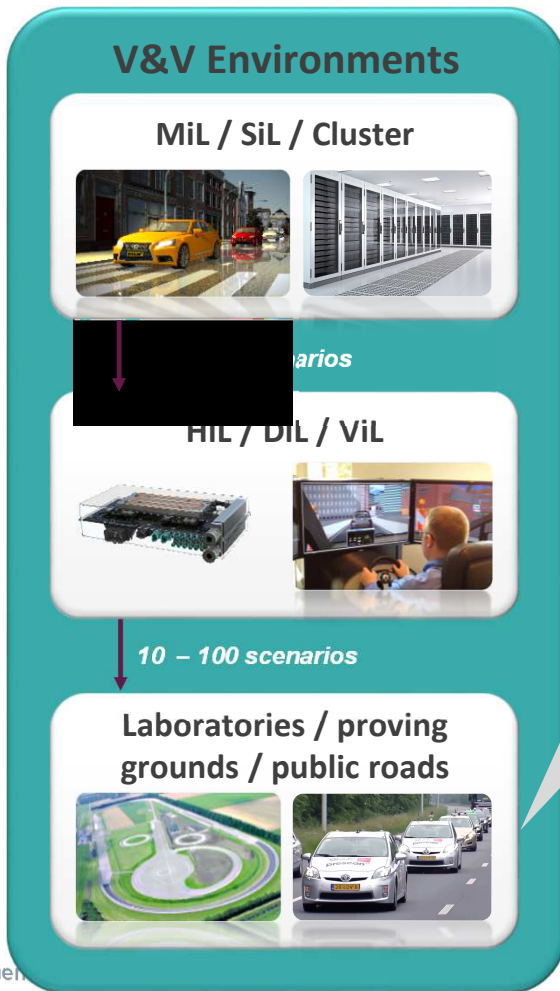
TASS International Services and Siemens Testing Solutions for physical validation of automated and connected driving technology

- Physical verification & validation services
- Certification of automated and connected systems
- Design consultancy for "next-generation" AD test facilities

Development of automated vehicles requires realistic sensor data

Algorithm development
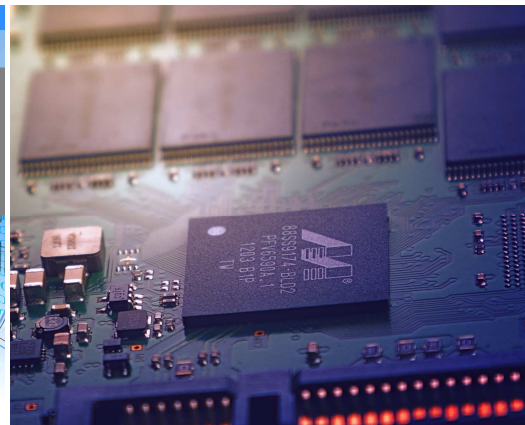
Sensor development
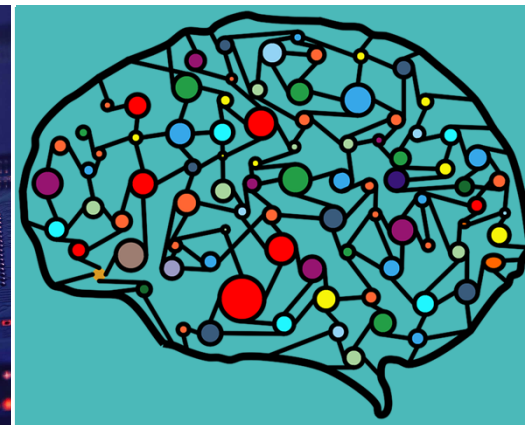
DNN Training

Validation

Two sources of sensor data

Recorded

+ **Real data**
- Expensive
- Time consuming
- Not (easily) repeatable
- Requires a physical sensor
- Must be annotated
- Open loop (recorded)

Simulated

? Realistic data
+ **Inexpensive**
+ **Fast to acquire**
+ **Perfect repeatability**
+ **Physical sensor not needed**
+ **Annotation is free**
+ **Can be closed loop**

Siemens PLM Software

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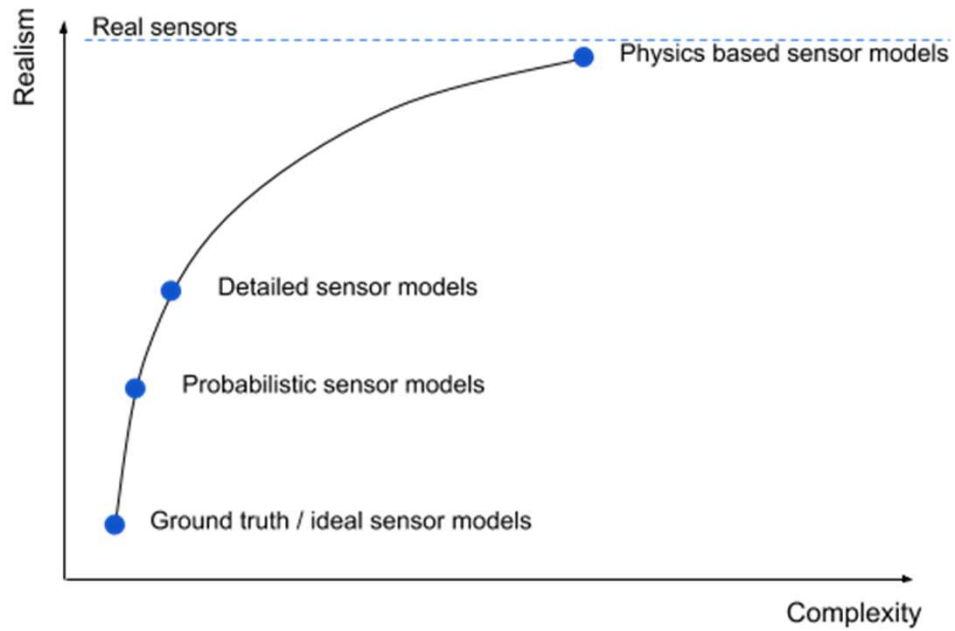
We use simulation to compute real world effects on actual sensors

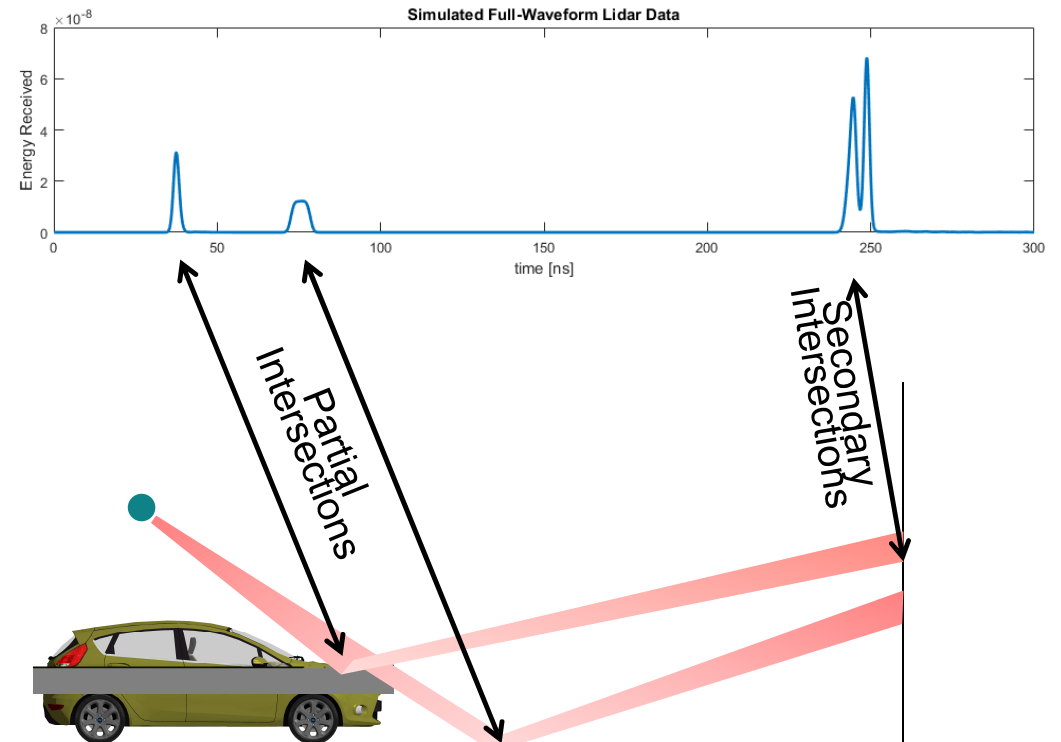| Physical artefacts are faithfully reproduced	Raw signal is computed	Output verified & validated
• Distortions • Multi-bounce • Time effects • Weather • …	• Lidar full-waveform signal • Radar channel response • Raw camera images • …	• Verify against real sensors • Validate for specific use cases

prescan

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Color filter array

Beam cross section

MTF
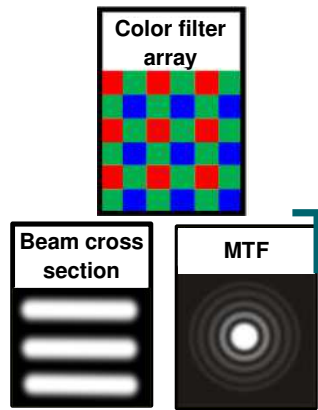
Simulation Engine

Three key components are needed

Physical Device

World
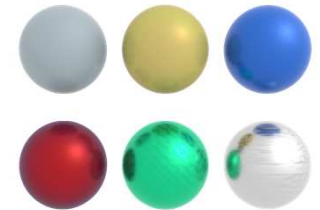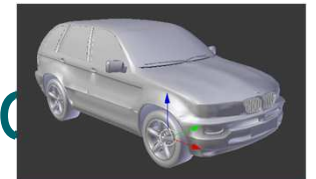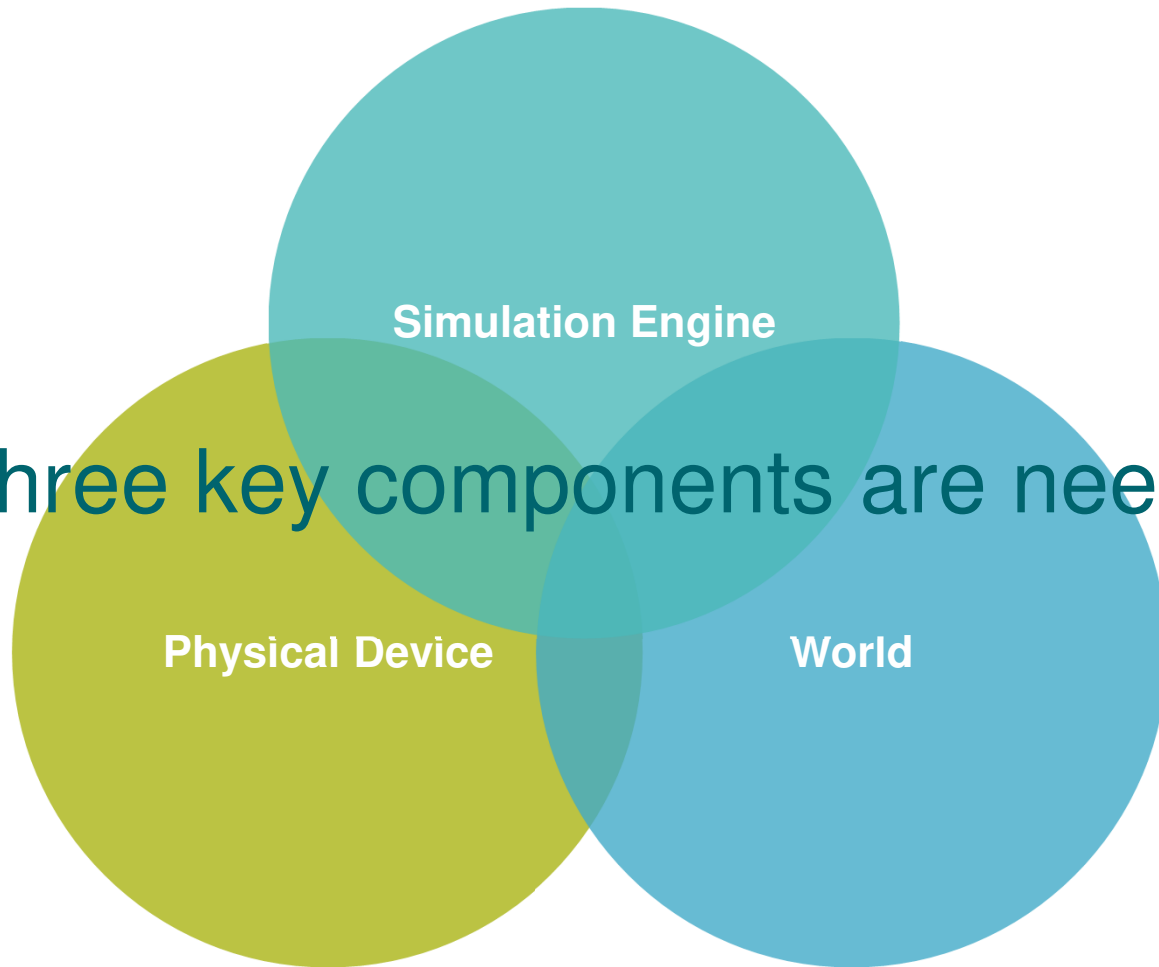
Physics Based Lidar Simulation

Simulated Full-Waveform Lidar Data

Our solutions support autonomous vehicle development needs
Across all engineering domains

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Continuous Verification and Validation Framework

System on Chip

Vehicle & Occupant

AD Compute Platform

Product Innovation Platform
Multi-Domain Data Orchestration

System Integration

Embedded Software

Sensor & Environment

Algorithms

Start Integrated – Stay Integrated

Integrated Circuit level
Systems Level
Vehicle Level

Ensuring digital continuity, multi-domain traceability and functional safety of autonomous systems