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# Physics Based Sensor simulation

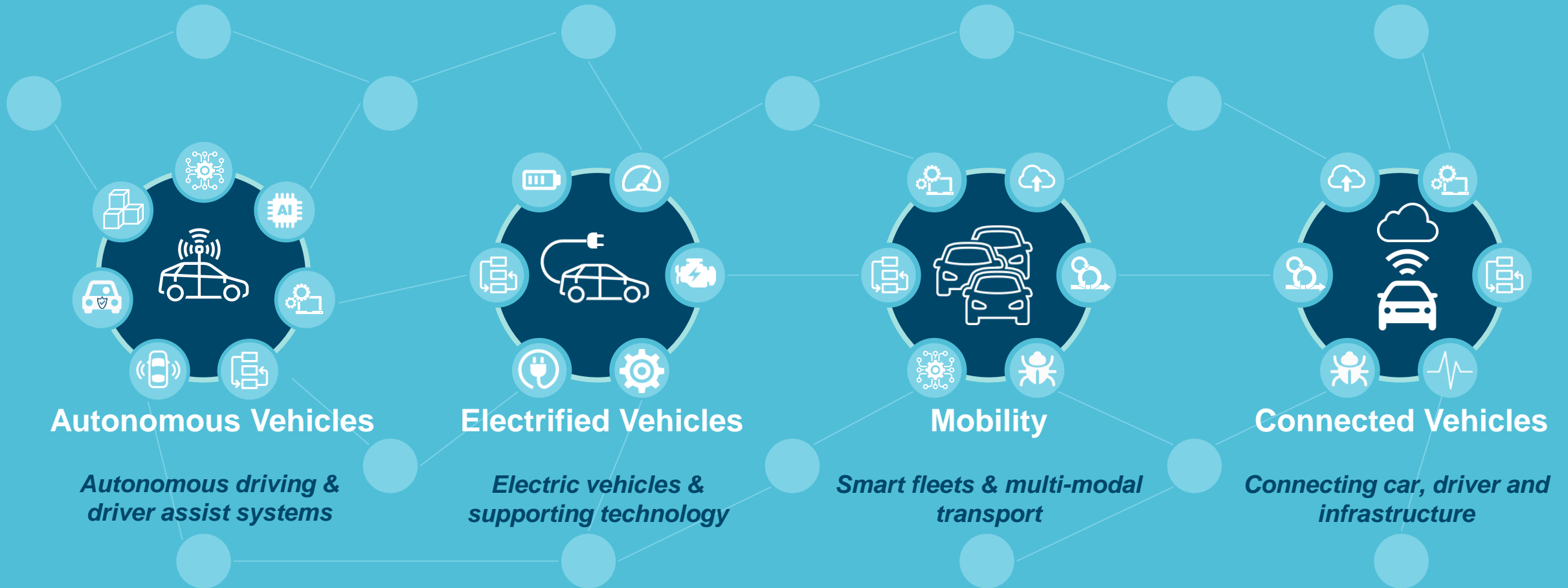
Jordan Gorrochotegui - Product Manager Software and Services

Mike Phillips – Software Engineer

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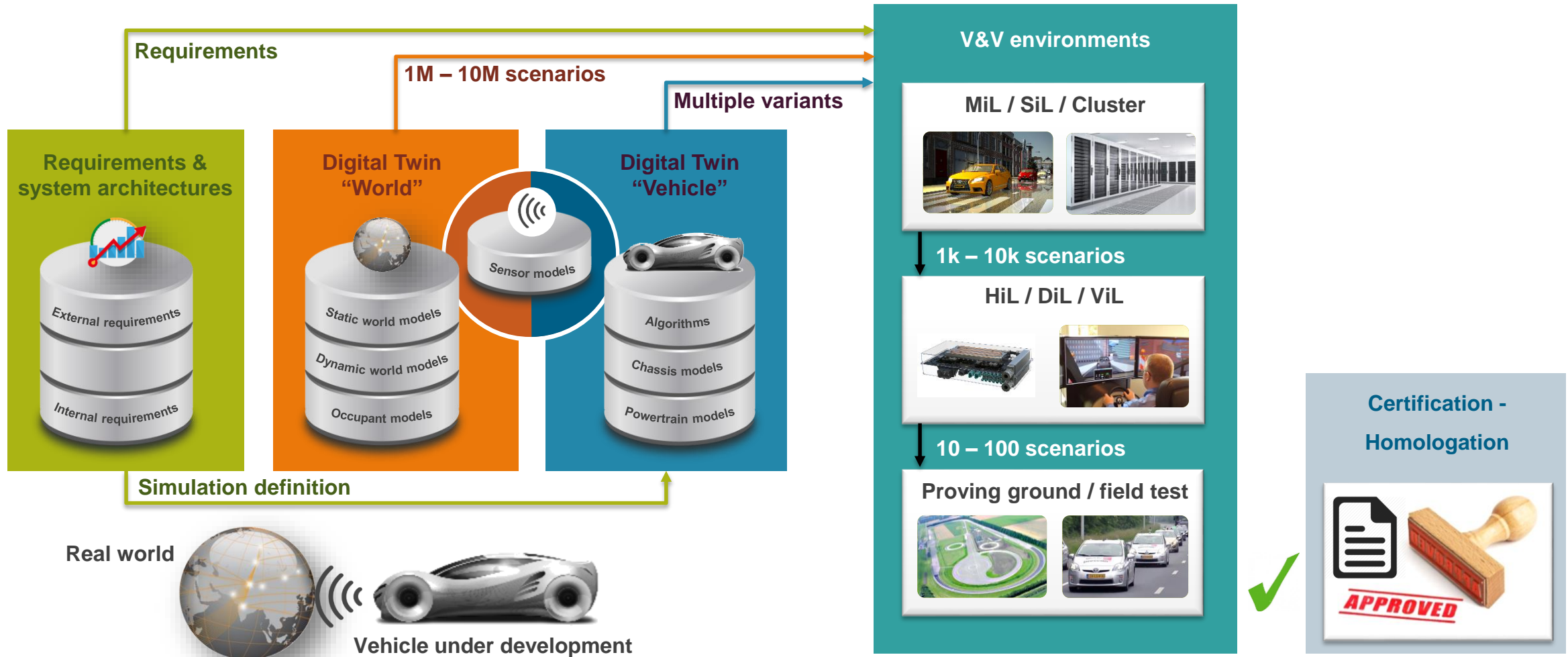
Realize innovation.

# Siemens offers solutions across all automotive mega trends

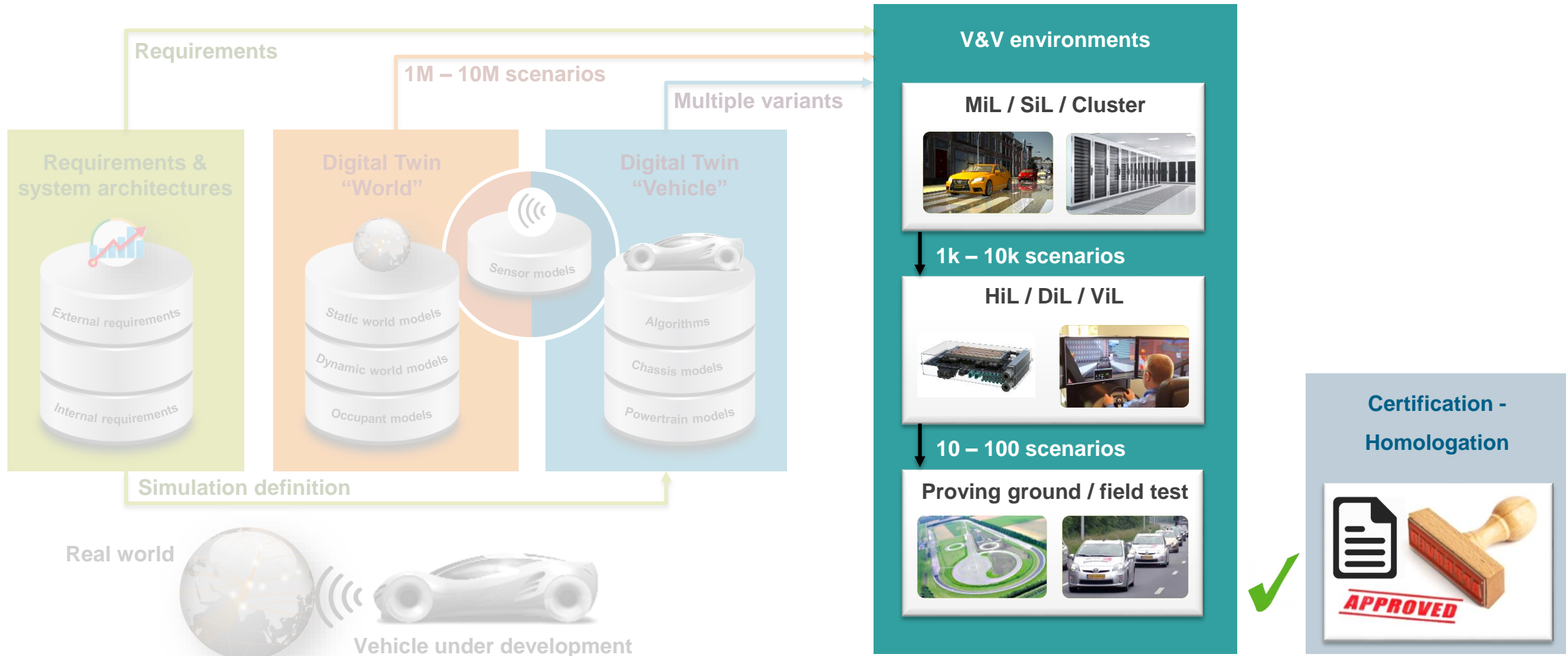


Engineering the **next** product not just the best product for the future

# Validation and Verification framework for AVs



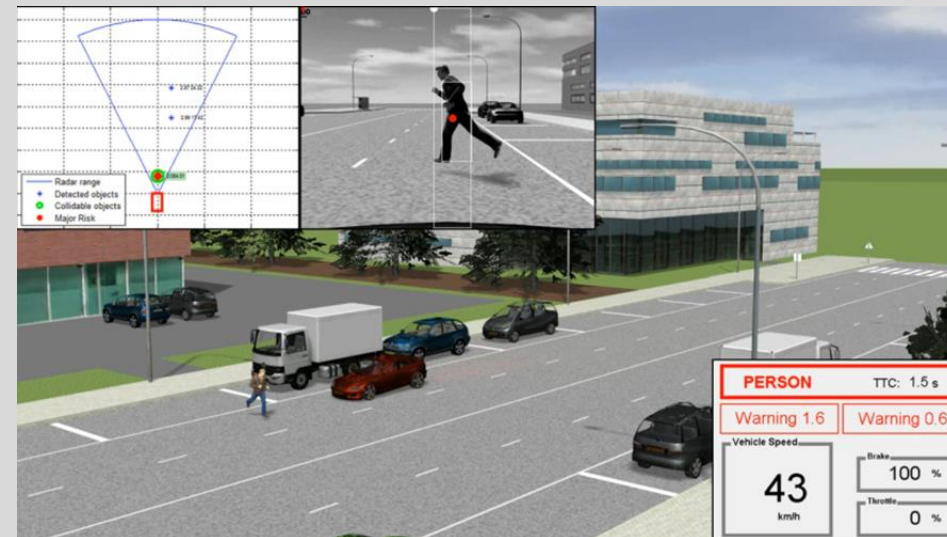
# Validation and Verification framework for AVs



# Example #1: MiL / SiL / Cluster

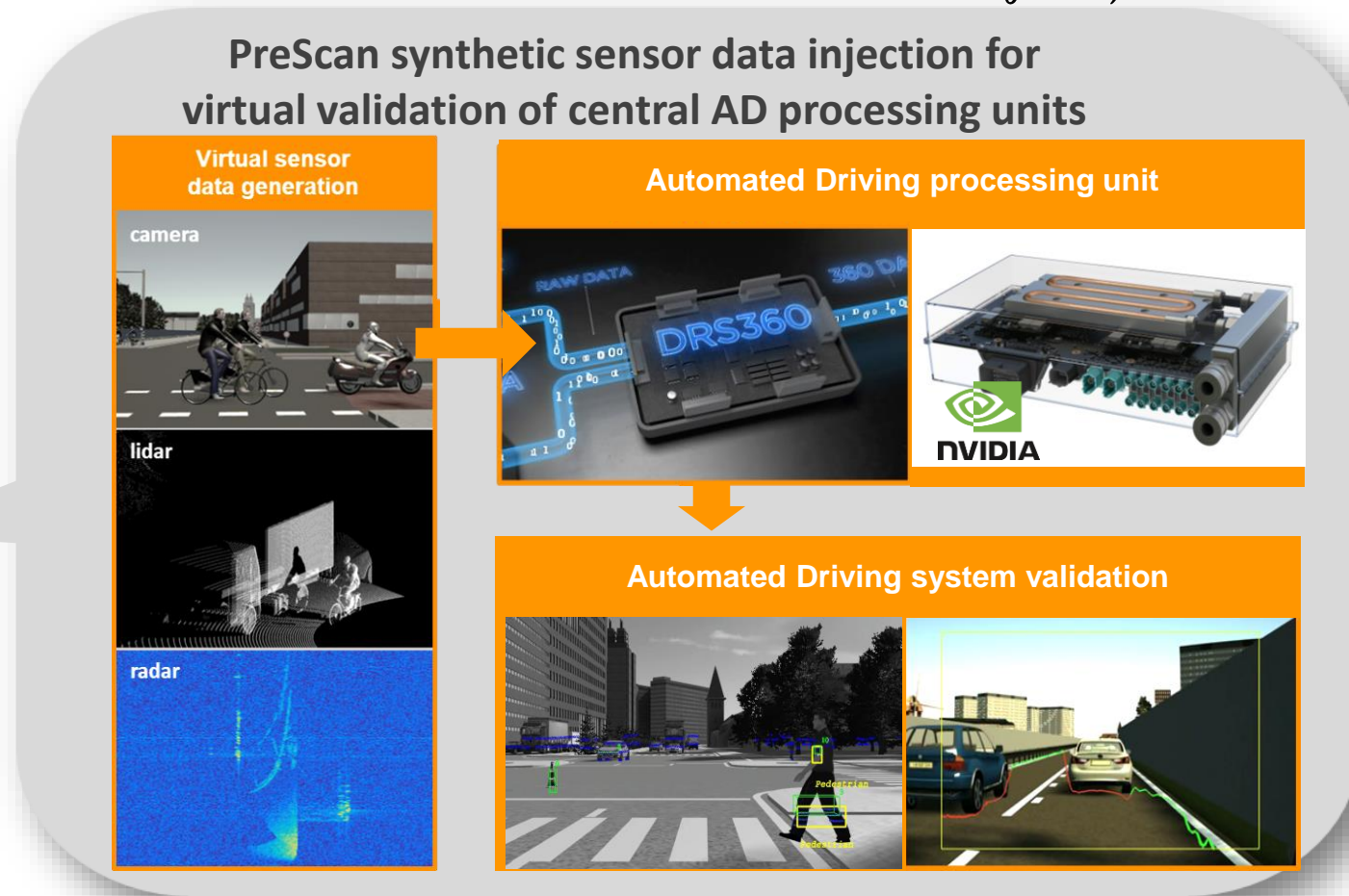


Run massive amounts of Prescan scenarios for Automated Vehicle development and optimization



- Design space exploration using large scenario databases
- Virtual development, verification and robustness testing
- Optimized automated vehicle designs

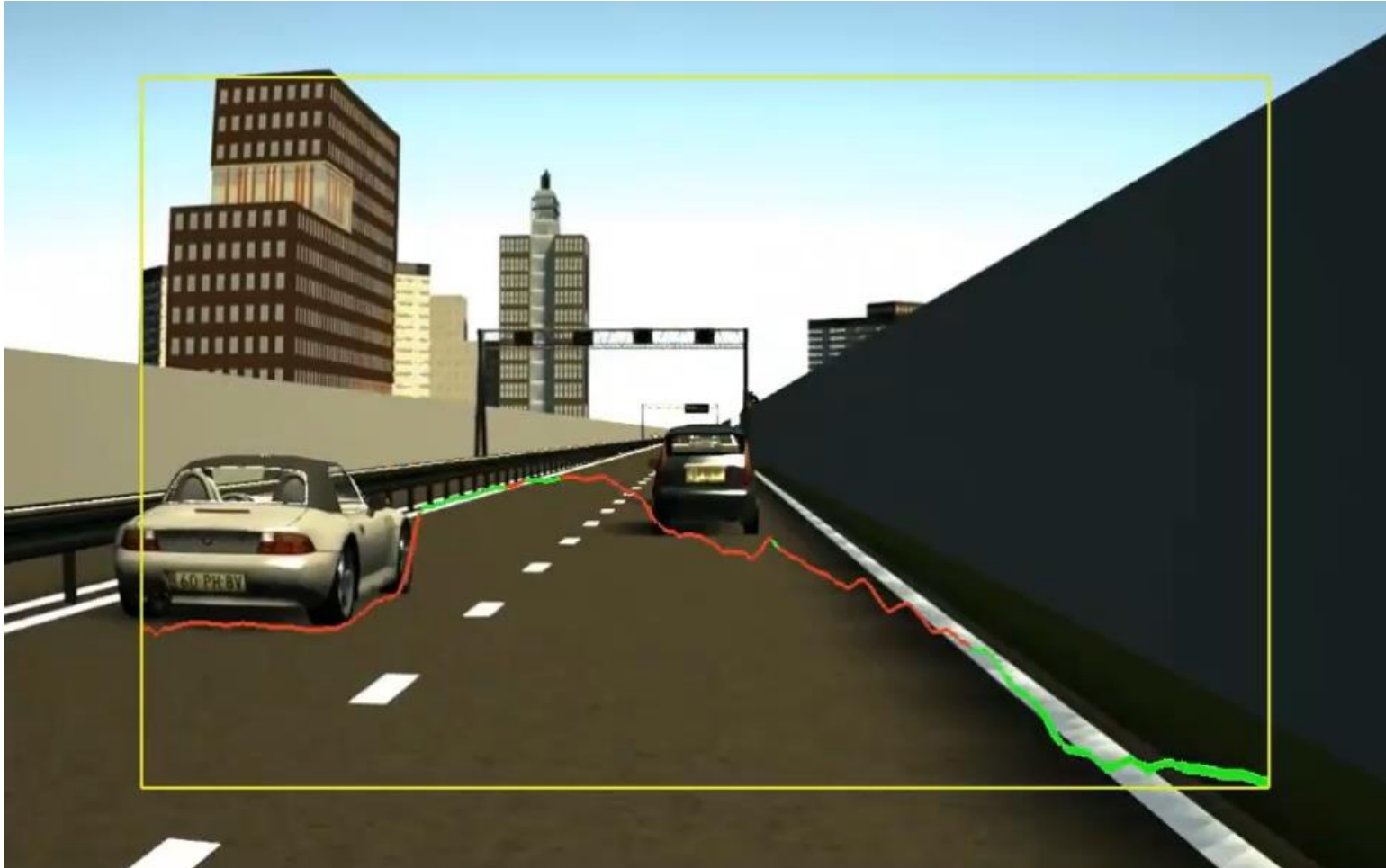
# Example #2: HiL testing of central AD processing unit



- Training and evaluating Deep Neural Networks (DNNs)
- Virtual validation of automated driving processing units
- Accelerated automated vehicle development

## Example #2: HiL testing of central AD processing unit

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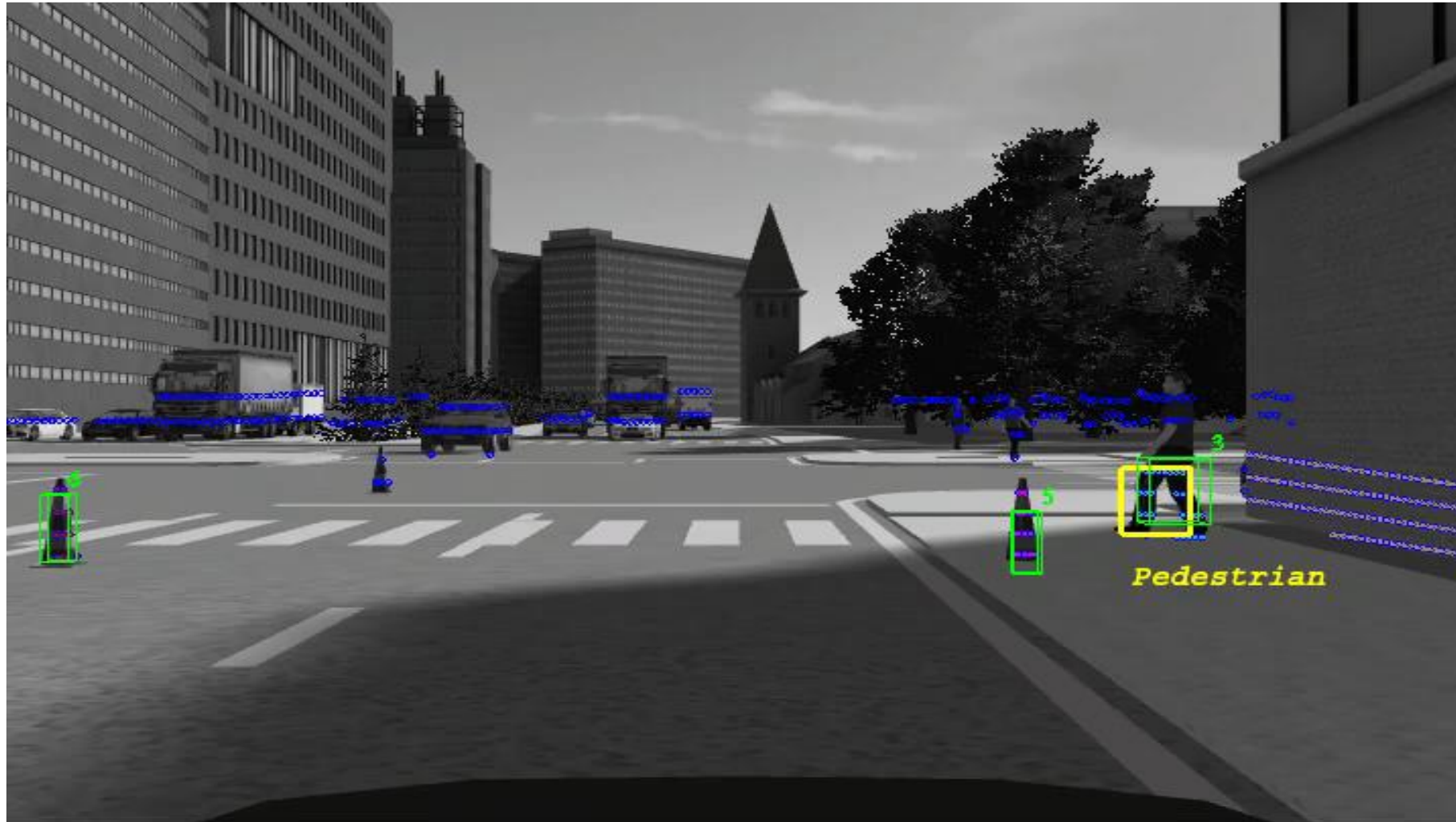


Free space detection on Nvidia Drive PX2



## Example #2: HiL testing of central AD processing unit

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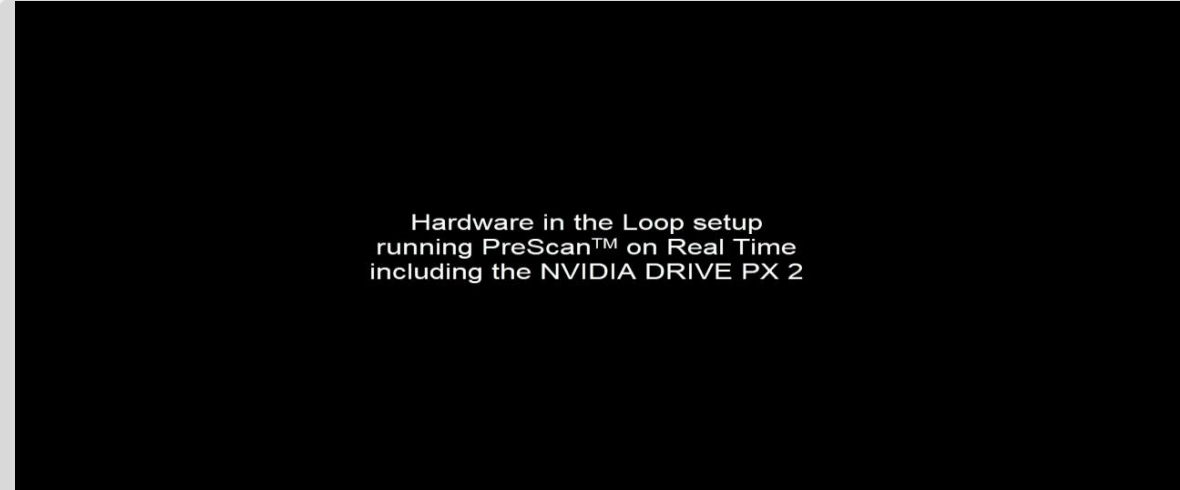


Object detection on Mentor DRS360

**Mentor**<sup>®</sup>  
A Siemens Business



# PreScan – HIL application examples



# Example #3: Automated Driving physical validation



TASS International Services and Siemens Testing Solutions for physical validation of automated and connected driving technology

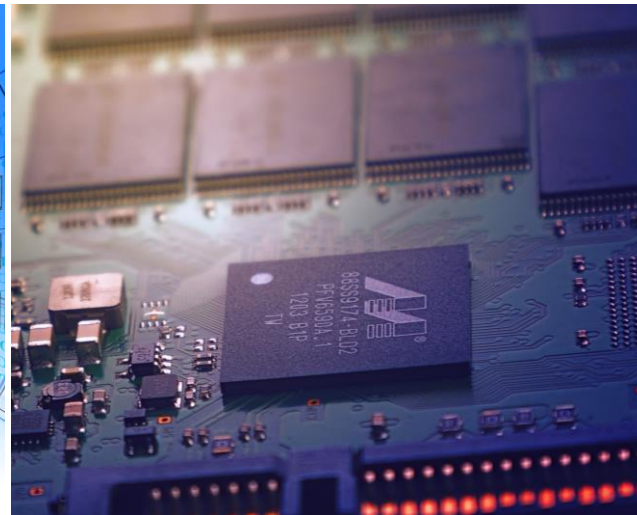


- Physical verification & validation services
- Certification of automated and connected systems
- Design consultancy for “next-generation” AD test facilities

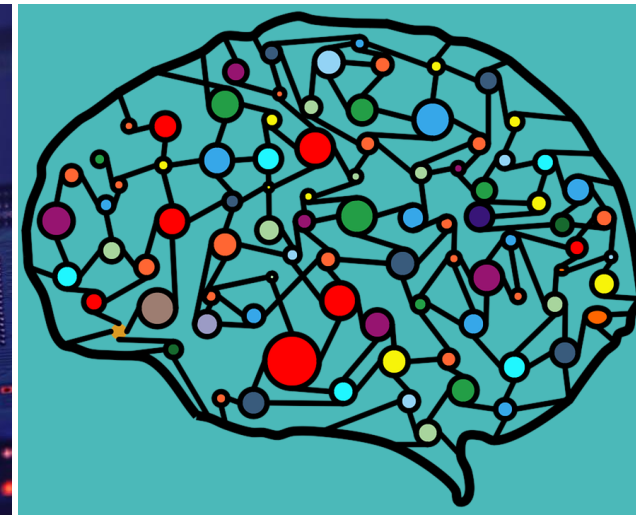
## Development of automated vehicles requires realistic sensor data



**Algorithm development**



**Sensor development**



**DNN Training**



**Validation**

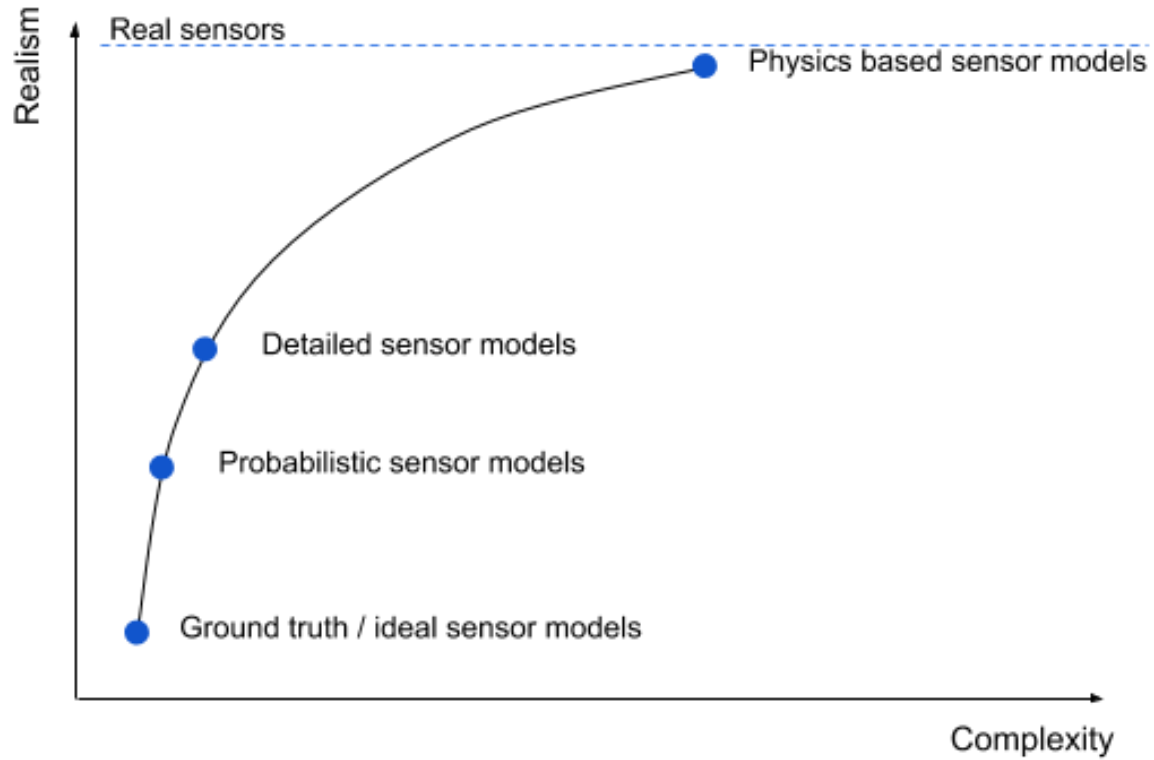
## Two sources of sensor data

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

**Recorded**

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

**Simulated**



Camera & Ground Truth

Radar & V2X

Lidar & Point Cloud

## We use simulation to compute real world effects on actual sensors

### Physical artefacts are faithfully reproduced

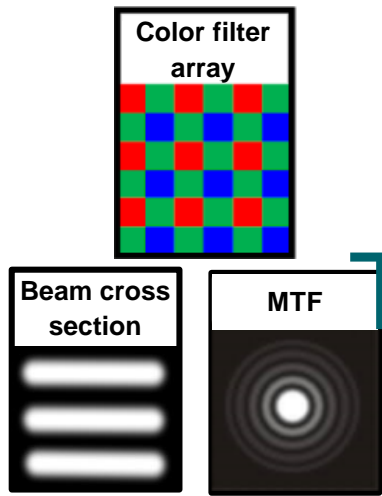
- Distortions
- Multi-bounce
- Time effects
- Weather
- ...

### Raw signal is computed

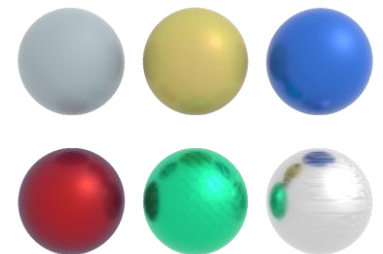
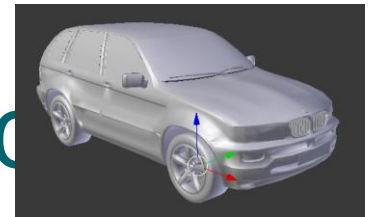
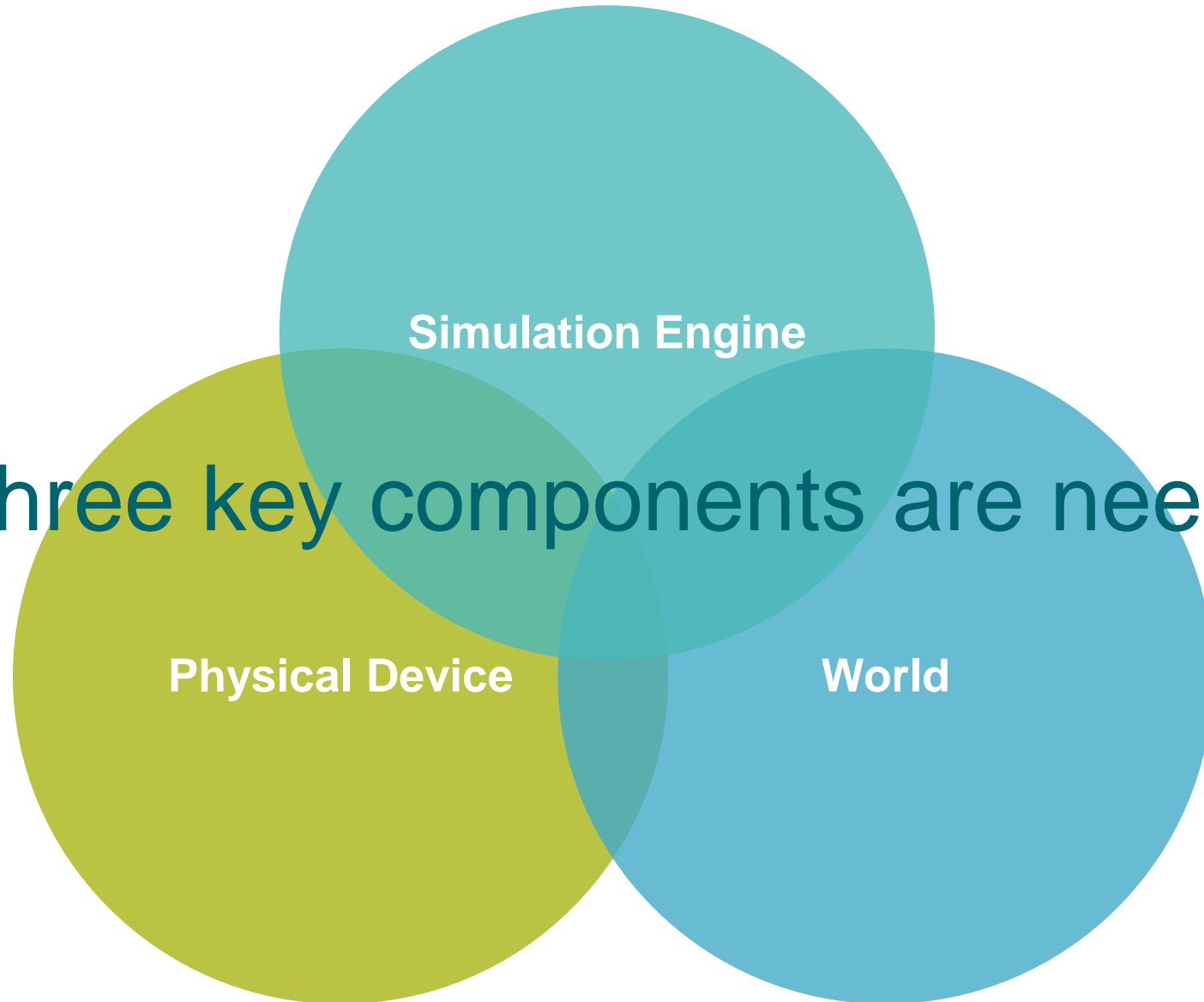
- Lidar full-waveform signal
- Radar channel response
- Raw camera images
- ...

### Output verified & validated

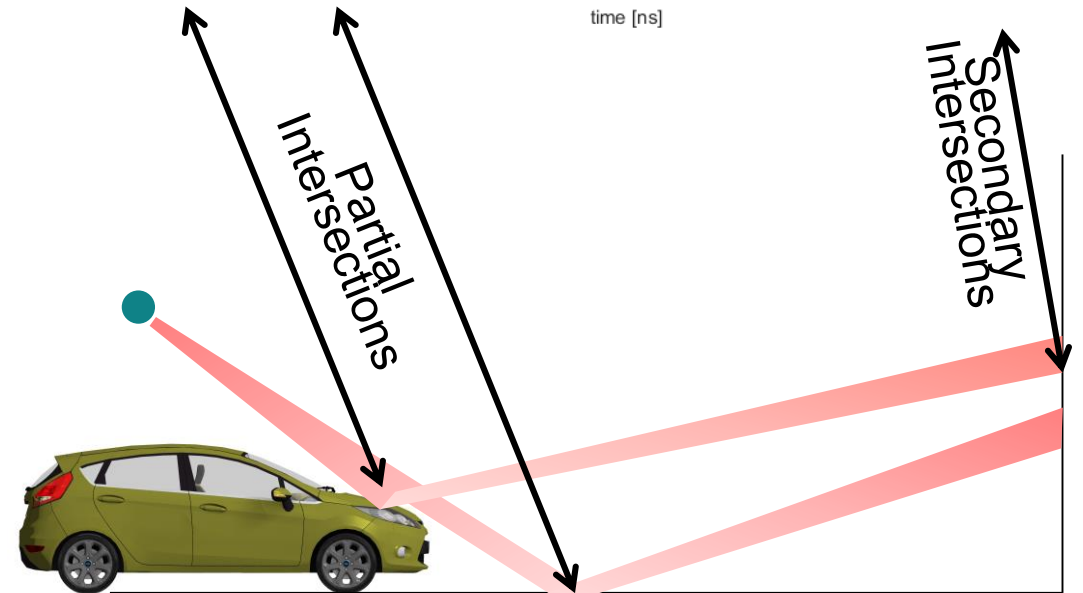
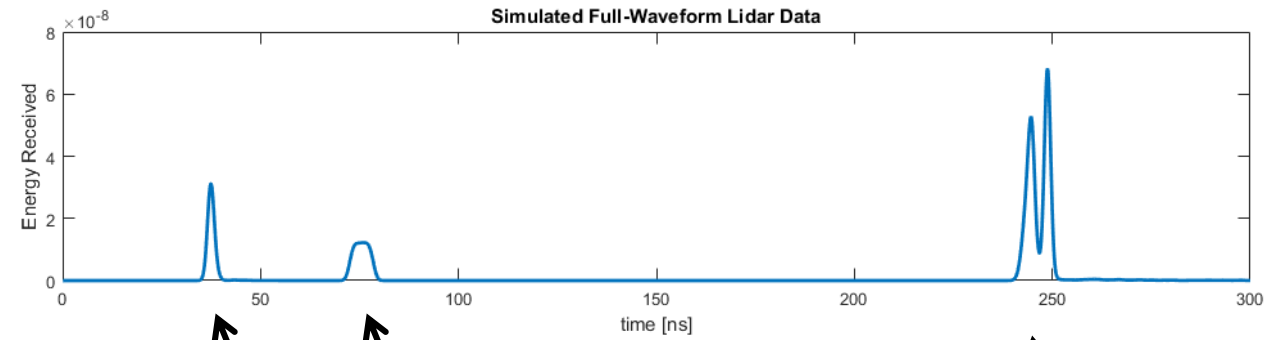
- Verify against real sensors
- Validate for specific use cases



Three key components are needed



# Physics Based Lidar Simulation





# Our solutions support autonomous vehicle development needs

Across all engineering domains



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