Create Seamless Design-to-Test Inverter Validation Workflows

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Test Approaches Along the Design Lifecycle

Design World | **Simulators/Emulators** | **Lab/Test Cell/Track Controlled Testing** | **Real World Trials**

PURE SOFTWARE TESTING — PURE PHYSICAL TESTING

Lower cost, faster, less dependencies, but lower fidelity and introduces simulation/emulation complexity

REALISM →

← FLEXIBILITY

Higher fidelity but more expensive and time consuming

GOAL

Confidently Test Earlier in the Development Cycle

Increasing ability to choose scenarios
Flexibility to test different technology
Less dependence on real system availability
Accelerate test (faster than real time)

INCREASING COST, RISK, TIME TO FIX, AND EFFORT

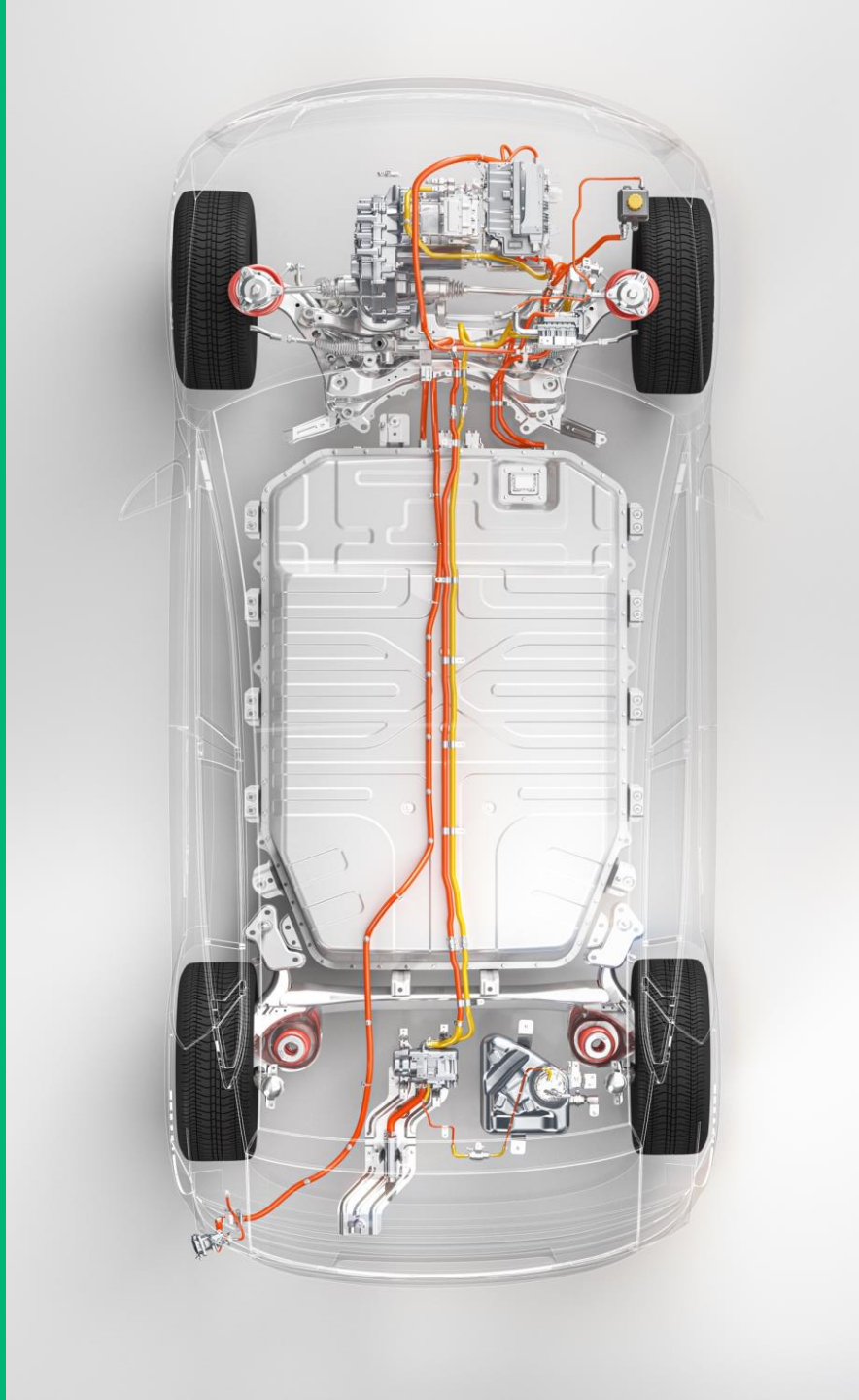
Unique Challenges of EV HIL

Near impossible to achieve complete automated test coverage with conventional dynamometers and road testing

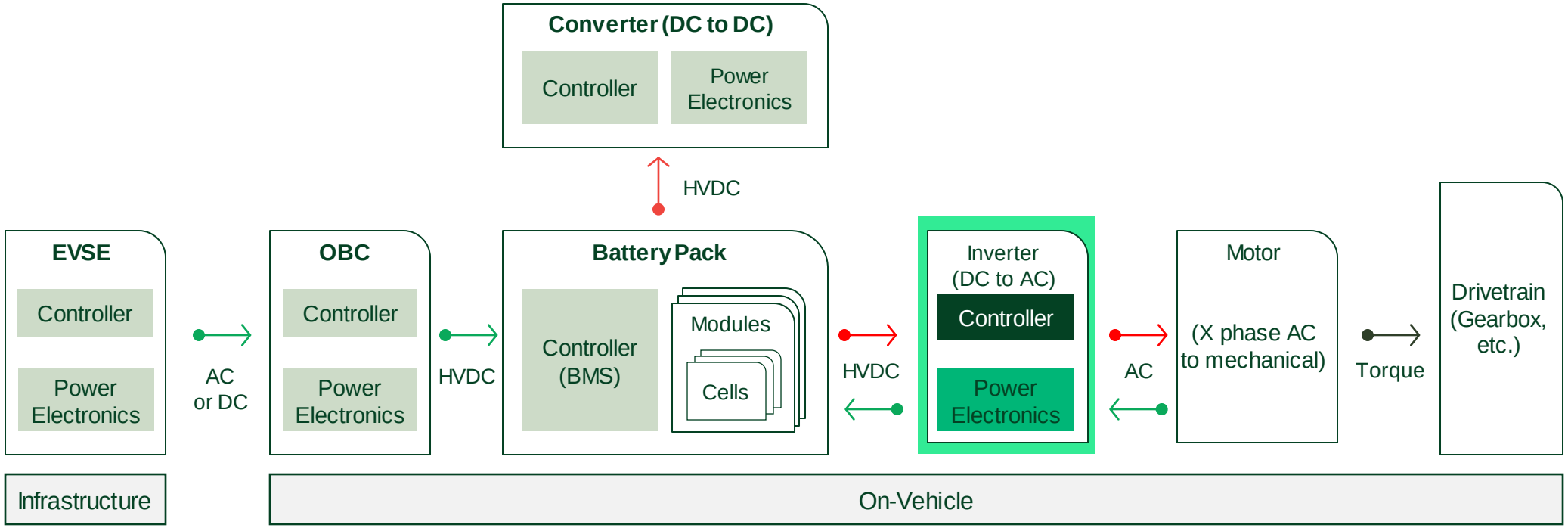
Fast dynamic response of power electronics inverters and motors makes conventional HIL Test systems unsuitable for EV HIL

Power electronics simulation should be at least 100x faster than inverter switching frequency to achieve 2% accuracy

10kHz switching frequency = 1MHz simulation



EV Traction Inverter



Testing Enabled Through HIL

Validate ECU performance over a wide range of parameter variations to achieve full test coverage

Verify ECU functionality in range of conditions, including extreme environments not easily created or replicated in the real world

Map test cases to requirements to ensure complete test coverage

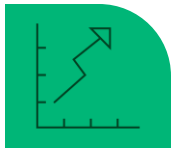
Perform regression tests with ease to quickly validate design iterations

- Control Tuning
- Fault Handling
- I/O Validation
- Parameter Variation
- Control Performance Analysis
- Control Stability Analysis
- State Machines
- Thermal Management
- Performance Mapping
- Sensor Failure
- DUT Bring-Up
- Safe Operating Regions

Top Priorities for NI Inverter Test System

Minimize the time and complexity for the test engineer

- When mapping the test and DUT needs to the required hardware
- Configuring the IO and signal paths in the tester
- Getting initial DUT communication working for “Hello World” (fault free DUT-tester setup)
- Getting models integrated into the tester toolchain



Improve model performance and integration with The MathWorks Simulink™ tools

NI SOLUTION

Inverter Test System

Signal-Level Traction Inverter Validation

HIL Real-Time Powertrain Simulation

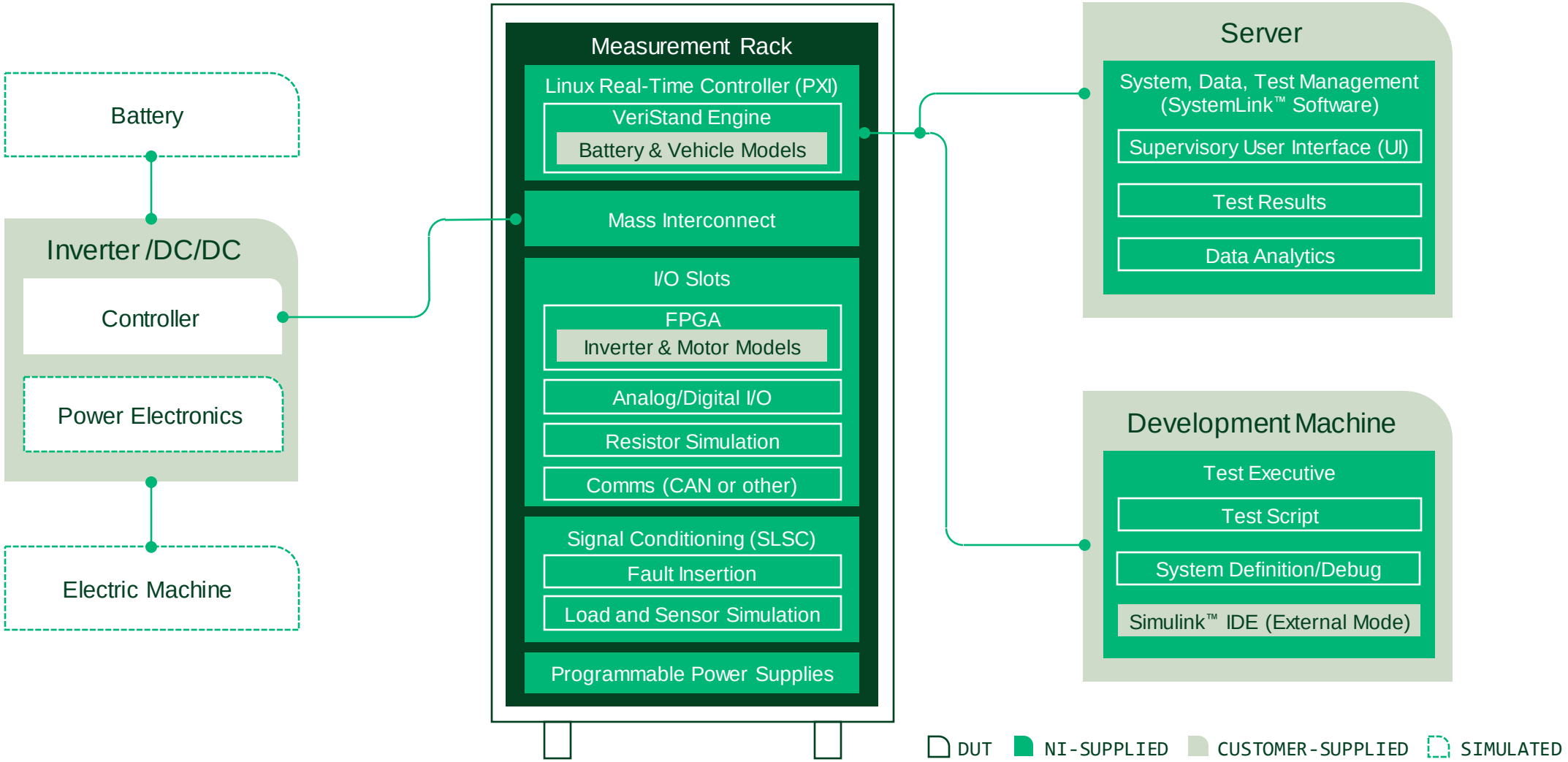
1 or 2 DUT Configurations

Integrated Model Workflow

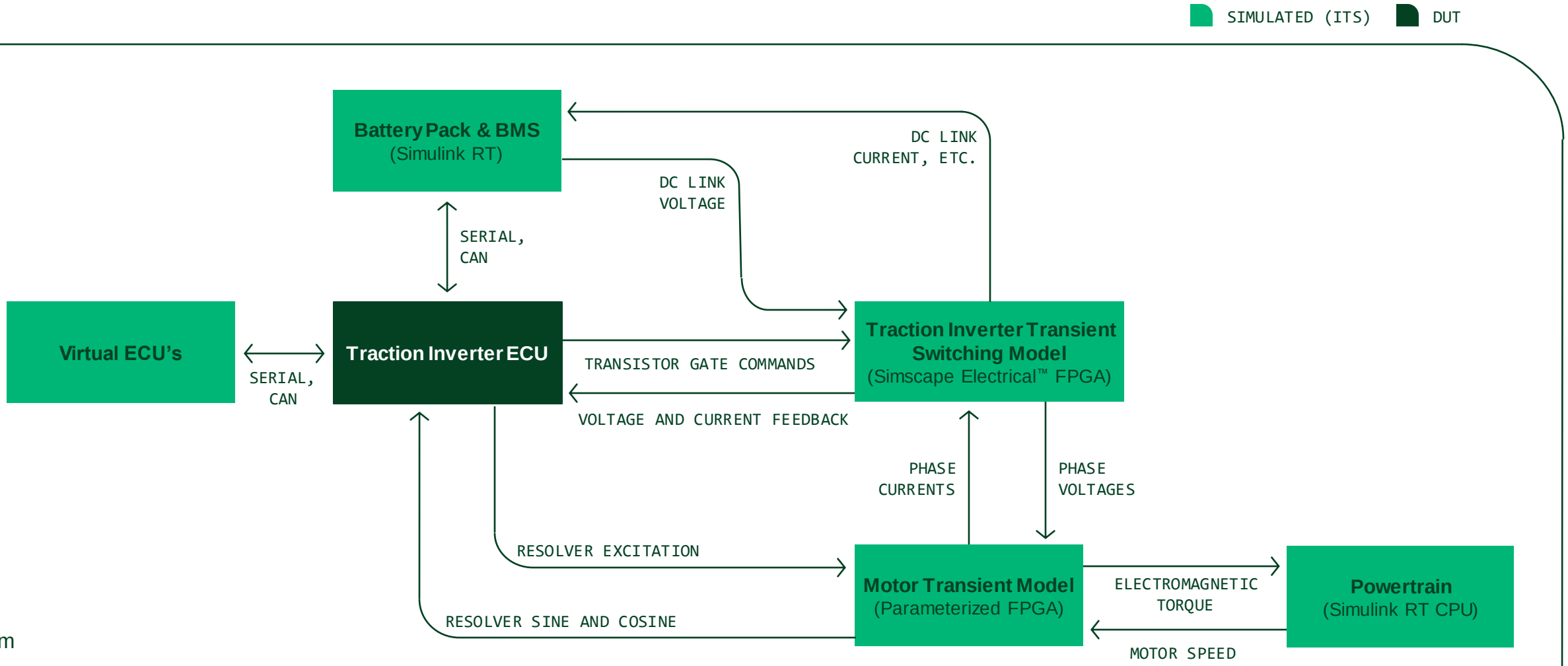
Signal Banked Mass Interconnect

Faster Deployment and Procurement

NI Inverter Test System Diagram



NI ITS Traction Inverter HIL Test

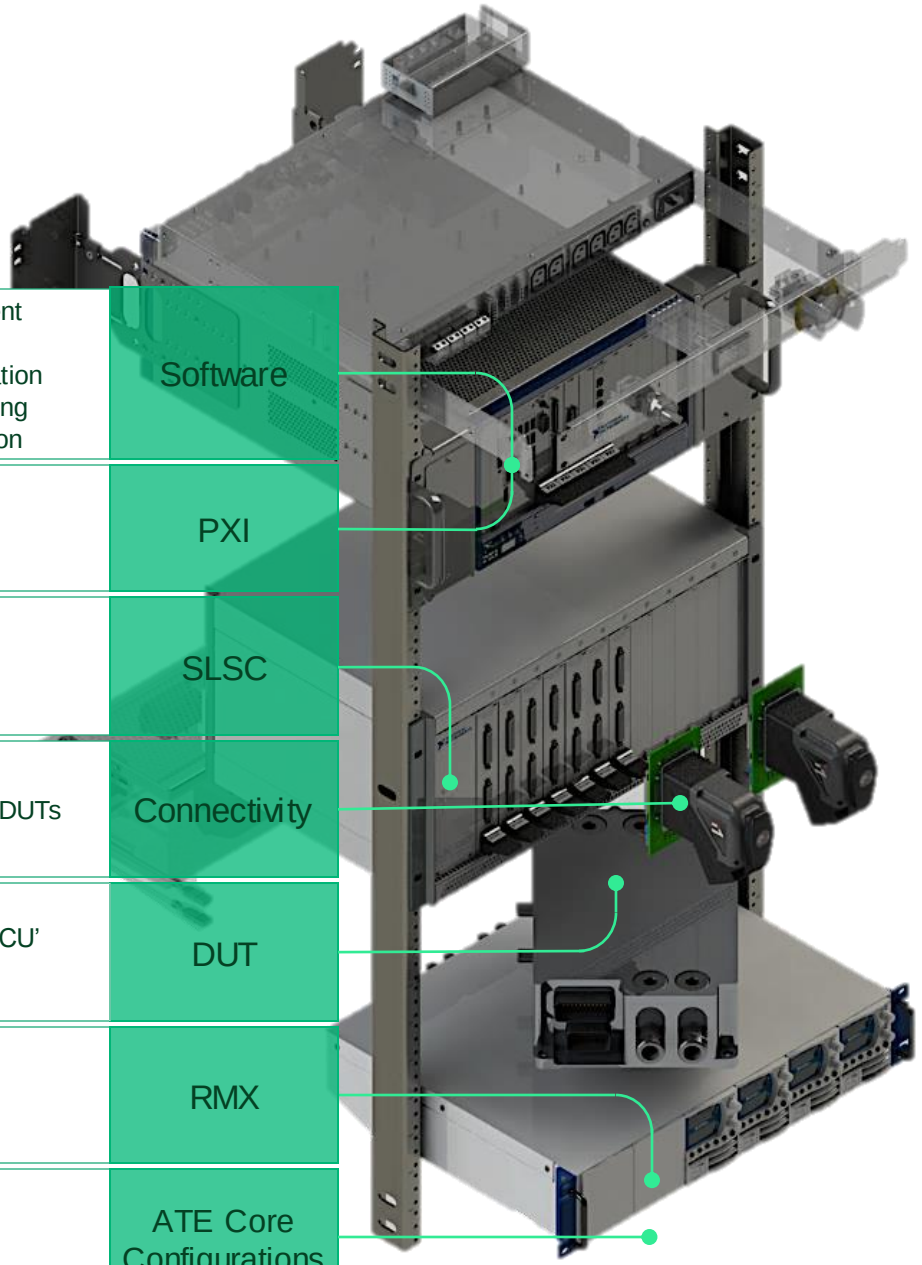


NI ITS Architecture & Advantages

NI Inverter Test System Summary

Customer Defined, Flexible & Scalable, High Performance, Open For Integration

SystemLink – data and system management TestStand – test executive VeriStand – real-time test and model integration Opal-RT add-on – FPGA based PE modeling LabVIEW – programming and customization	Software
Measurements and I/O Communications Power Electronics Models in FPGA	PXI
Switch, Load, Signal Conditioning for fault insertion and routing signal paths. Ease of connection and wiring.	SLSC
Cabling references for flexible connections to DUTs	Connectivity
Traction inverter 'control board' aka 'MCU/VCU' aka 'cracked inverter'	DUT
Programmable loads and DUT power	RMX
Complete Test Systems Delivered	ATE Core Configurations



ITS ARCHITECTURE & ADVANTAGES

NI VeriStand

Embedded Test Software Functionality

RT Stimulus Generation

Hardware I/O

Alarming

Deterministic Model Execution

MATLAB® and Simulink® Support

Mapping and System Visualization

Multi-chassis Synchronization

Closed-Loop Control

Data Logging

Test Automation

Calculated Channels

User Account Management

Multi-chassis Data Sharing

Scaling and Calibration

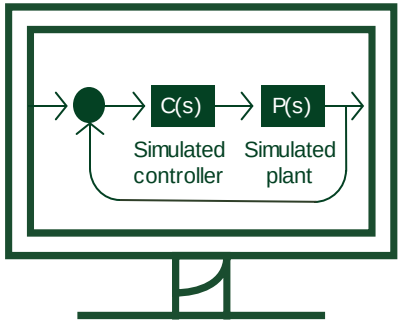
Model Based Development

MODELS

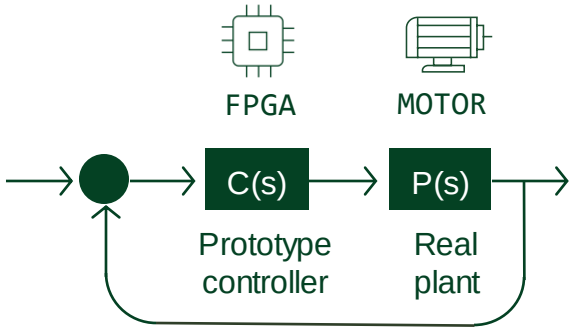
CONTROLS ENGINEER ⟷ TEST ENGINEER

Model in the Loop	Software in the Loop	Signal Level Hardware in the Loop (HIL)

Design

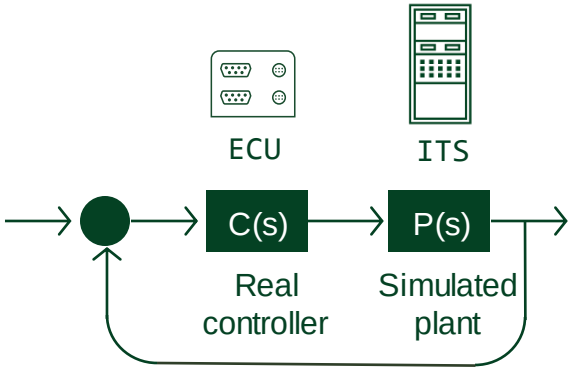


Prototype



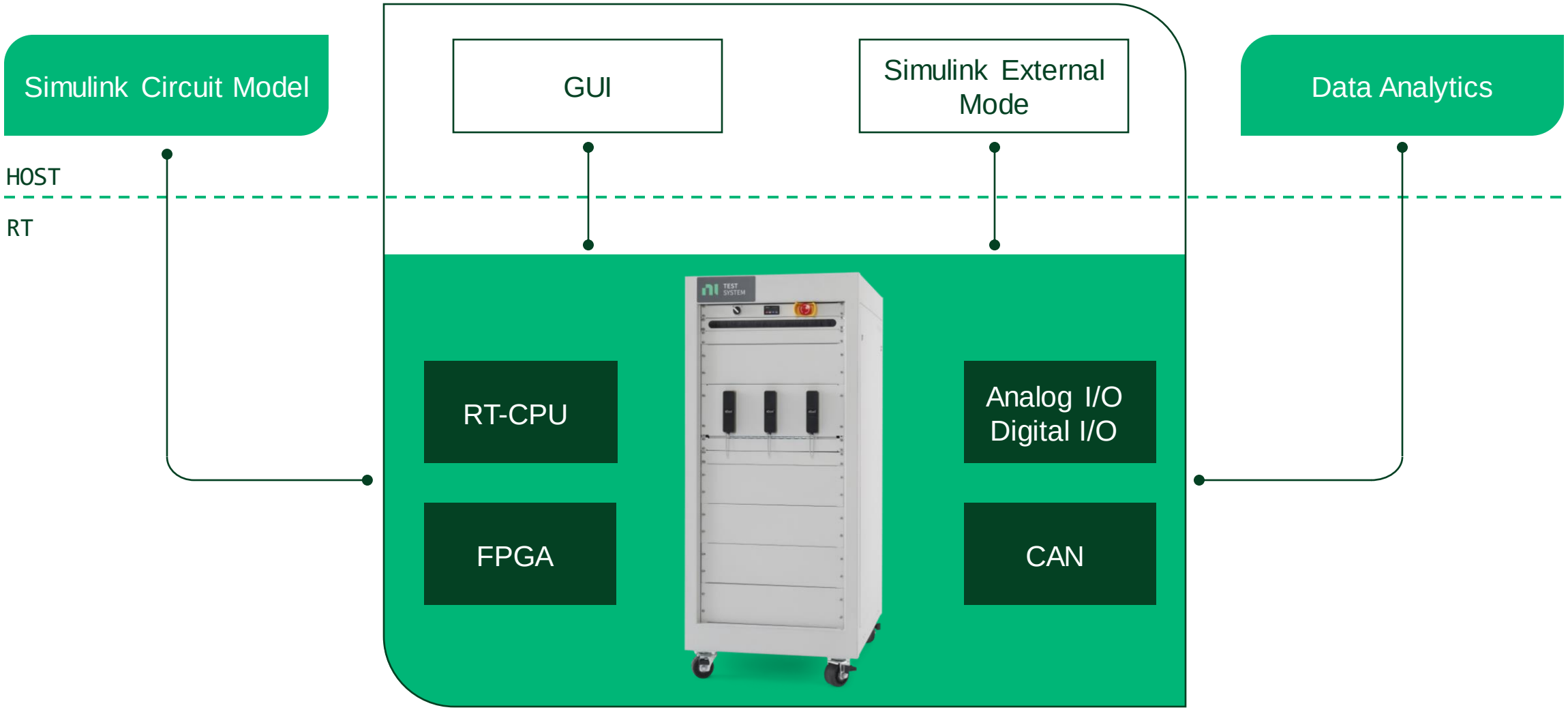
Software and Controller Test

HIL, Functional Test, etc.

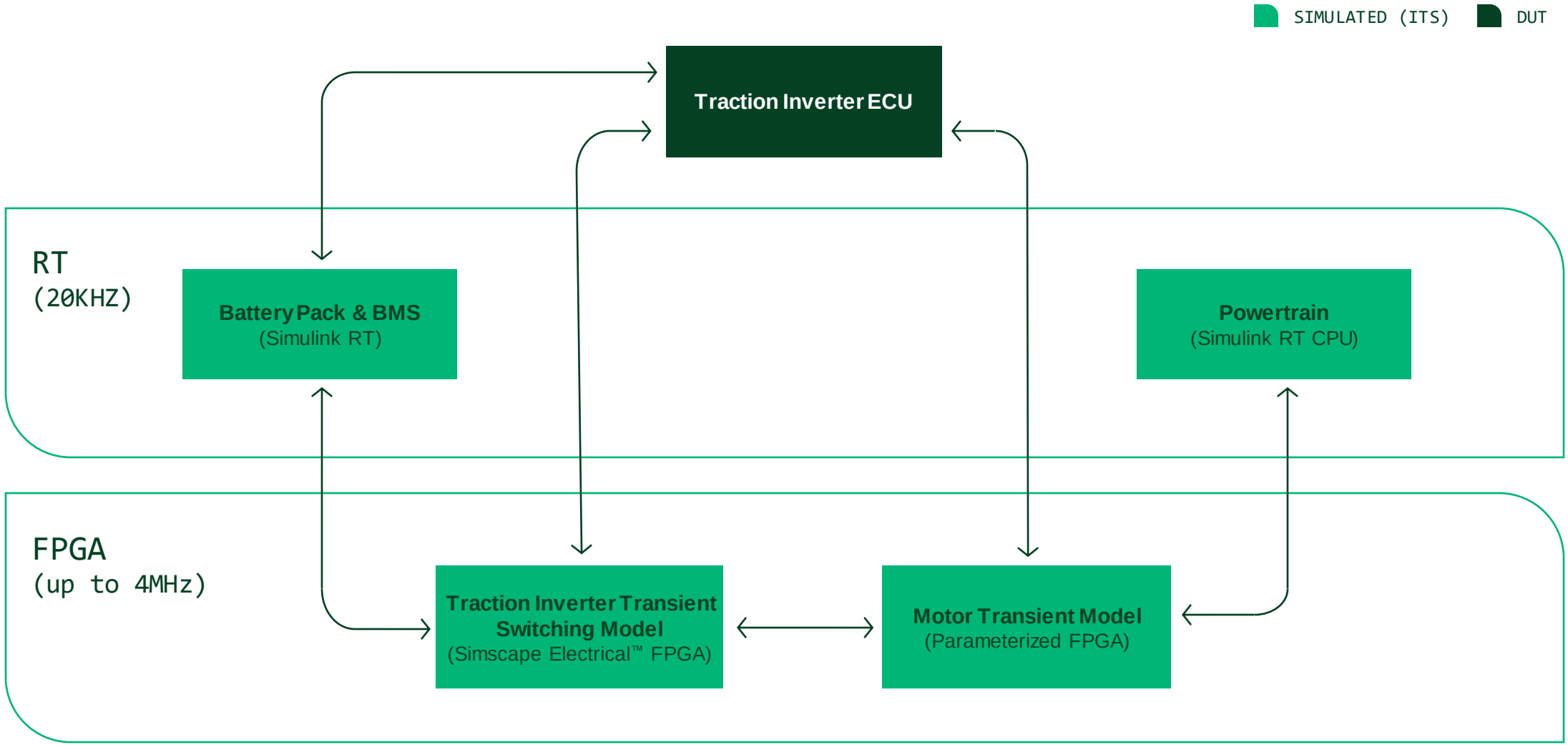


ITS Model Integration

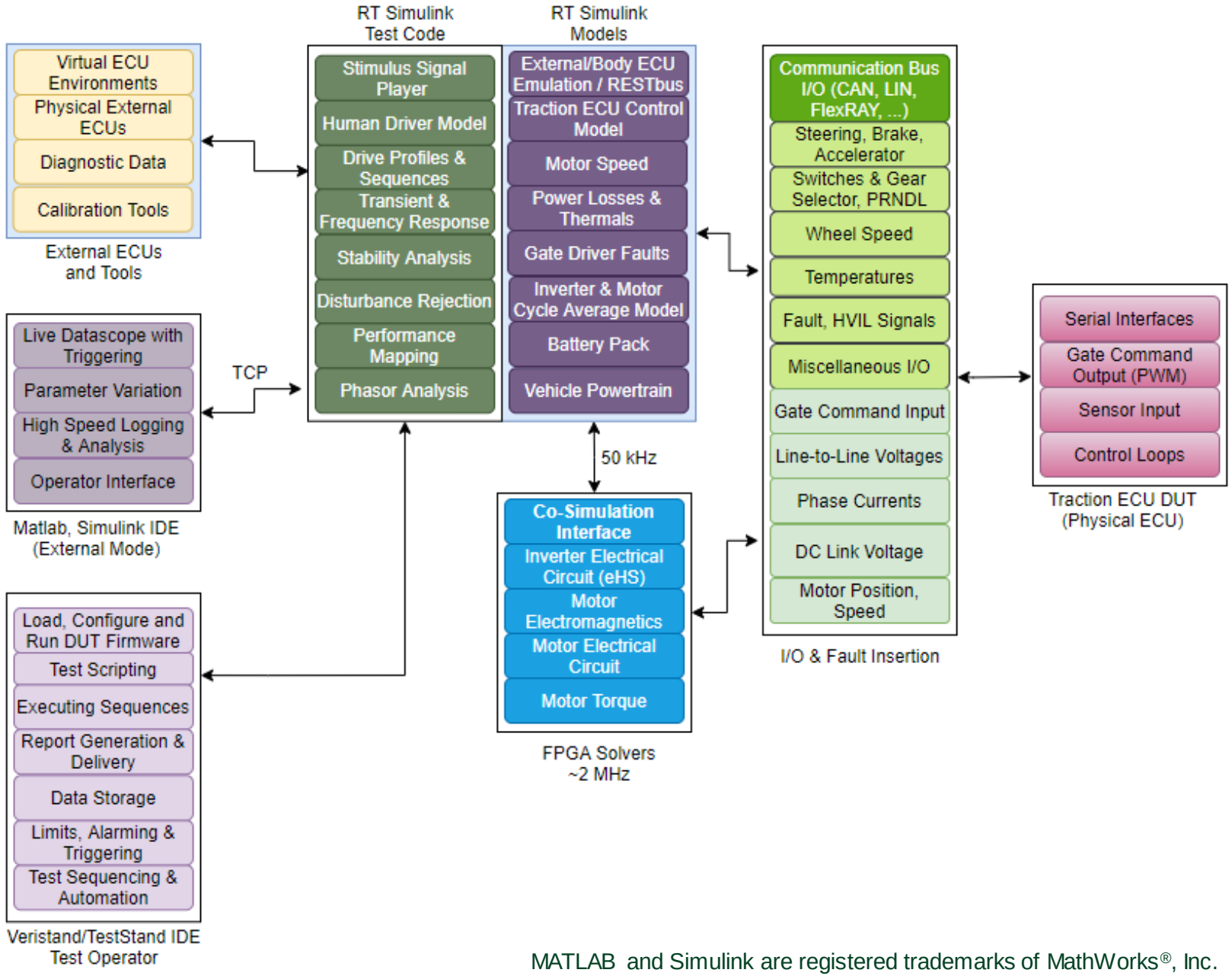
SIMULINK EXAMPLE



Model Co-simulation



ITS Components



Demo

ITS Getting Started and Model Integration Experience

ITS Benefits for EV HIL

- Model Integration
- Advanced Compute
- I/O Breadth
- Customizability
- Integration

NI Offerings Along the Inverter Design Lifecycle

Reduce Development Time and Improve Engineering Efficiency Through Model Reuse

Powertrain and Vehicle Models

Model-in-the-loop
Software-in-the-loop

Signal-Level HIL
sHIL

Power-Level HIL
pHIL

Test Cell – eDyno
Physical Testing

Field
Test

Next Steps

Learn More

View the ITS Webinar

Contact Us

Hardware-in-the-Loop Testing of EV Traction Inverter ECUs