Apply & Innovate - TECH WEEKS - Closed Loop Connected Autonomous Vehicle Data Logging and Perception Testing using High Fidelity Synthetic Environments

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- Introduction
- Background and Motivation
- Quick IV Facilities and Equipment Overview
- The 3xD Simulation System updates and the NI, IPG, rFpro demonstrator
- Test Continuum: How NI enabled the demonstrator?

Introduction: WMG

- An academic department within the science faculty of Warwick University
- Established in 1980 by Professor Lord Bhattacharyya as Warwick Manufacturing Group to facilitate technology transfer and knowledge creation for Industry
- 500+ people (800+ university and industry) working in 10 buildings
- Training over 1,500 individuals in the UK and abroad (from school to post experience)
- Co-located with Jaguar Land Rover & Tata Motors European Technical Centre

BACKGROUND: CHALLENGES FOR CAVs IN NUMBERS

11 Billion miles[1]

To demonstrate with 95% confidence that AVs are 20% better than human drivers

100,000 lives[2]

Saved (in the next 30 years) if AVs which are 10% better than human drivers are introduced

Around 50% [3]

Of the time, drivers don't use current ADAS systems

[1]N. Kalra and S. M. Paddock, "Driving to safety: How many miles of driving would it take to demonstrate autonomous vehicle reliability?," *Transp. Res. Part A Policy Pract.*, vol. 94, no. December, pp. 182–193, 2016

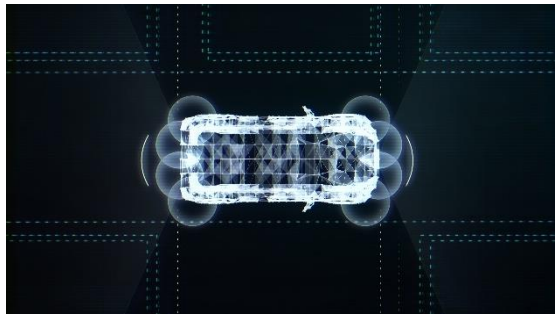
[2]N. Kalra and D. G. Groves, *The Enemy of Good*. 2017

[3]A. F. L. Larsson, "Driver usage and understanding of adaptive cruise control," *Appl. Ergon.*, vol. 43, no. 3, pp. 501–506, 2012

BACKGROUND: CHALLENGES FOR CAVs IN NUMBERS

We need to ensure that new products and services are:

- **Dependable and affordable**
  - In a complex real world operating environment
  - With new high value components integrated on-board (and off!)
- Commercially **viable**
  - With new entrants to the value chain
  - And new services and business models
- **Desirable**
  - Gaining public acceptance and trust
  - Achieving societal benefits



How? *Learn from a continuum of simulation; testing; trials; and early deployment*

MOTIVATION: ACCELERATING TECHNOLOGY & SERVICE DEVELOPMENT

*To make future vehicles, technologies and services **dependable, desirable** and **viable**, we need to learn from a continuum of simulation, testing, trials and early deployment*

Modelling and Simulation

Controlled Environments

Public Environments

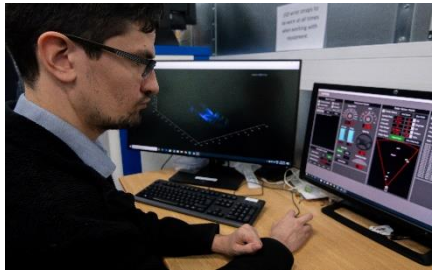
Aim: to confidently test/certify earlier in product development

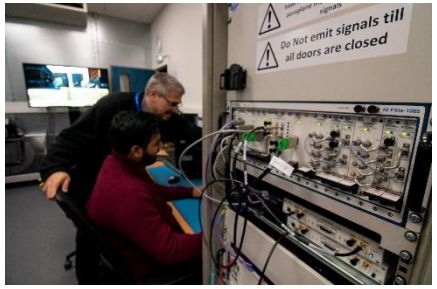
https://warwick.ac.uk/fac/sci/wmg/research/cav/ivfac

WMG
THE UNIVERSITY OF WARWICK

WMG IV Facilities and Equipment Overview

Our Vision: To test or evaluate any new CAV technology (infrastructure, communications and on-vehicle) in representative real world conditions with a “driver” in the loop

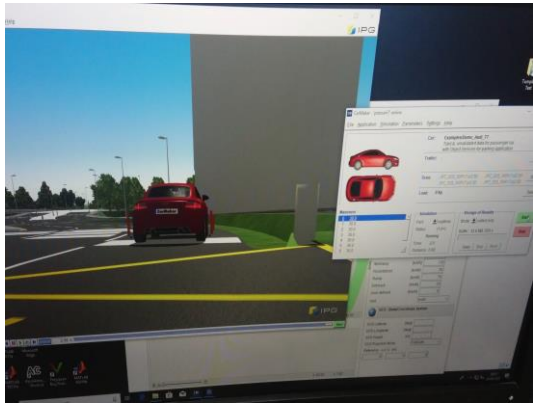




Autonomous Pods

rFpro

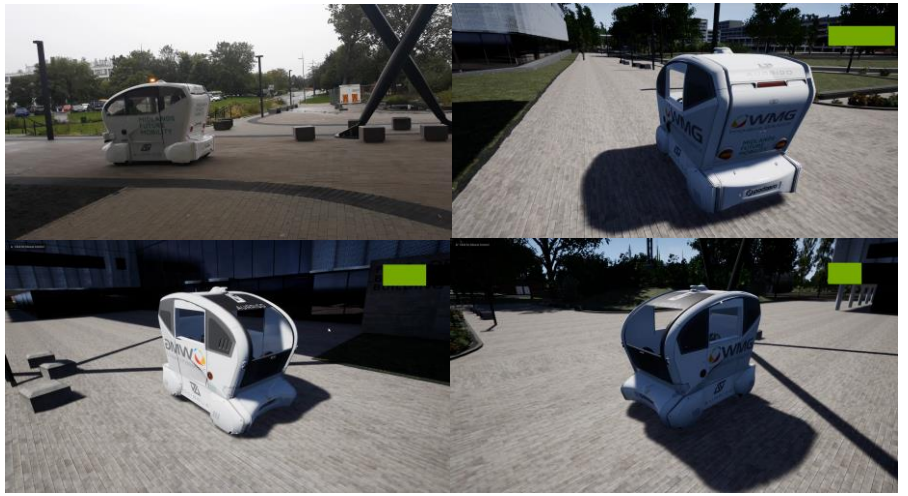
IPG



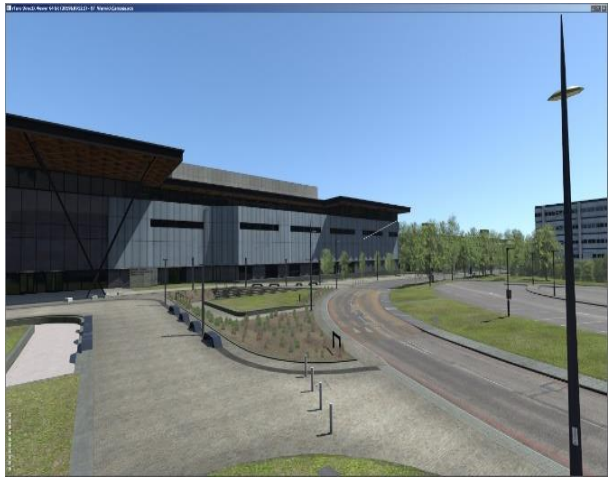
Unreal

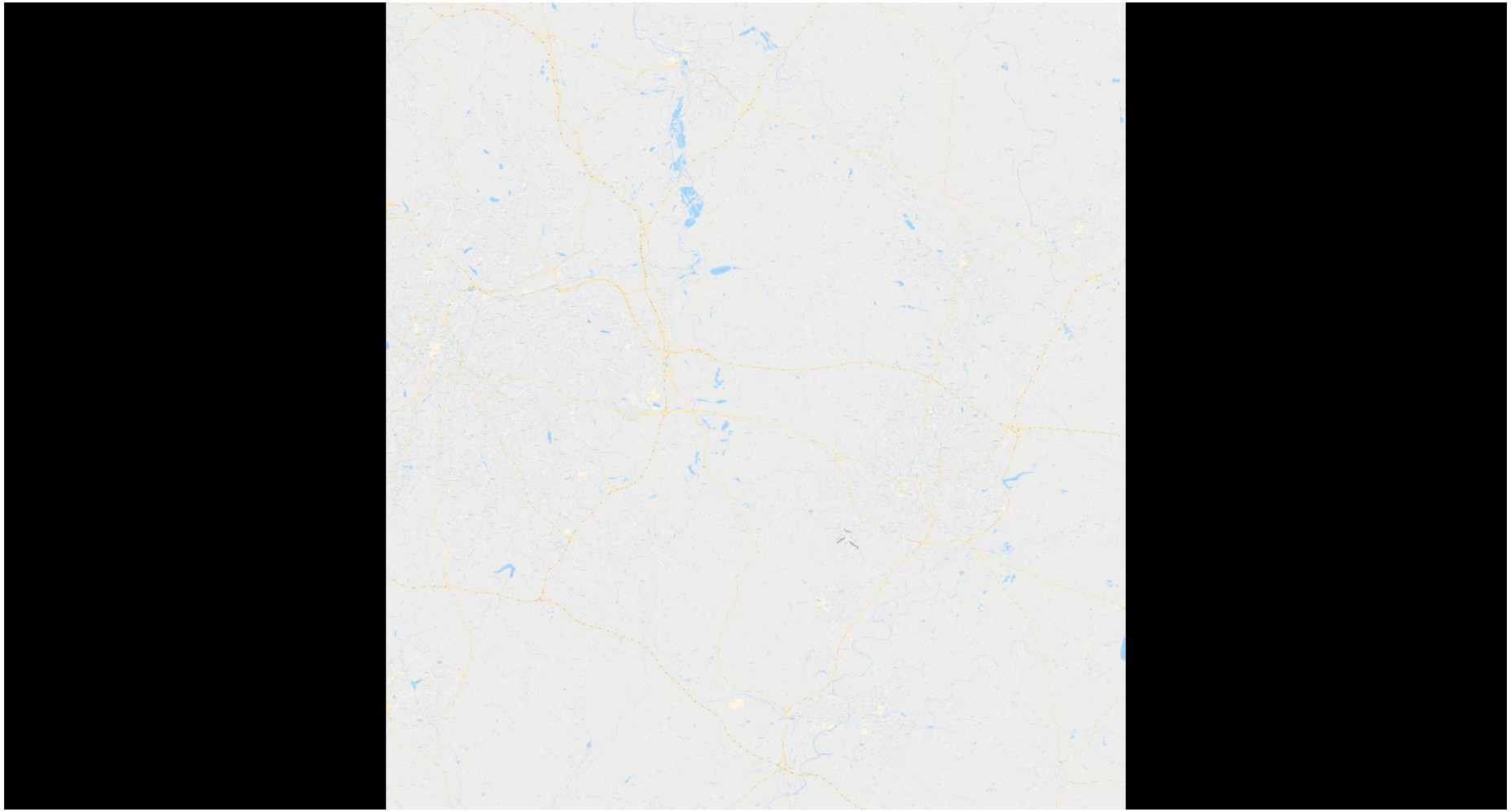
The 3xD Simulation System –The early days and IPG

Autonomous Pod Testing in a Closed Loop

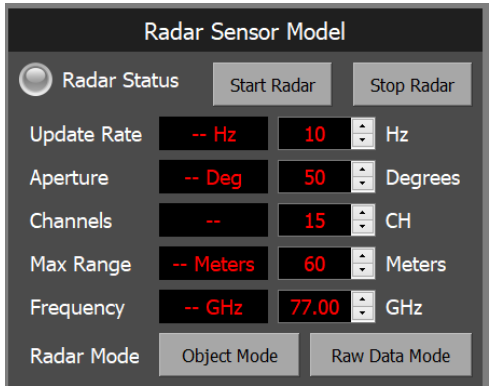


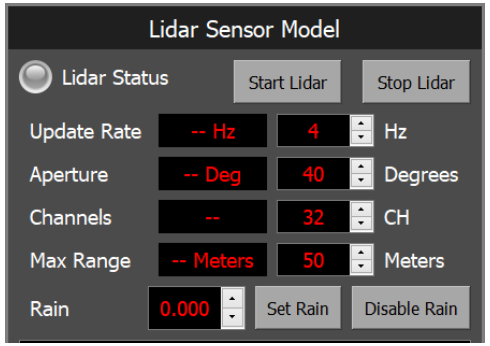
The 3xD Simulation System – World Models



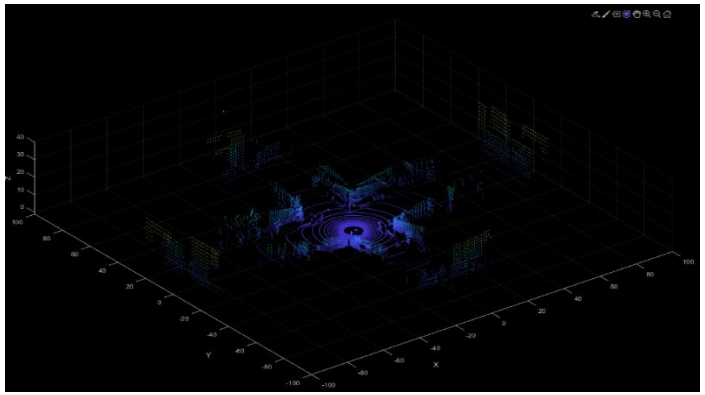


The 3xD Simulation System – Sensor Models

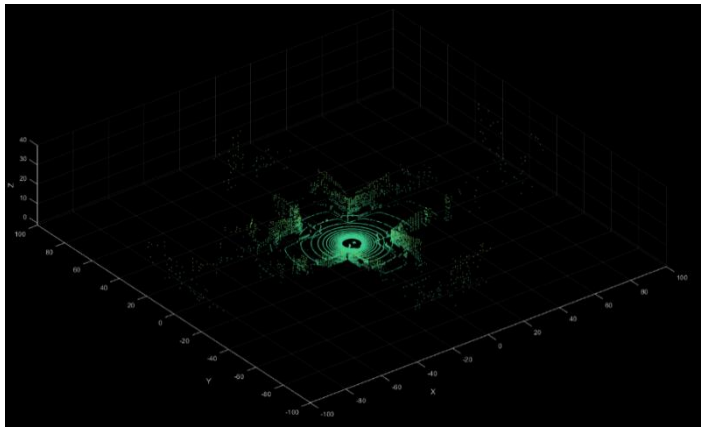




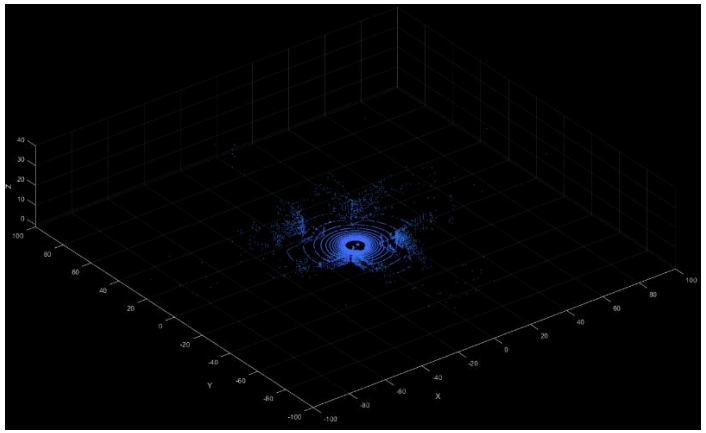
The 3xD Simulation System – World Models



Rain Rate = 0mm/h

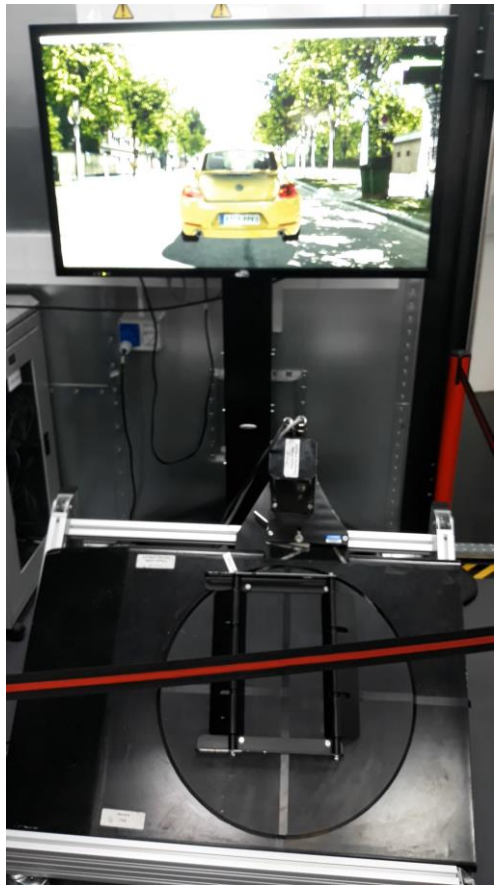


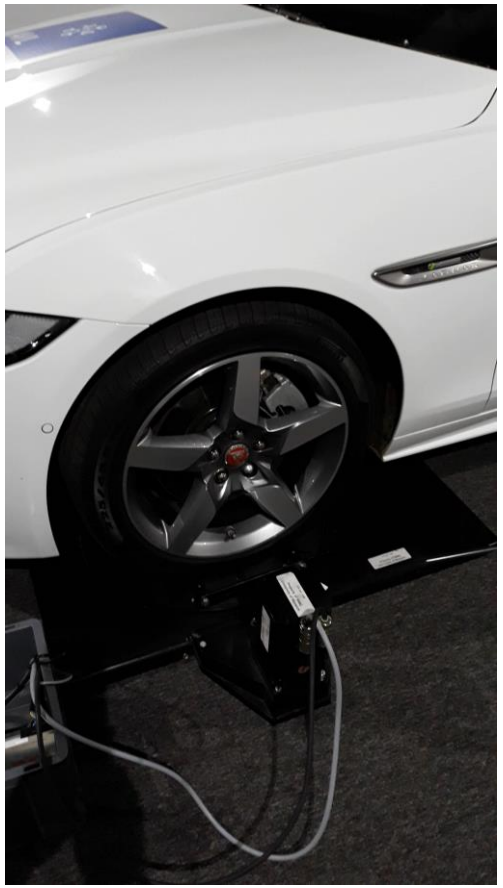
Rain Rate = 25mm/h

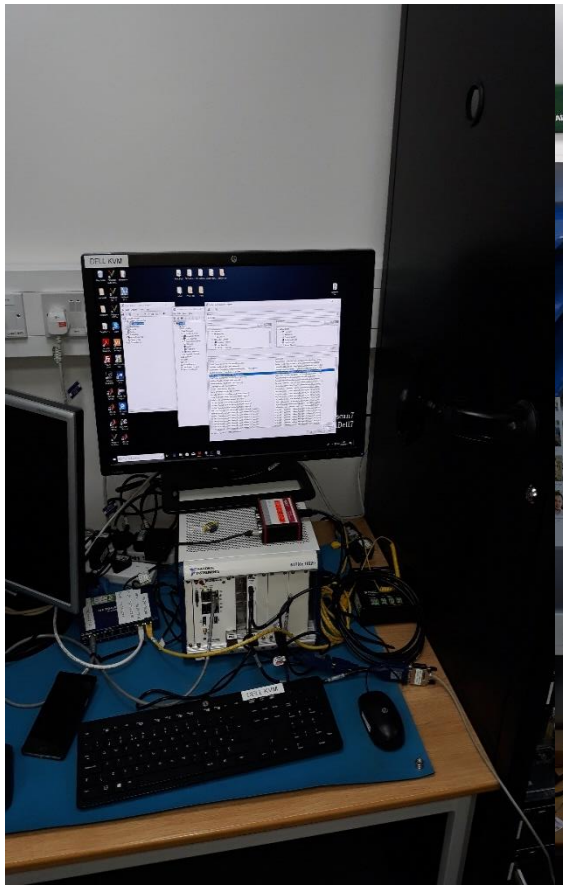


Rain Rate = 99mm/h

WMG,NI, IPG, rFpro demonstrator

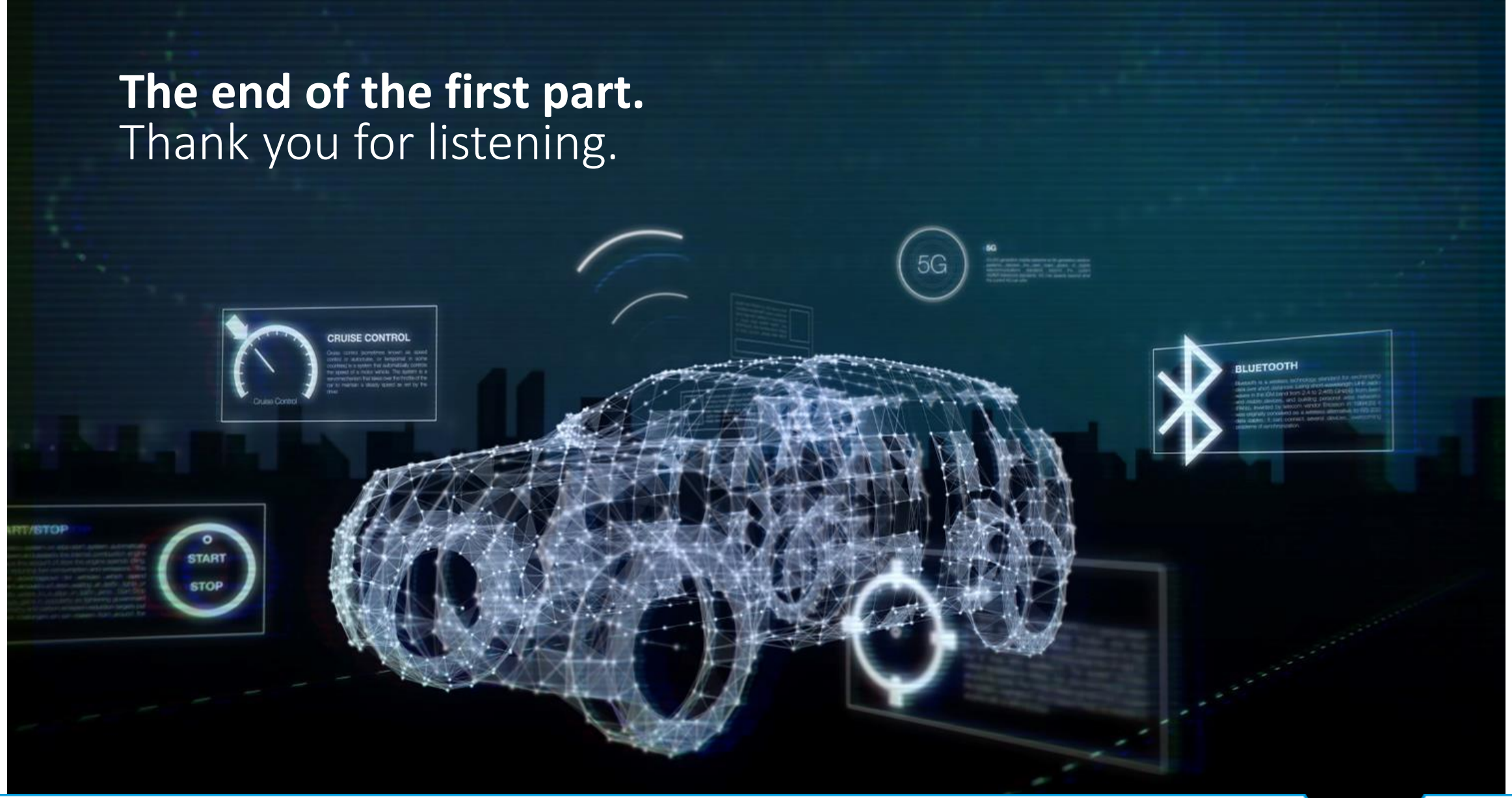






WMG,NI, IPG, rFpro demonstrator

The end of the first part.
Thank you for listening.



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(Jakes Groenewald, Lead Engineer– Intelligent Vehicles)

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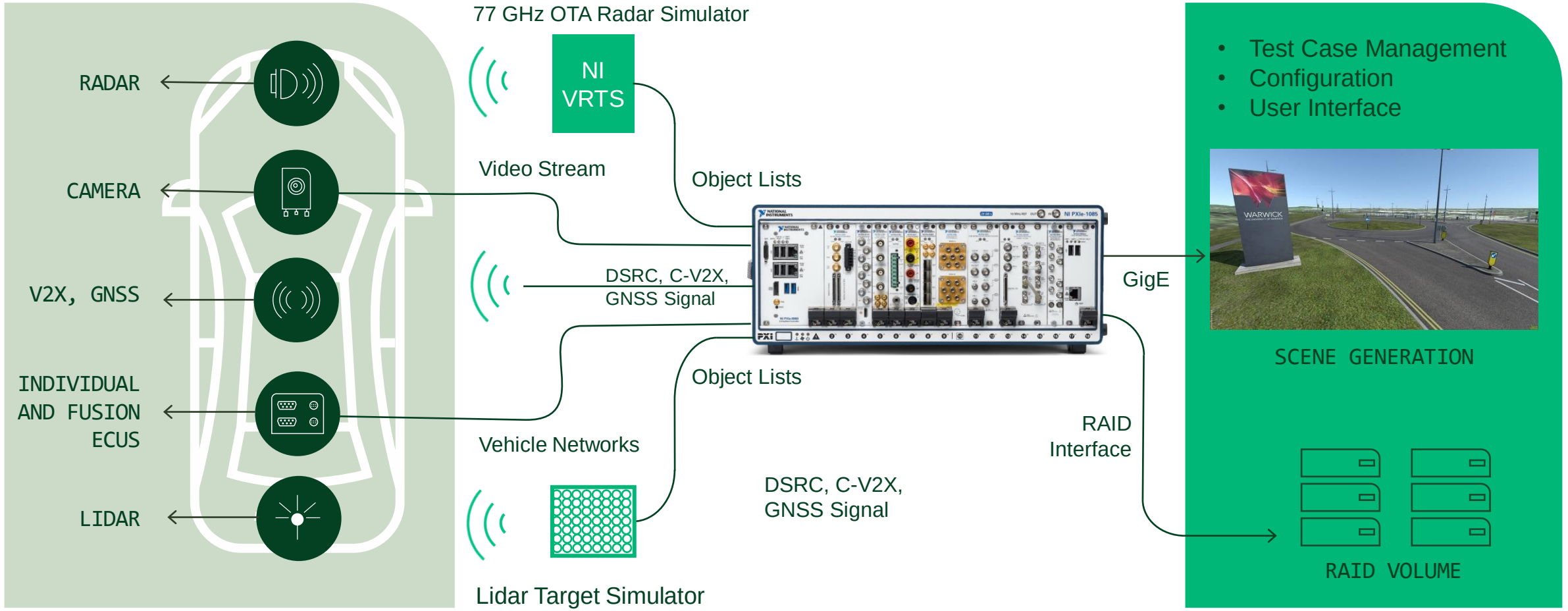
National Instruments
is now NI.

Single Platform for ADAS Test



Closed Loop Perception Test – Camera Example

High Fidelity Image

World Model Running on GPU

Sensor Model Running on GPU

Direct Sensor Injection With NI FPGA

Vehicle Dynamics Model & Road Terrain Hard Real-Time

Radar Object Lists

Lidar Point Cloud

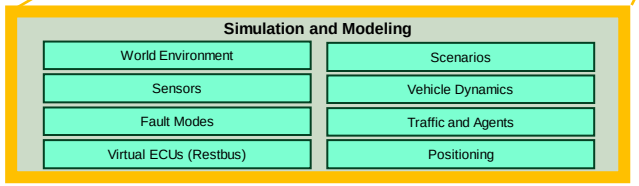
Throttle, Brake, Steering

Automotive Buses

rFpro

Customer Choice in simulation tools and can be co-simulated

IPG AUTOMOTIVE



Closed Loop Perception Test – WMG Initial Project Example

World Image

World Model Running on GPU (WMG)

Vehicle Dynamics Model in Hard Real-Time

NI V2X

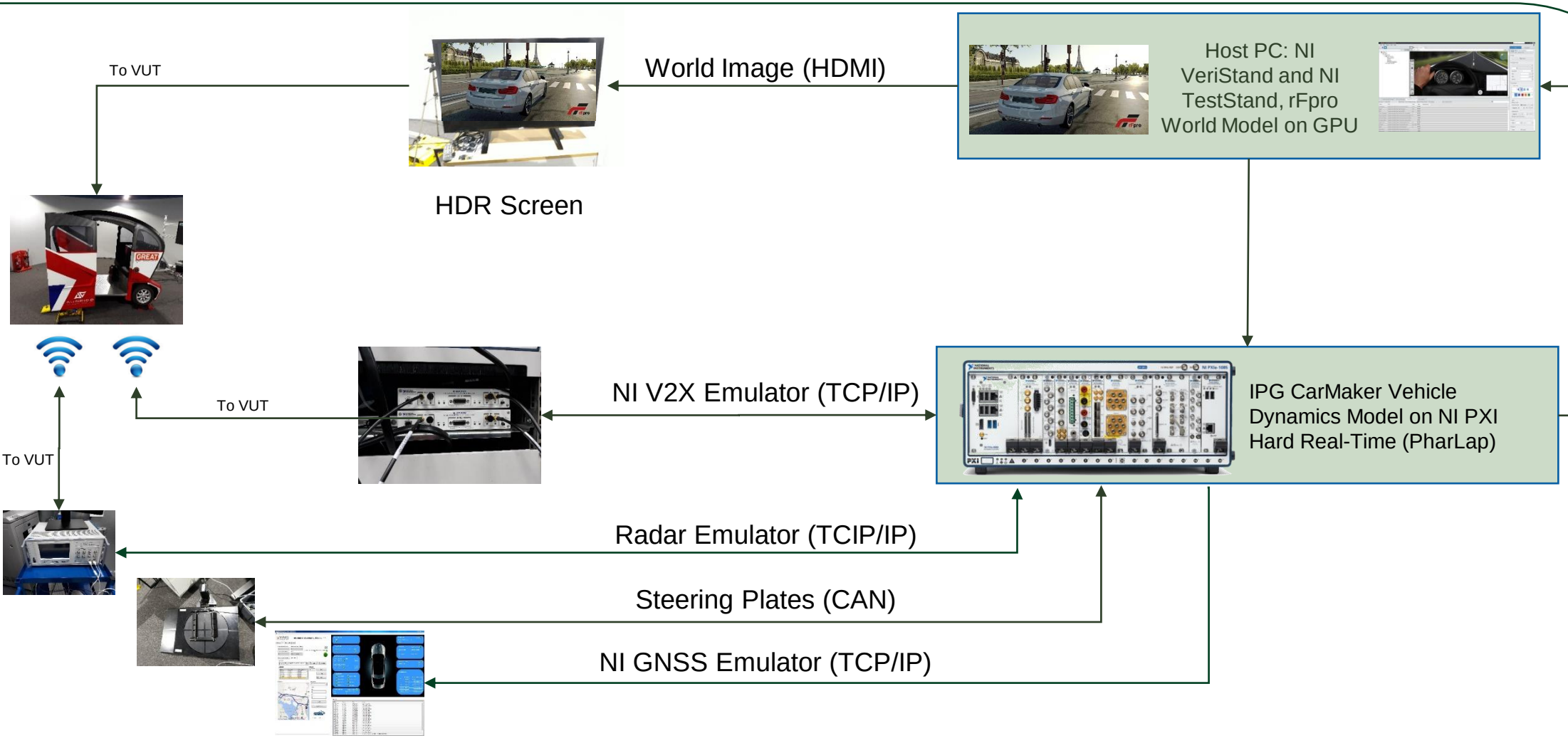
OTA Sensor Emulators

Simulator Environment

Vehicle Information

https://warwick.ac.uk/fac/sci/wmg/research/cav/ivfac/industry

Closed Loop Perception Test – WMG Initial Project Example Phase 2

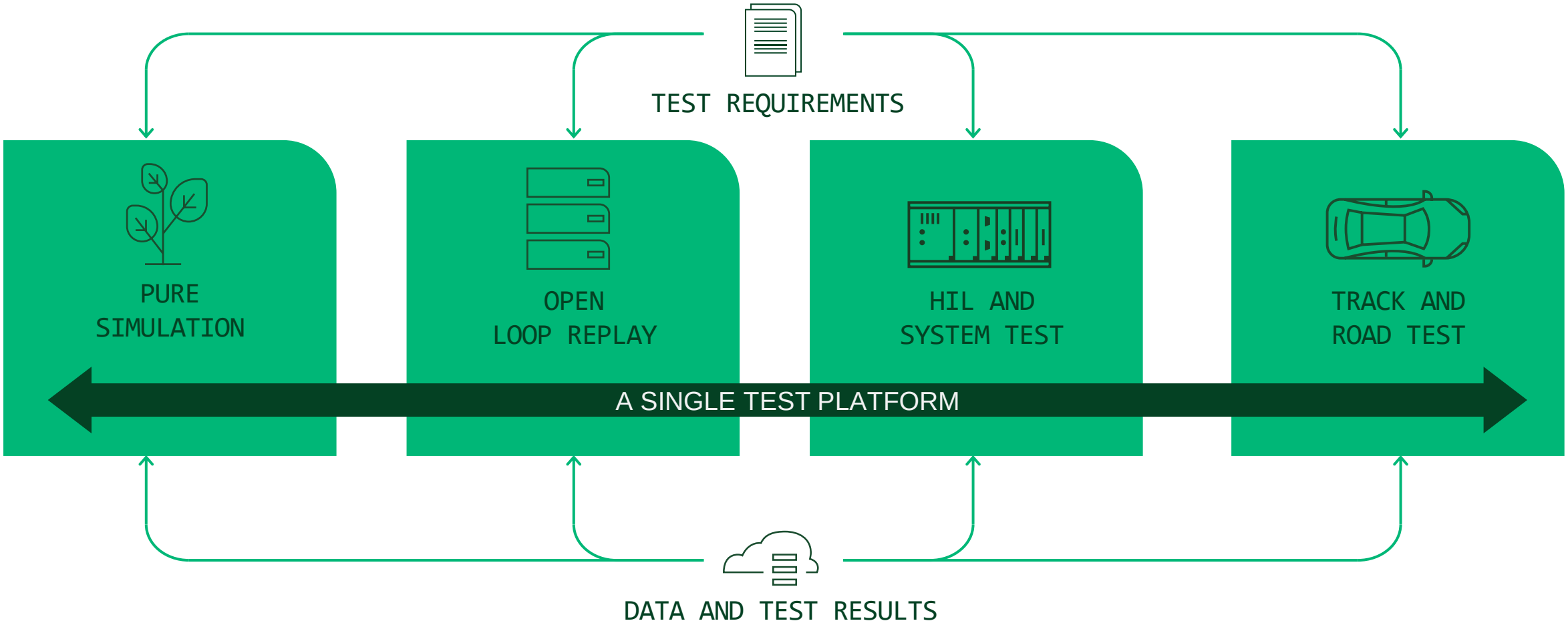


Partnerships – stronger together & enabling customer choice

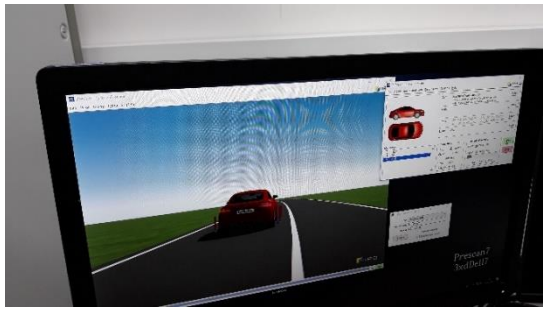
- Highly-representative vehicle model
- Advanced traffic and road simulation
- Intelligent driver model
- Integration platform
- Euro NCAP Scenarios Included
- Pharlap & Linux RT support for NI

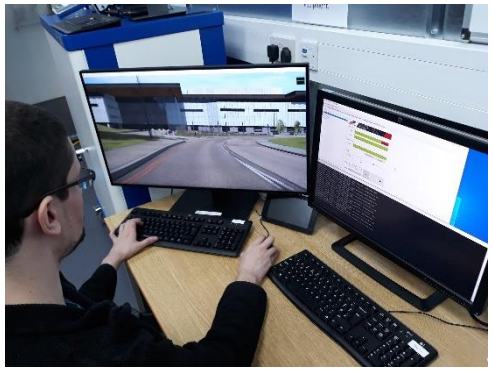
- Open, software-centric platform
- Expansive technology eco-system
- FPGA-enabled I/O
- Advanced RF & TSN capability
- Certain IPG M-Board support natively in VeriStand

Best Practice – Reused, Unified Test Architecture



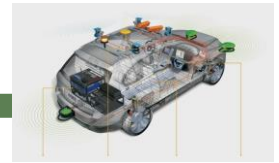
Achieving a Software-Connected Test Continuum





SIMULATION

HIL TEST
FUNCTIONAL TEST and REPLAY



Driving Simulators
& In-Vehicle Recording

Thank you!

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WMG

A Naik

NI