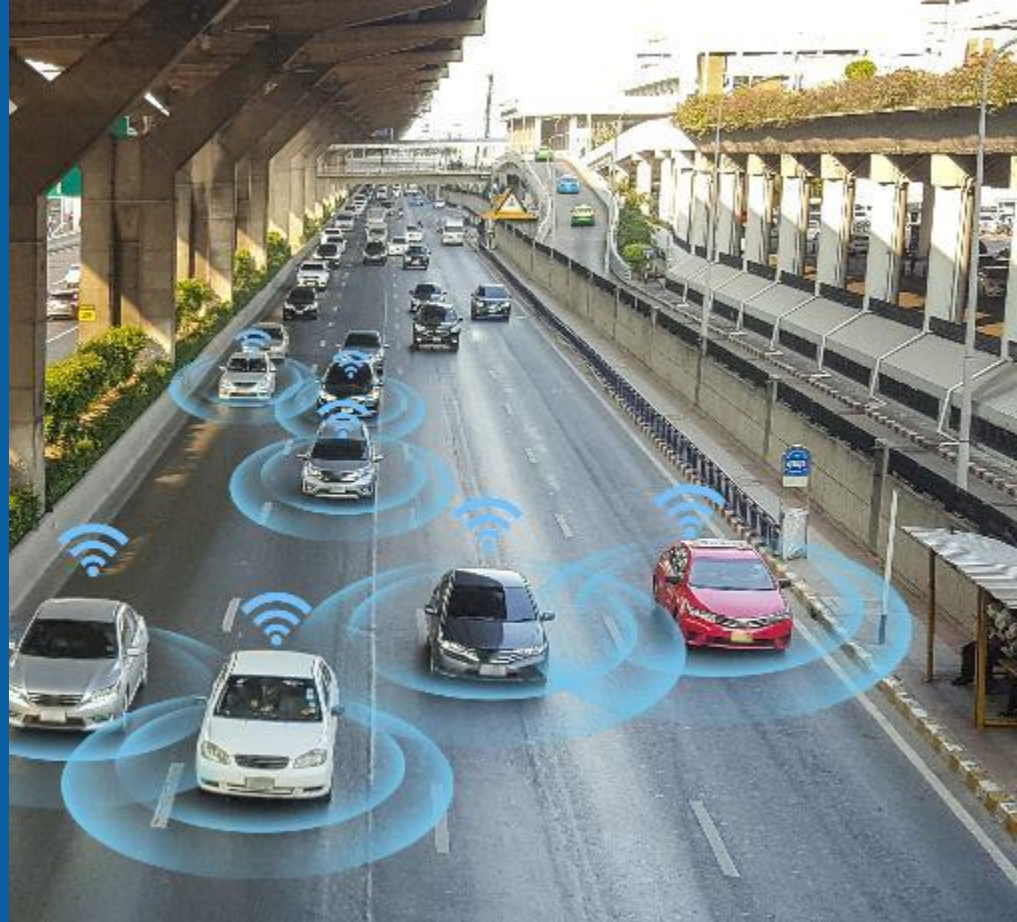


NI HIL Overview

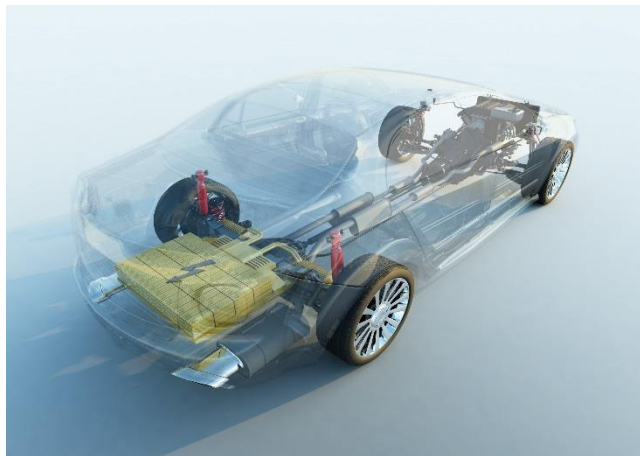
Prepared for Jaguar Land Rover

May 15th 2019



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JLR-NI Collaboration Workshop

Goal of this workshop

- Mutual understanding of ideal PT test workflow from design through validation
- Clarify and understand NI's capability today and future aspirations
- Prioritization of areas for collaboration to improve test

Outcome of this workshop

- Showcase areas of pre-qualified interest in NI's test capability
- Documented understanding of JLR's V&V workflow
- Agreed areas to follow-up together after workshop

JLR-NI Collaboration Workshop

Agenda (4 Hours)

- Introductions
- Overview of NI & Test Platform
- Discussion on workflow/major challenges today
- Powertrain Test Overview
- Coffee Break & demos
- How to build a NI HIL
- Lunch & Discussion
- Confirm Next Steps



Activities between NI and JLR

- Data management in powertrain
- Crash data analysis tools
- Infotainment test
- ADAS V&V
- Vehicle in the Loop
- BMS V&V
- VITAL (infotainment)

Short Introduction

- Name
- Role
- Key interest for today





OPERATIONS IN
50+ COUNTRIES

\$1.4

BILLION
IN 2018



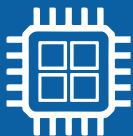
35,000+
CUSTOMERS WORLDWIDE



18%
INVESTMENT IN R&D

NI equips engineers and scientists with
systems that accelerate productivity,
innovation, and discovery.





Research Design
and Prototyping



Validation



Production Test



Fleet Maintenance

Leaders in Software-Defined Automotive Test
and Measurement Systems



Image source: PSA Peugeot Citroën

“By adopting open and scalable NI hardware and software platforms, we reduced a number of prototype systems by 30% and increased test bench usage by 100%”

—Gregory Gackel, Electronic Integration & Verification Manager, PSA Peugeot Citroën



SAAB Reduces Cost of Test with SLSC

“We chose an NI HIL test system because it is built on open, standard platforms that allowed us to reduce the overall cost of test and the long-term maintenance and ownership of our hardware. It also allowed us to customize the system to our exact needs, increasing the speed at which we could find and fix embedded software defects while integration testing LRUs for our Gripen fighter.”

—Anders Tunströmer, Technical Manager, Saab Aeronautics



“By adopting FPGA-based simulation using the NI hardware and software platforms, we achieved the simulation speed and model fidelity required for verification of an electric motor ECU. We reduced test time to 1/20 of the estimated time for equivalent testing on a dynamometer.”

—Mr. Tomohiro Morita, Subaru



SUBARU



Evolution of NI Automotive Business Strategy

Broad-Based Platform Instrumentation

- Leverage platform investments for automotive testing needs
- Differentiate on real-time data acquisition and processing
- Focus on technology first, applications second



Expand NI and Ecosystem Capabilities for Vertical System Integration

- Partner with automotive leaders to overcome test challenges
- Invest in automotive platform capabilities
- Strengthen our solution and service partner ecosystem



Delivering Customer Value

ACCELERATING TIME TO MARKET:

Software-defined platform promotes test platform flexibility and re-use

High-speed, real-time data logging, processing, and playback

Ubiquitous I/O including automotive sensors and high-voltage measurements

EARLIER INVESTMENTS IN CUTTING EDGE TECHNOLOGY:

18% of revenue invested in R&D

Deeply stable financials with ample cash

Earlier investment in areas of rapid technology change, such as electric vehicles and automated driving

SCALE:

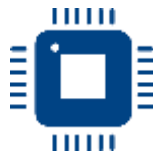
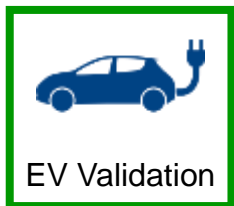
Accelerating inorganic investments to fill gaps – including global servicing

NI's test expertise can help you reduce capital expenses with faster test times and inherent flexibility

NI's Transportation Business Team

Collaborate with customers and industry leaders to eliminate test barriers and accelerate the future of Transportation – drastically reducing deaths, minimizing emissions, and improving quality of life

Key Collaboration Areas



Electronics Production Test



Radar Test



ADAS Validation



AV Research and Testing



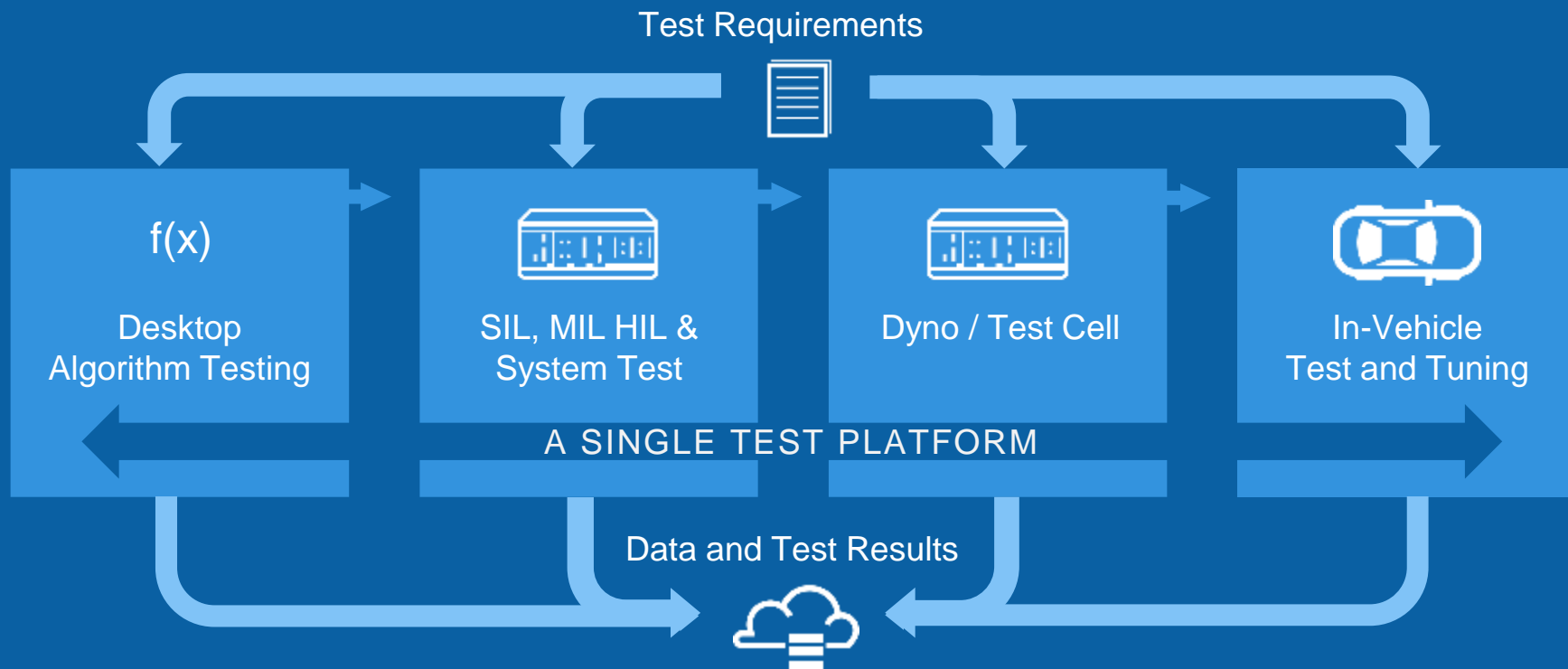
V2x Research

Unified Test Platform

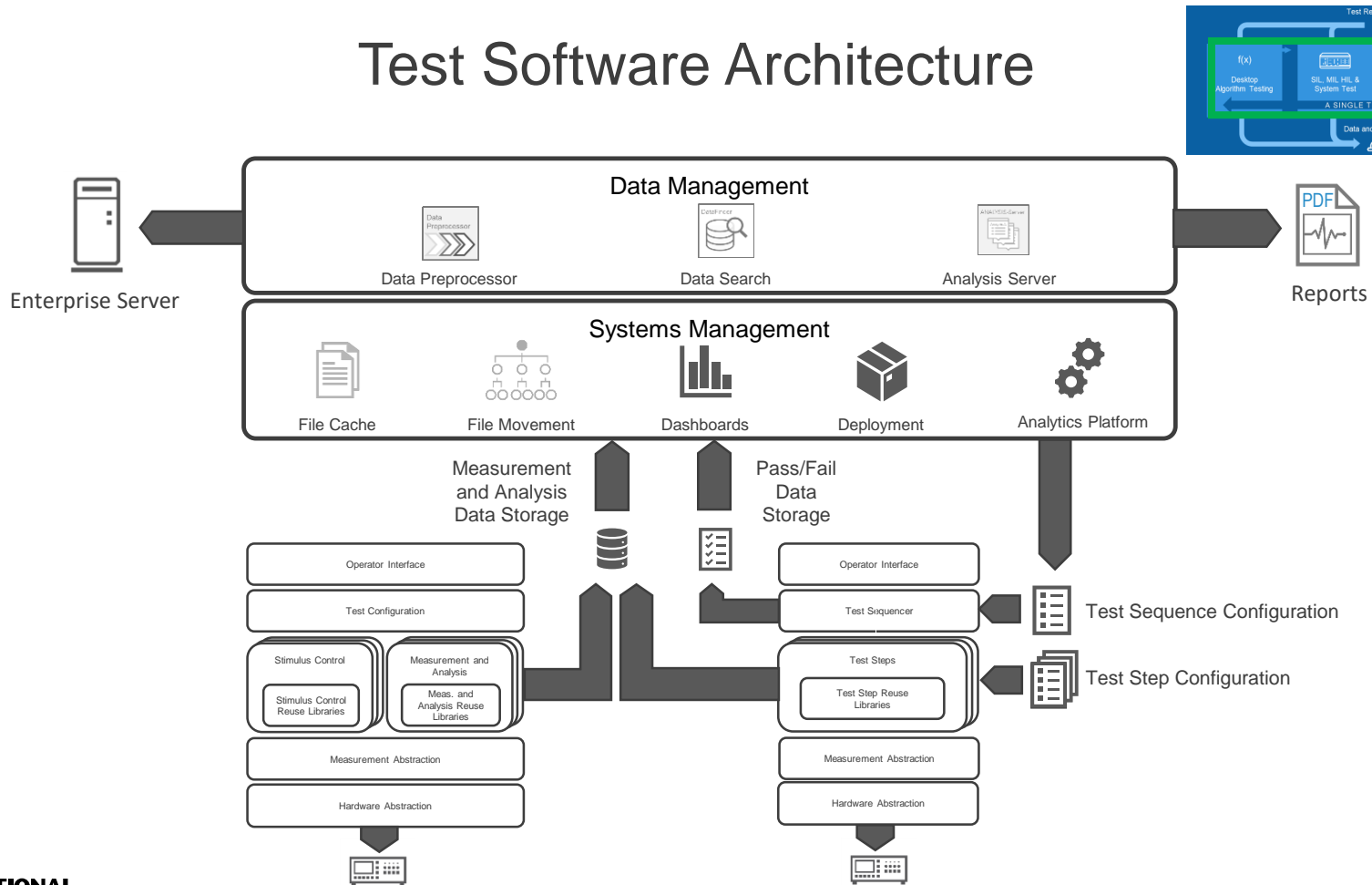
Summary of JLR Challenges

- Flexibility of HIL Systems
- Complexity of Validation task due to complex and fast changing customer requirements
- EV Validation not well supported with current tools
- Lack of commonality across different levels of testing and different modelling environments impedes rapid progress
- High cost and low efficiency / validation tool utilisation
- Validation process can be too manual
- Running simple tests on complex test systems (underutilising test asset)

Best Practice – Reused, Unified Test Architecture



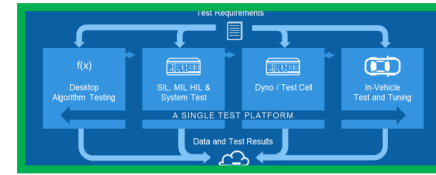
Test Software Architecture



Global Support & Training

Enterprise and Volume License Agreements

SIL/MIL/HIL Platform



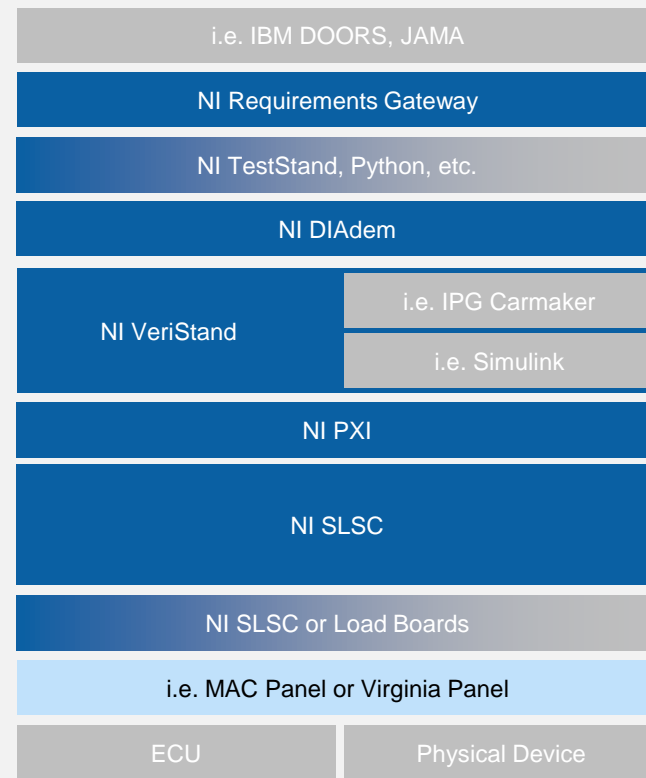
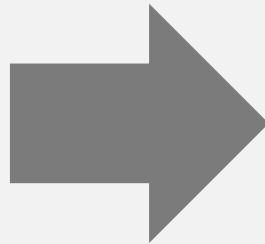
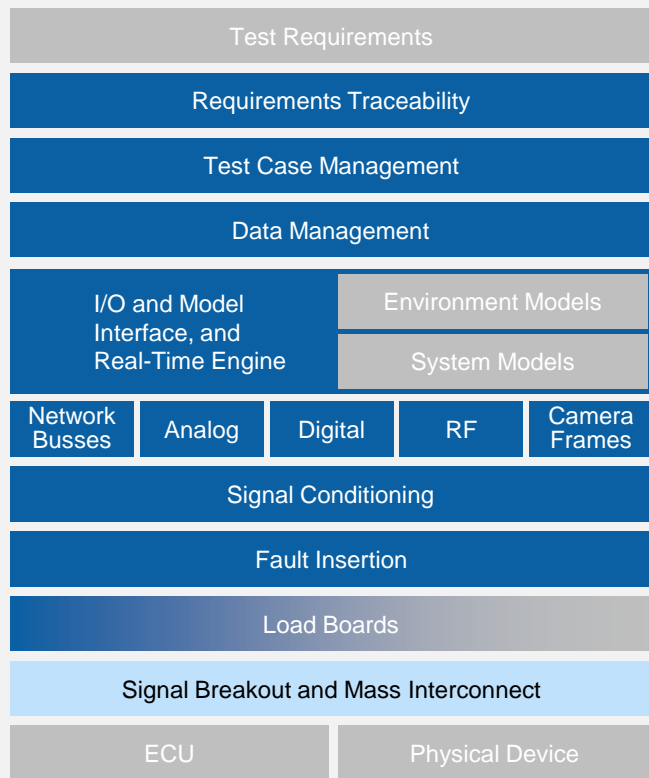

SystemLink[™]
Systems Management


Data Management Suite
Data Management

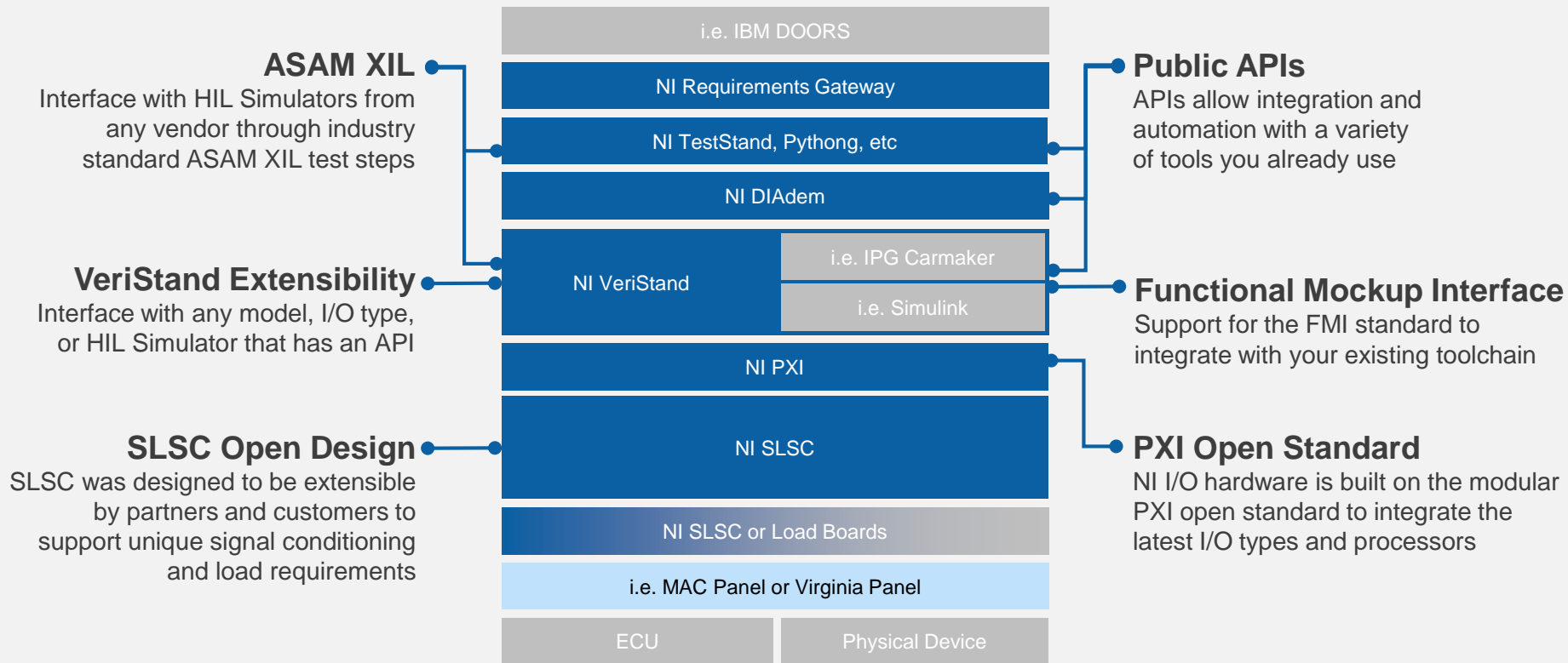

NI TestStand[™]
Test Case Management


NI VeriStand[™]
Real-Time Test Execution

Building a HIL System on COTS Components

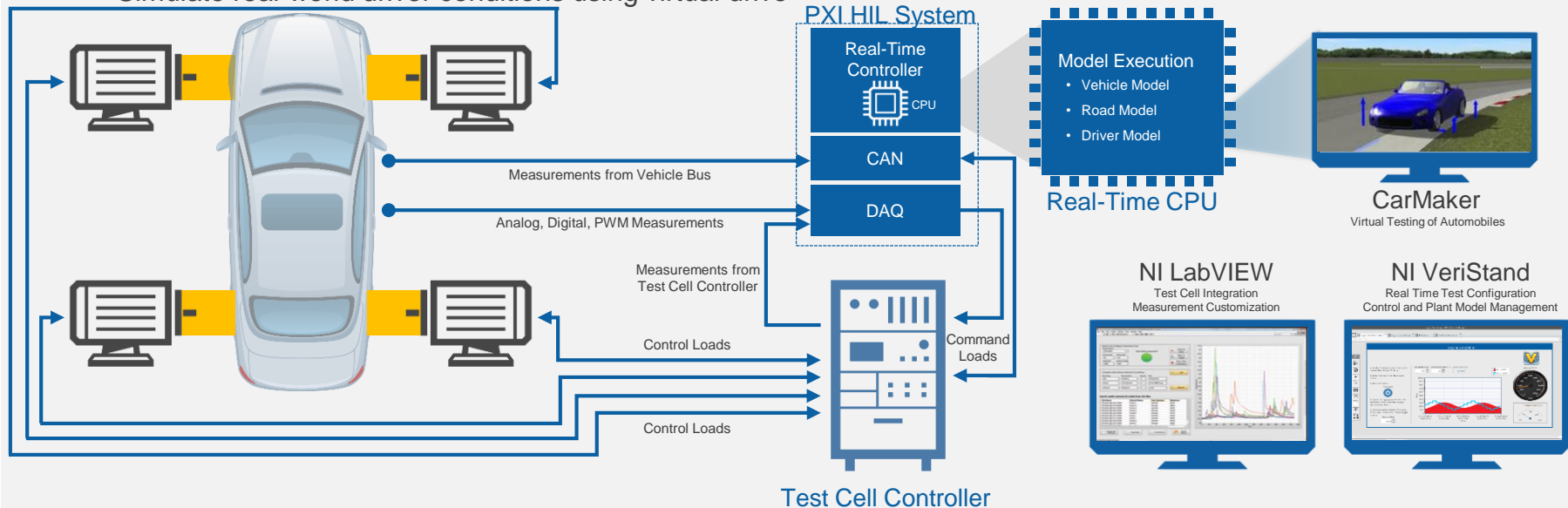
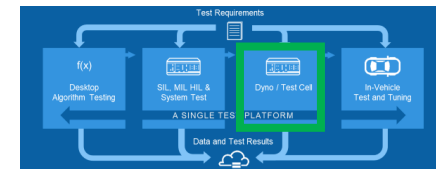


Built Around Openness and Interoperability Standards



System Performance Test (Model-based Test Cell)

- Real-time model execution (Vehicle, Road, and Driver)
- Dedicated motors for each wheel apply loads to wheels in real time
- Malicious Tests – conditions cannot be realized in field tests
- Easy to change conditions (ex. Icy road surface with a 30% gradient → change it to 40% instantly)
- Simulate real-world driver conditions using virtual drive



Vehicle Radar Test System (VRTS)

Features At A Glance

Radar Obstacle Emulation:

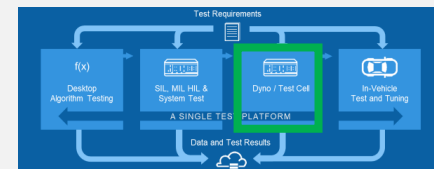
- Velocity, Range, RCS, and Angle of Arrival

Sensor Fusion Algorithm Tests

- Tight Synchronization with other PXI Instruments and Automotive Bus Communication

Parameter	Specification for Bi-static
Number of obstacles	1 to 4 per PXI chassis
Distance between VRTS and DUT (L1)	0.7 m - 3 m
Distance range (L2)	4 m - 300+ m
Resolution	10 cm - 12 cm
Accuracy	± 15 cm
Doppler range	0 to ±500 km/hour (75 kHz)
Resolution	0.1 km/hour (15 Hz)
Accuracy	± 0.05 km/hour typical (7.5 Hz)
Radar cross-section (RCS)	85 dB (-10 dBsm to 75 dBsm) typical
Fixed amplification	60 dB
Attenuation control	50 dB minimum
Resolution	0.25 dB
Tx Output Power (with +10dBi horn)	+20 dBm nominal
Phase Noise, 77 GHz at 100 kHz Offset	-85 dBc/Hz typical

All specifications subject to change



Vector Signal Transceiver
(PXIe-5840)

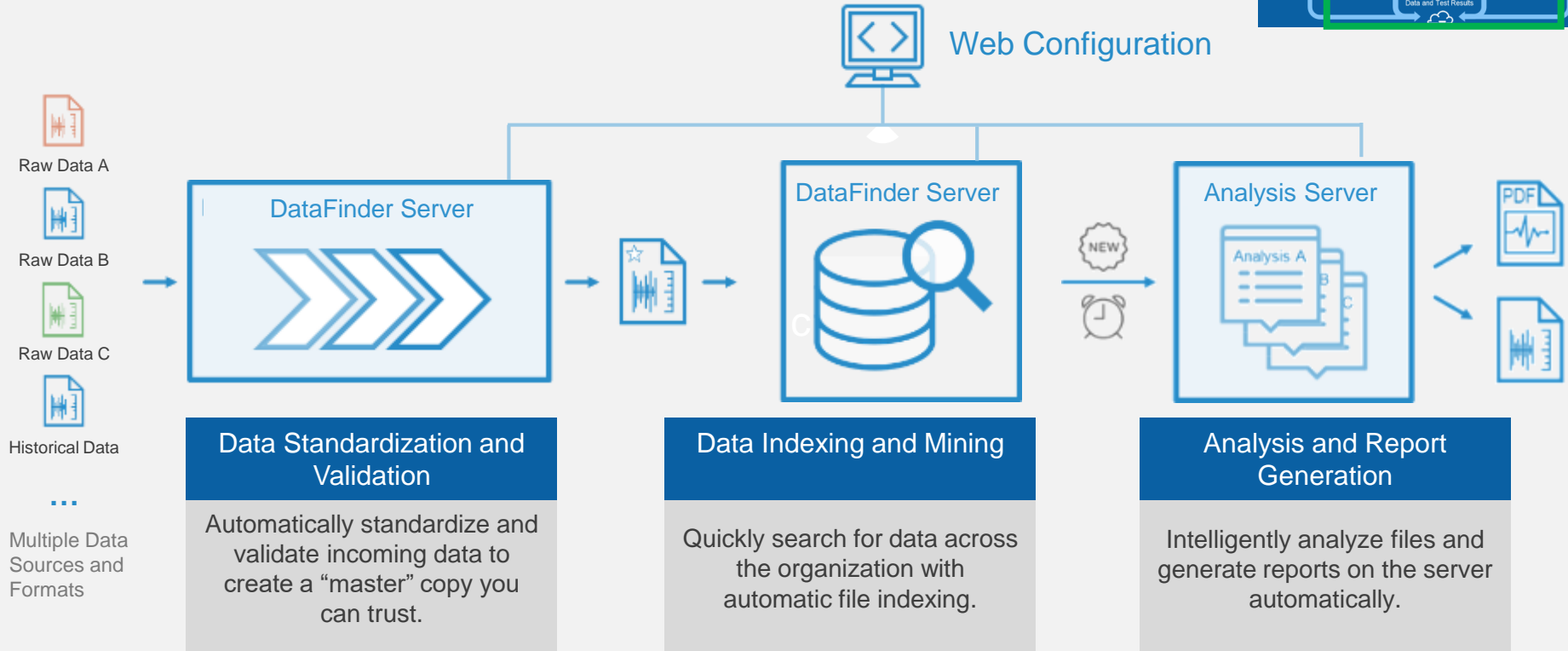
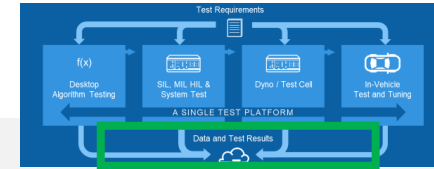
Variable Delay Generator
(NI-5692)

mmWave Transceiver
(mmRH-3608)

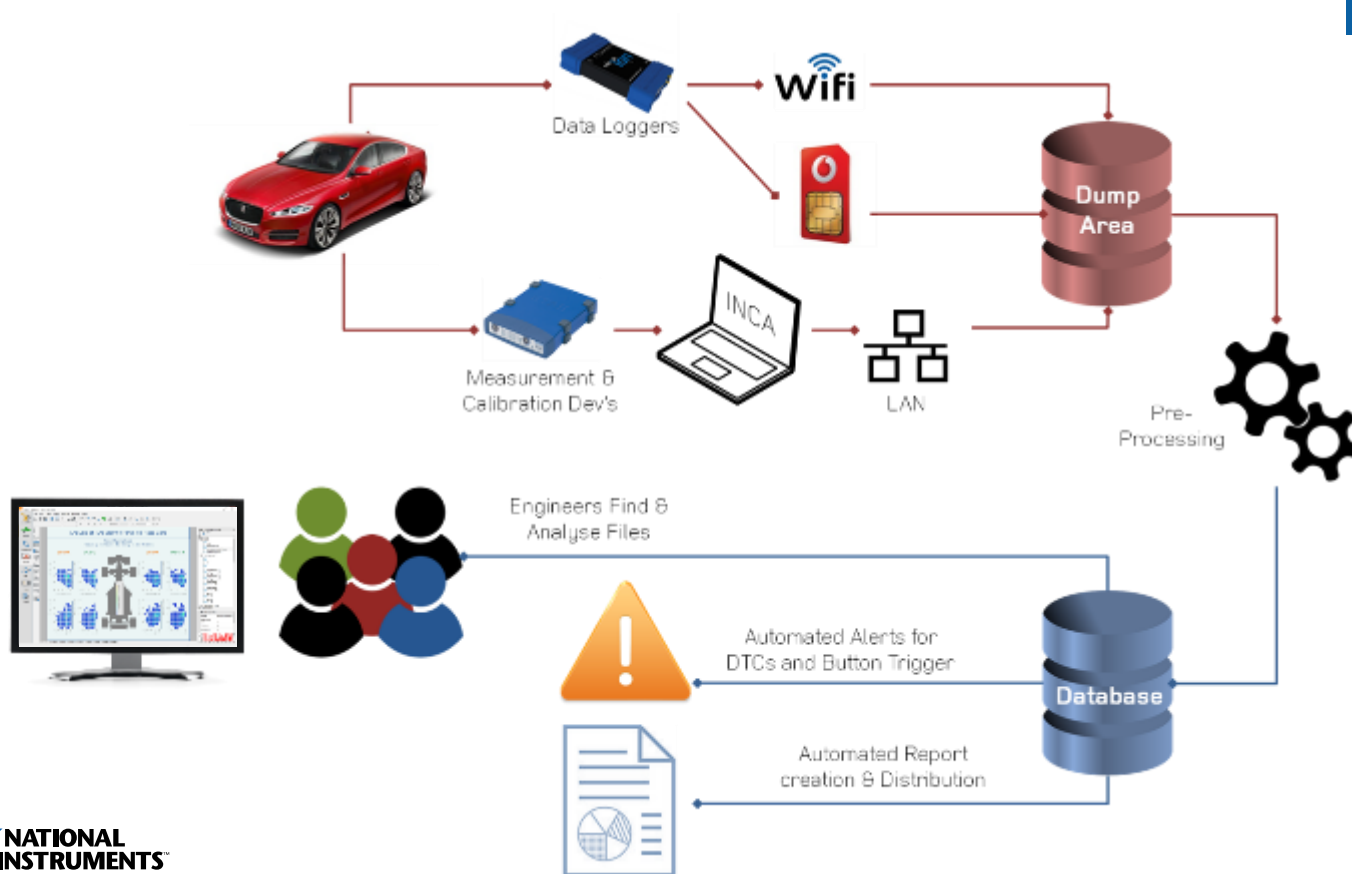
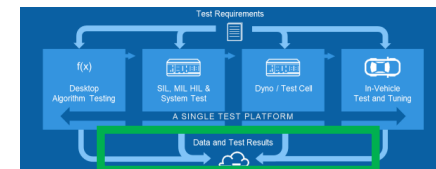


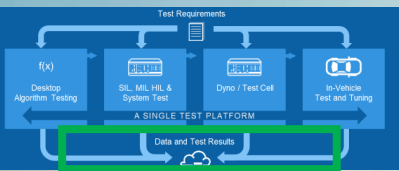
The NI VRTS is a flexible test system that combines PXI hardware with modular millimeter wave radio heads

Automated Data Management Workflow



JLR: End to End Test Data Management





Improve Product Design and Validation Through Connected, Real-World Data

Jaguar Land Rover implemented an enterprise data management solution based on DIAdem and DataFinder Server Edition to manage and analyze up to 500 GB of time-series data per day. As a result, it increased the amount of data analyzed from ~10 percent to over 95 percent.

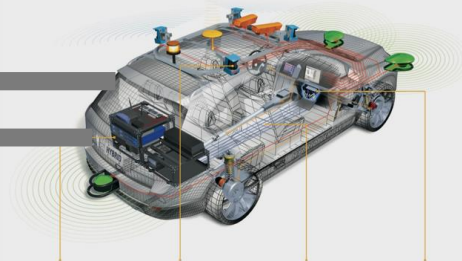
Use A Combination of Simulation, HIL, and Road Data



SIMULATION



HIL TEST
FUNCTIONAL TEST PLAYBACK



ROAD TEST
DATA RECORDING

JLR Test Coverage Model

?? %

Testing Scenarios

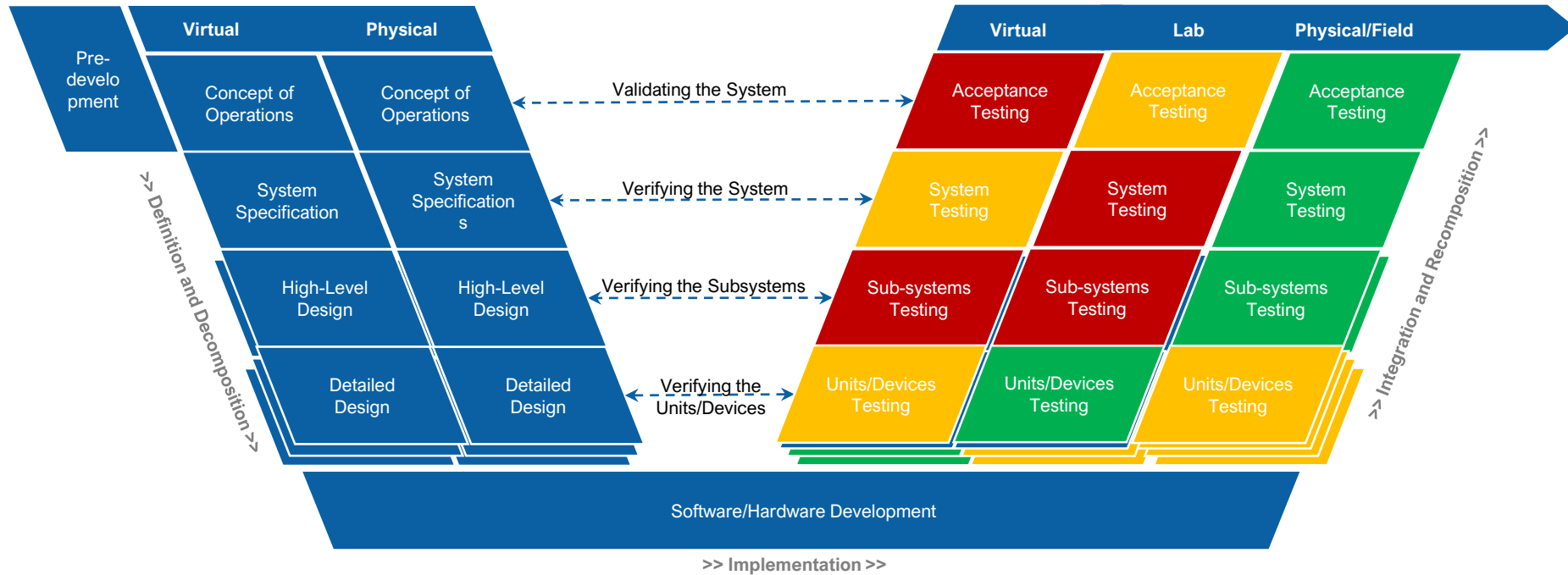
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Testing Scenarios

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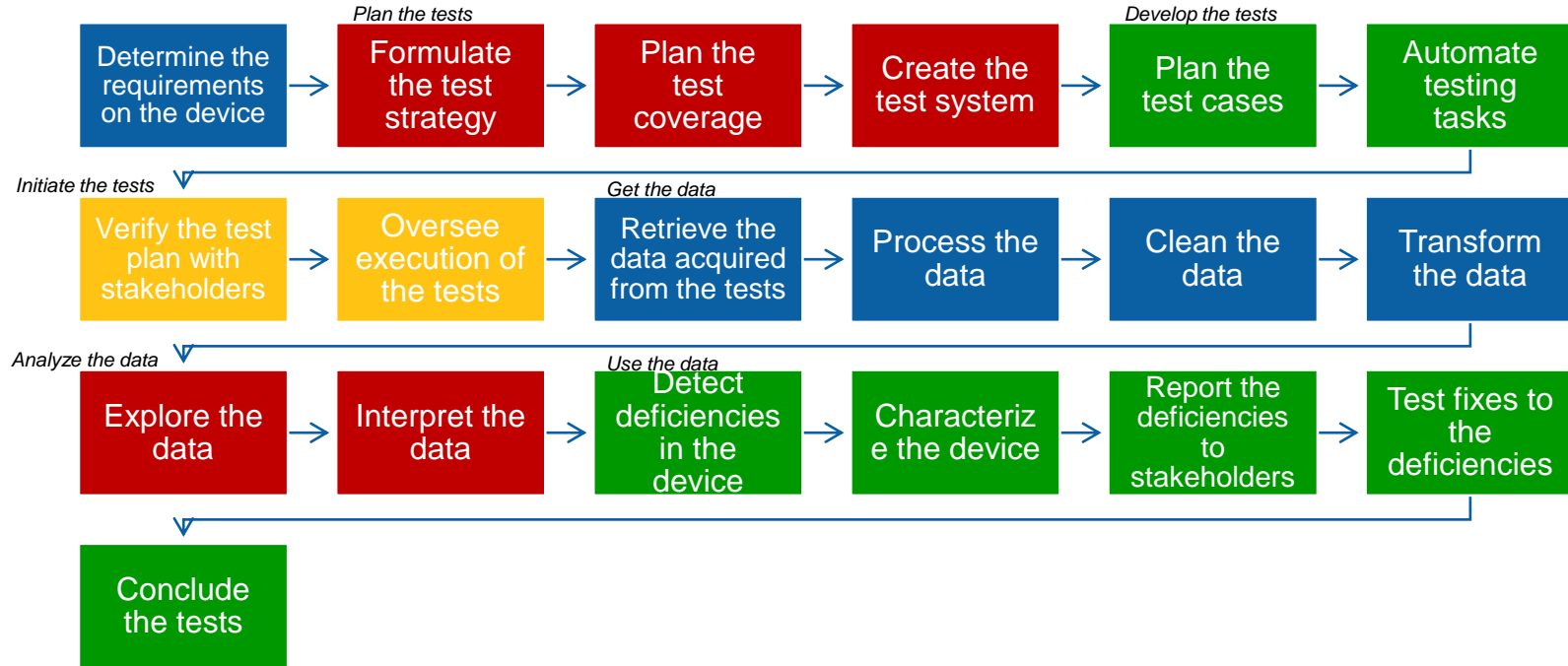
Testing Scenarios

Example Assessment of Customer's V&V Capability



The goal is to optimise the balance of test across the grid

Example Assessment of Customer's V&V Workflow

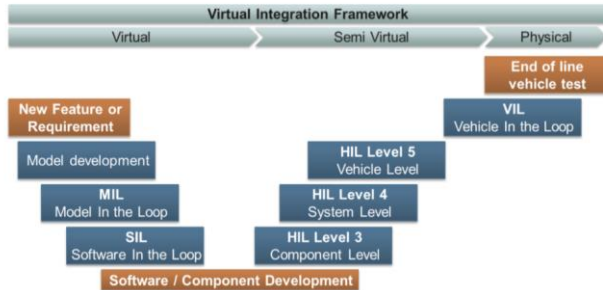


JLR – Electrical / Powertrain?

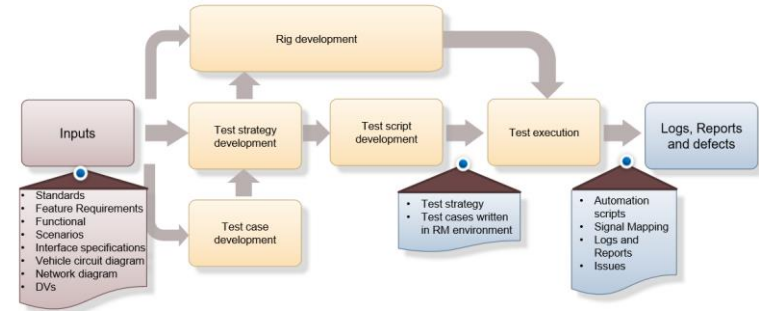
HIGH LEVEL MBPE PROCESS



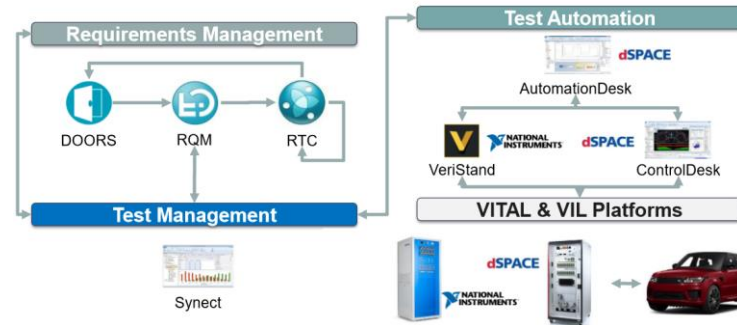
• Internal Standards for Model & Software V&V



HIGH LEVEL TEST PROCESS



SYSTEM INTEGRATION TESTING TOOL WORK FLOW



Coffee Break & Demos

- Signal Level Inverter HIL Test System
 - NI PXI, FPGA HW and VeriStand to run motor and inverter models in real time at high loop rates ~200MHz
- NI HIL with CarMaker – Adaptive Cruise Test
 - See NI VeriStand and CarMaker linked to perform closed loop control to test Adaptive Cruise SW.
- Mixed Supplier HIL systems
 - How to use NI HIL along side 3rd part HIL systems using the ASAM XIL API.

