



VIRTUAL DEVELOPMENT

by efs

FROM IDEA TO
ROAD WITHOUT
THE PROTOTYPE
DETOUR

INTRO

Three connected capability areas that let development teams test and integrate ECU software long before the first prototype exists. Physical-based models, virtual buses and networks, and simulation-based test benches.

KEY FACTS

- Physical-based virtual models: vehicle dynamics, traffic flow, energy supply.
- Virtual buses and networks for SIL test automation.
- Simulation-based HIL test benches with virtual models and physical buses.
- Validated models released via automated build pipelines.
- End-to-end coverage from MIL through SIL, PIL and HIL.

THE CHALLENGE

Hardware-first development is slow, expensive and finds defects too late.

WHERE TEAMS LOSE TIME

- Prototypes ready months after architecture is fixed. Late-stage defects cost the most.
- HIL rigs are scarce and expensive. Access is a scheduling problem.
- Test scripts written separately for each environment (MIL / SIL / HIL).

THE SOLUTION → VIRTUAL DEVELOPMENT

Three connected capability areas covering the full virtual development chain. Physical-based virtual models from validated equations, released via automated build pipelines. Virtual buses and networks for SIL software-in-the-loop. Simulation-based test benches with HIL systems and ECUs in the loop. The same test setup adapts across MIL, SIL, PIL and HIL with continuous data flow.

PHYSICAL-BASED MODELS

- Vehicle dynamics
- Traffic flow
- Energy supply

VIRTUAL BUSES & NETWORKS / SIL

- vECU
- Network description
- Sensor model
- Scenario

TEST AUTOMATION + VIRTUAL TESTING

SPECIFICATIONS & USE CASES

TECHNICAL SPECIFICATIONS

CAPABILITY AREAS

- Physics-based models
- Virtual buses & networks
- Simulation-based test benches

MODEL DOMAINS

- Vehicle dynamics
- Traffic flow
- Energy supply
- Custom

MODEL PROPERTIES

- Validated
- Modular
- Released via automated build pipelines

SIL COMPONENTS

- vECUs
- Network descriptions
- Sensor models
- Scenarios

HIL COMPONENTS

- ECUs in the loop
- Physical buses
- Networks
- IO

TEST LEVELS

- MIL
- SIL
- PIL
- HIL
- vPIL

USE CASE

EARLY ARCHITECTURE VALIDATION

Validate architecture decisions on physical-based models months before the first prototype. Defects caught in the model phase, not on the test track.

USE CASE

CONTINUOUS INTEGRATION OF ECU SOFTWARE

Nightly regression across SIL and HIL with shared scenarios. Build pipelines stay green at the system level, not just at the unit level.

USE CASE

CROSS-DOMAIN CO-SIMULATION

Vehicle dynamics, traffic flow and energy supply connected in one scenario. Used with real pedestrian motion via OSI and CarMaker in mixed-reality research.



KEY CAPABILITIES I

01. PHYSICAL-BASED VIRTUAL MODELS

Models built from physical equations, validated and released through automated build pipelines. Vehicle dynamics, traffic flow and energy supply available as ready-to-use blocks.

02. VIRTUAL BUSES & NETWORKS (SIL)

Software-in-the-loop with virtual buses, vECUs, network descriptions and sensor models. Full SIL environment for test automation and delta tests.

KEY CAPABILITIES II

03. SIMULATION-BASED TEST BENCHES (HIL)

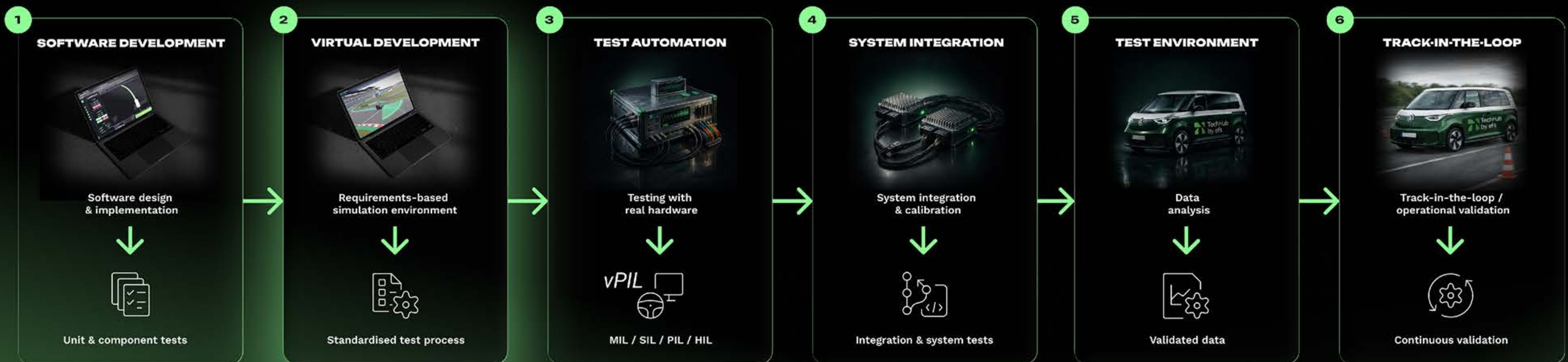
HIL systems with multiple ECUs in the loop, physical buses and IO. Remote access from anywhere; SIL scenarios re-used at the HIL stage.

04. TEST AUTOMATION

Standardised test processes spanning MIL, SIL, PIL, HIL and vPIL. Tests written once, executed across the chain with consistent results.



END-TO-END VERIFICATION WITH IDENTICAL TESTS AND CONSISTENT DATA FLOW



MODEL-BASED SYSTEMS ENGINEERING

AI METHODS AS ENABLERS

(test design, anomaly detection, data analytics, predictive analytics, scenario generation)



TechHub by efs
efs-techhub.com
info@efs-techhub.com