



**EUROPEAN
CONGRESS**
SEVILLE
19-21 May 2025
Clean, resilient and
connected mobility.

Digital twins: Enabling efficient and cost-effective transport electrification

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AVL Graz

SIS-13



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Who is AVL ?



Reimagining Motion

“We are driven by a **passion** to examine the science, mechanics and philosophy of movement. To help create a world that is **climate-neutral** and one that makes **safe, comfortable, green mobility** a reality for everyone.”

Helmut List

Chairman and CEO

AVL List GmbH



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Some Supplier Thoughts:

- **Why Digital Twins ?**
- **Example 1: Drivetrain Optimization and Calibration**
- **Example 2: “1000 times Real Time DGT” for
Energy Prediction to support
Fleet Logistics Planning**

Transformation from HW-centric towards more agile, continuous SW-driven Development Processes (SdV, DevOps)

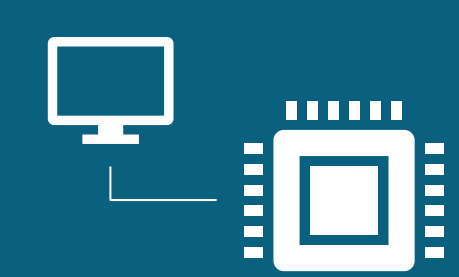
Hardware-centric development process

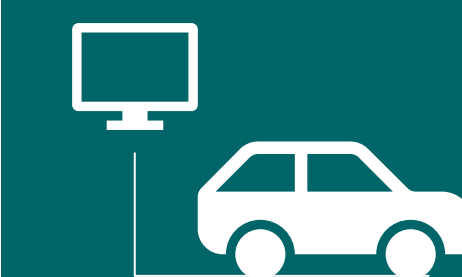


Calibration & optimization

Functional testing

 Simulation

 HiL

 Test Bed

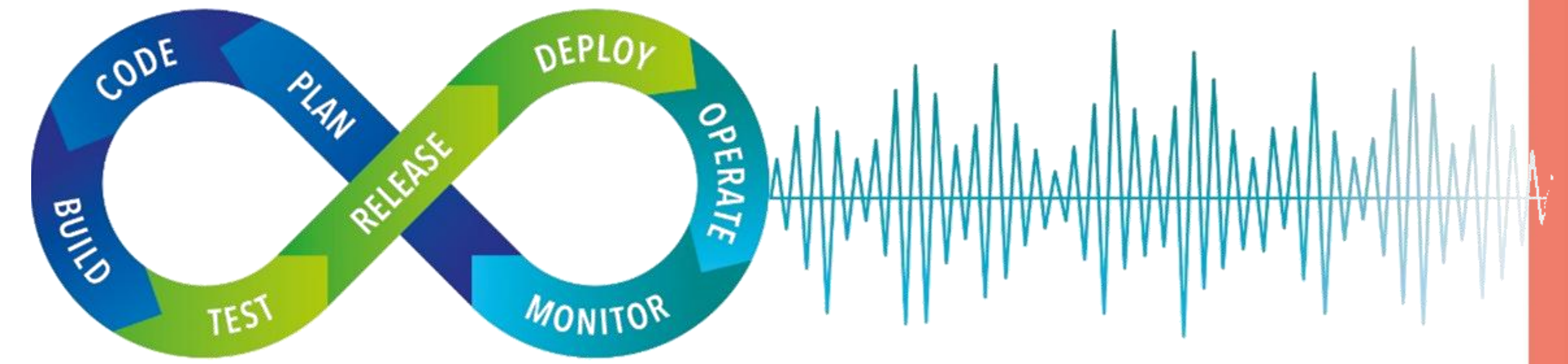
 Road

Transformation from HW-centric towards more agile, continuous SW-driven Development Processes (SdV, DevOps)

Hardware-centric development process

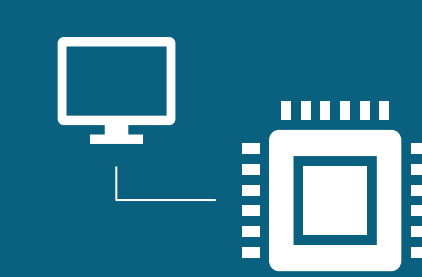


Software-centric development process (DevOps)



Calibration & opt Functional testing

 Simulation

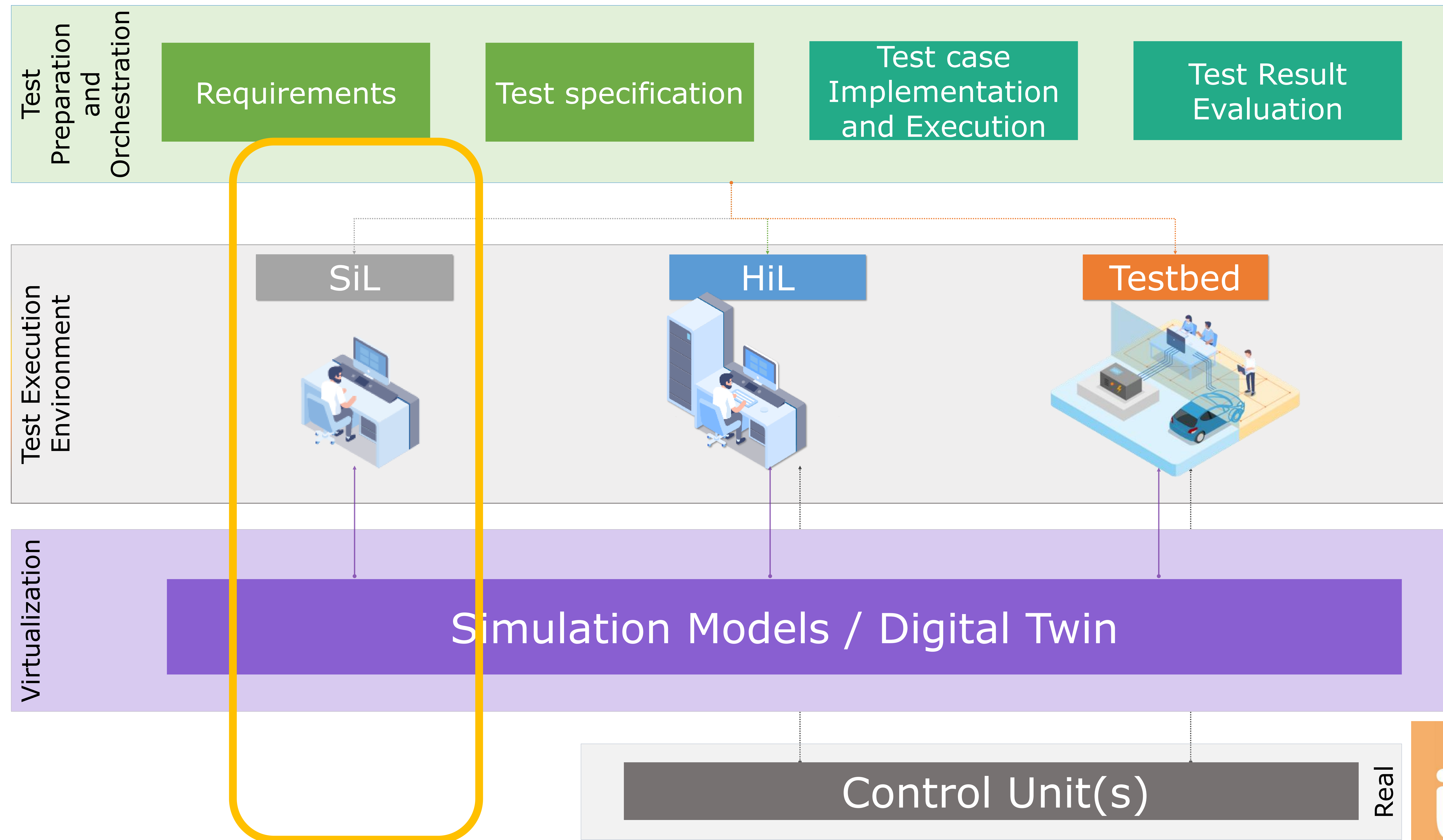
 HiL

 Test Bed

 Road

Seamless Integration of Digital Twin

Today's Focus

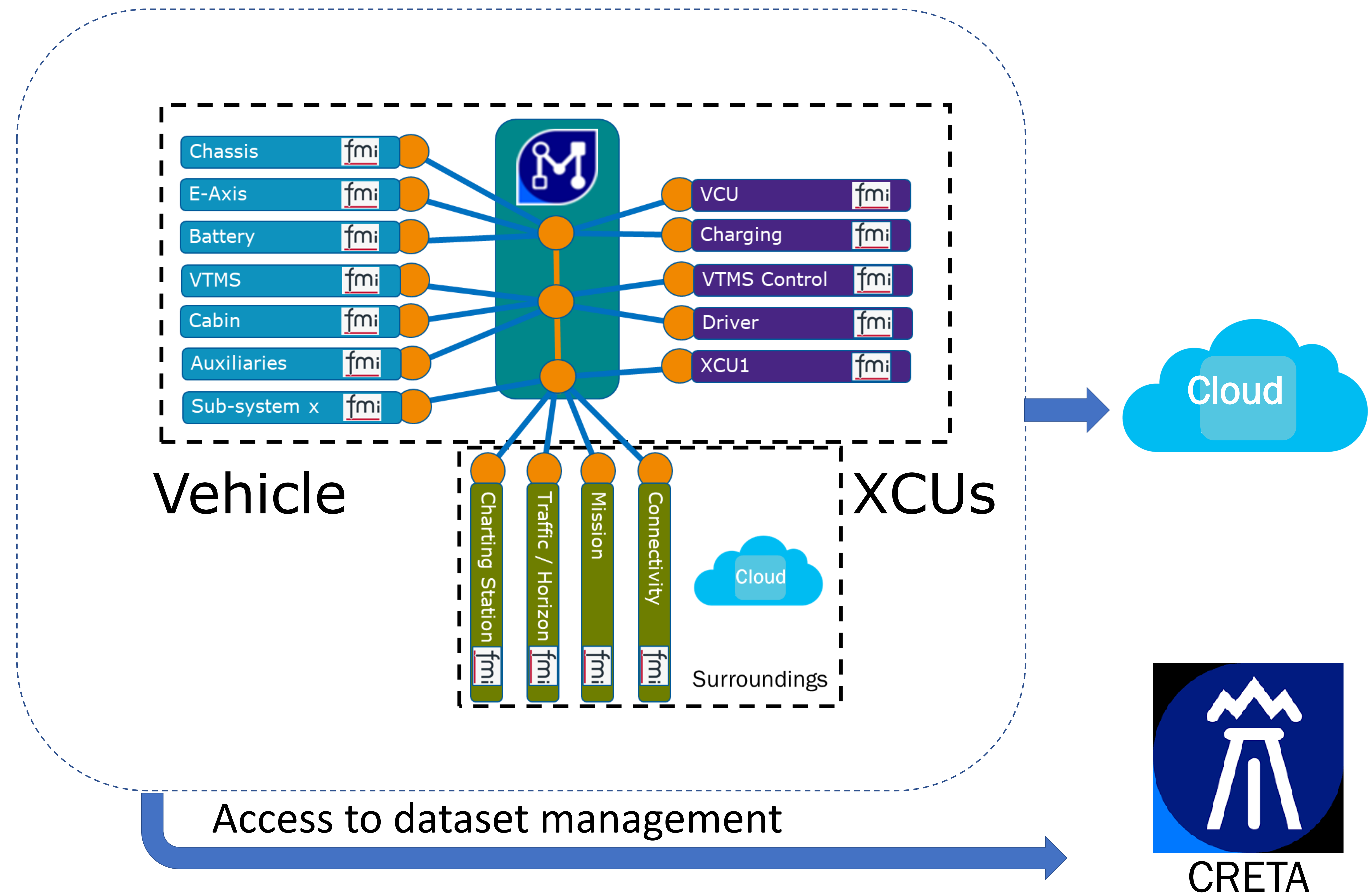


Approach: e.g.: Digital Twin (SiL) – Medium Duty BEV Truck (16 Tons)

Digital twin containing:

- Physical plant models
- Control unit software
- **Parameterization and Calibration of the DGT in SiL:**
 - Supplier data
 - Engineering knowledge
 - Component testbed data
 - Vehicle test data

→ **Several Quality levels**
possible, finally
→ **Leading to high fidelity**



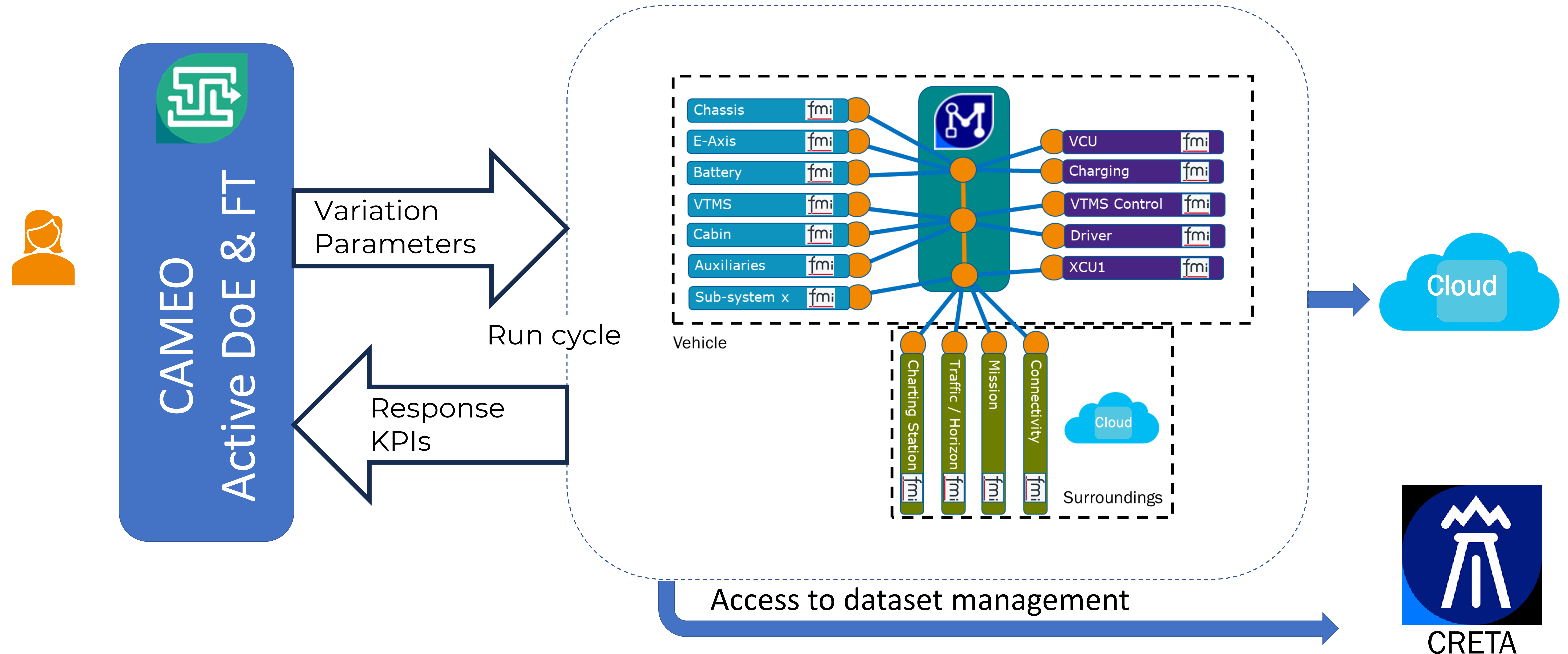
SiL Example 1: Drivetrain Optimization and Calibration

Rightsizing of components: e.g.: Size of the Battery

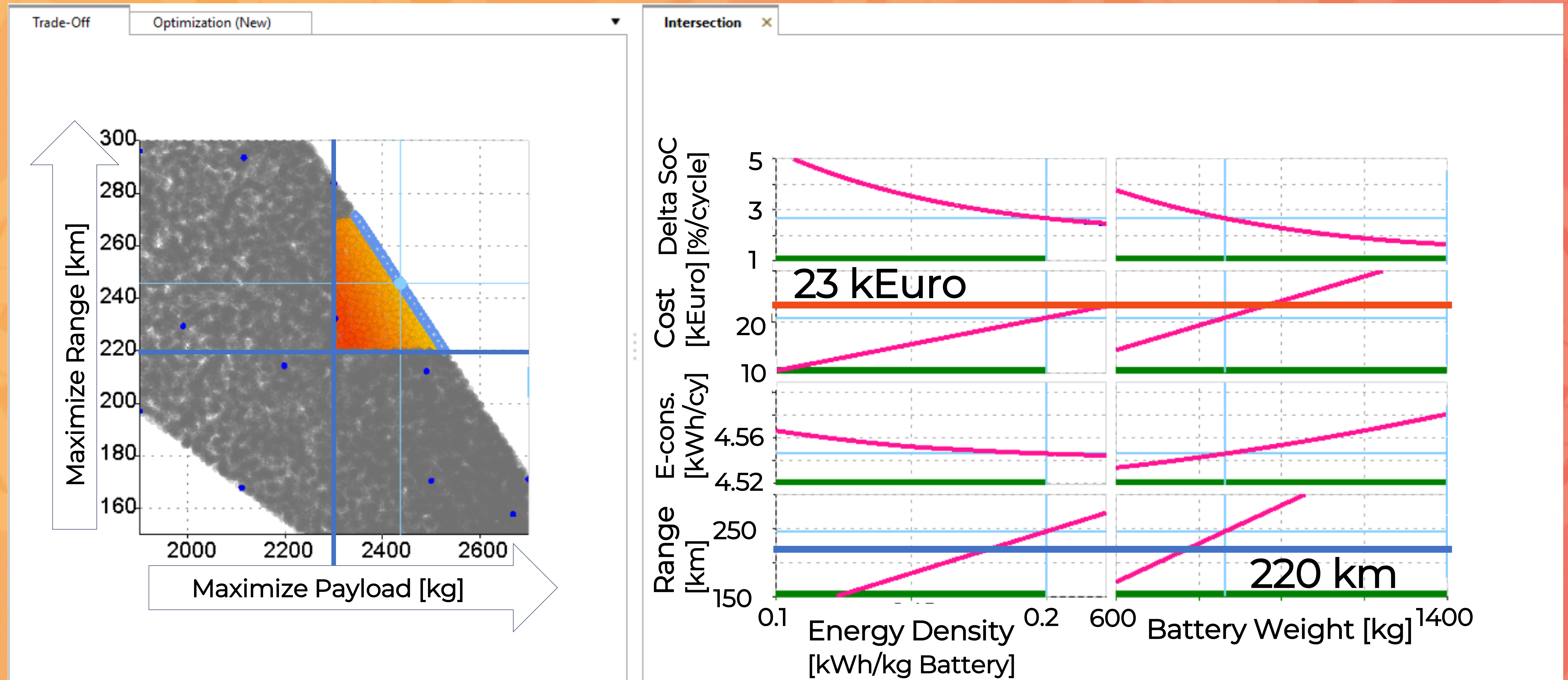
Pre - calibration of several components like BMS, HVAC or VCU for given vehicle missions

Functional tests according to requirements (high number)

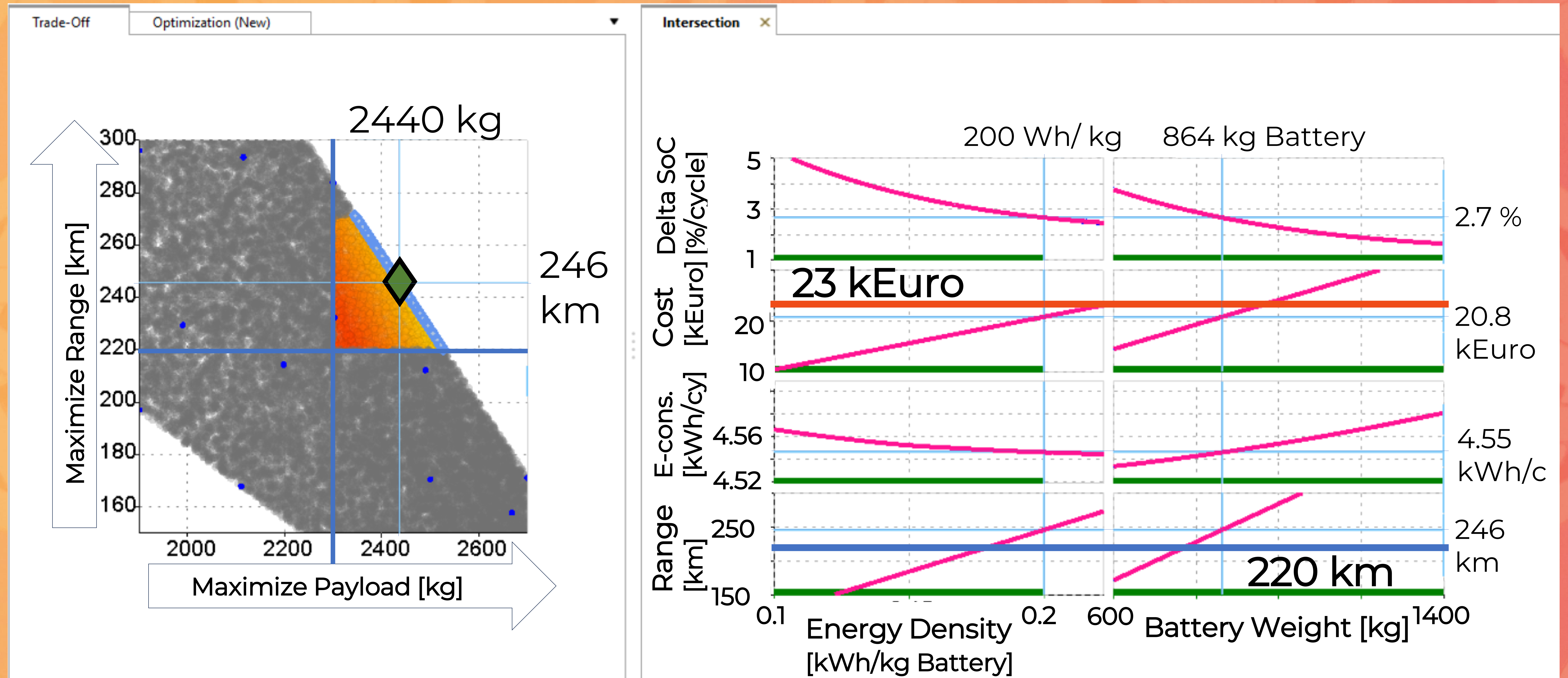
→ Add User-friendly Orchestration Tool



→ Informed Trade-Off Decisions (e.g.: Barcelona cycle / 8 T vehicle):



- Informed Trade-Off Decisions (e.g.: Barcelona cycle / 8 T vehicle):
- 864 kg High Density Battery



Example 2: 1000x Real Time DGT to Predict Range

Fleet Logistics and Planning SW needs situation dependent, reliable **Energy Consumption** prediction → **Much faster than realtime!**

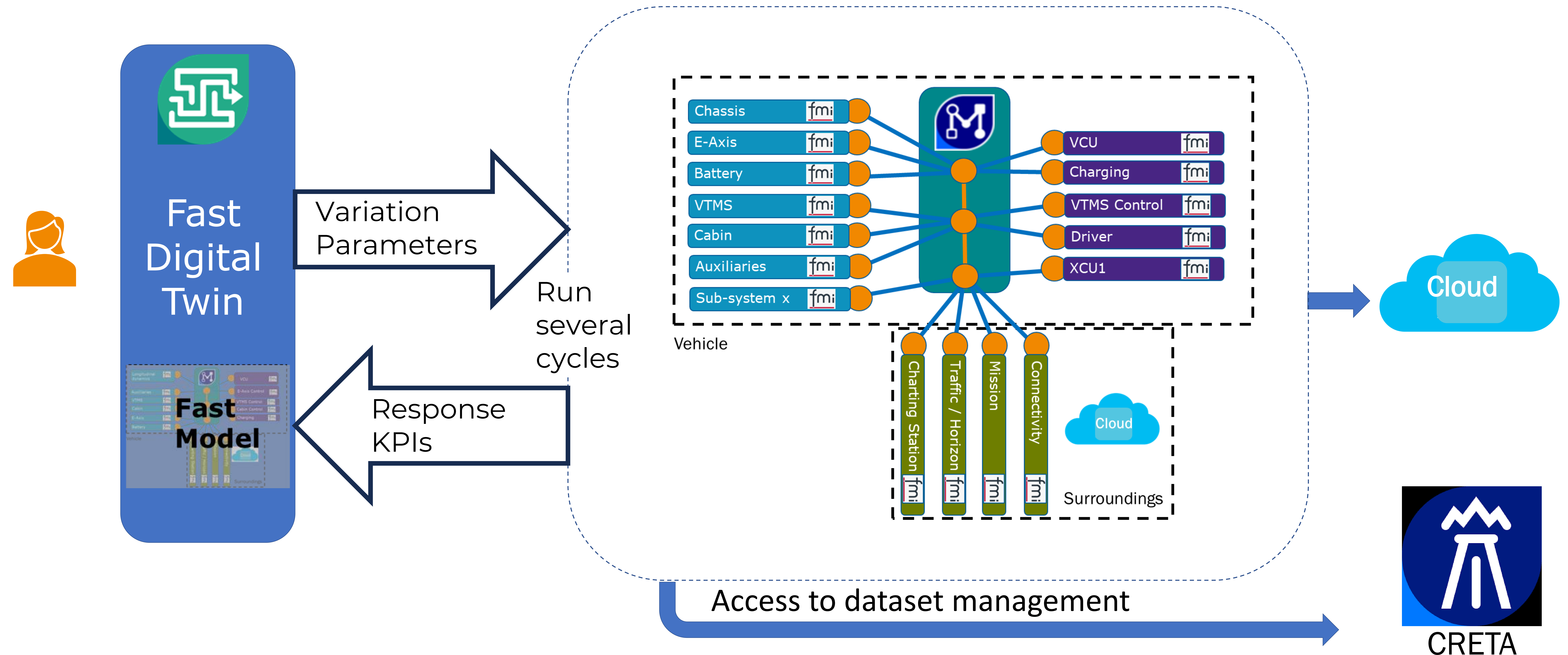
Validated SiL Digital Twin (slightly faster than real time only)

→ Data to train physical informed Neuronal Networks

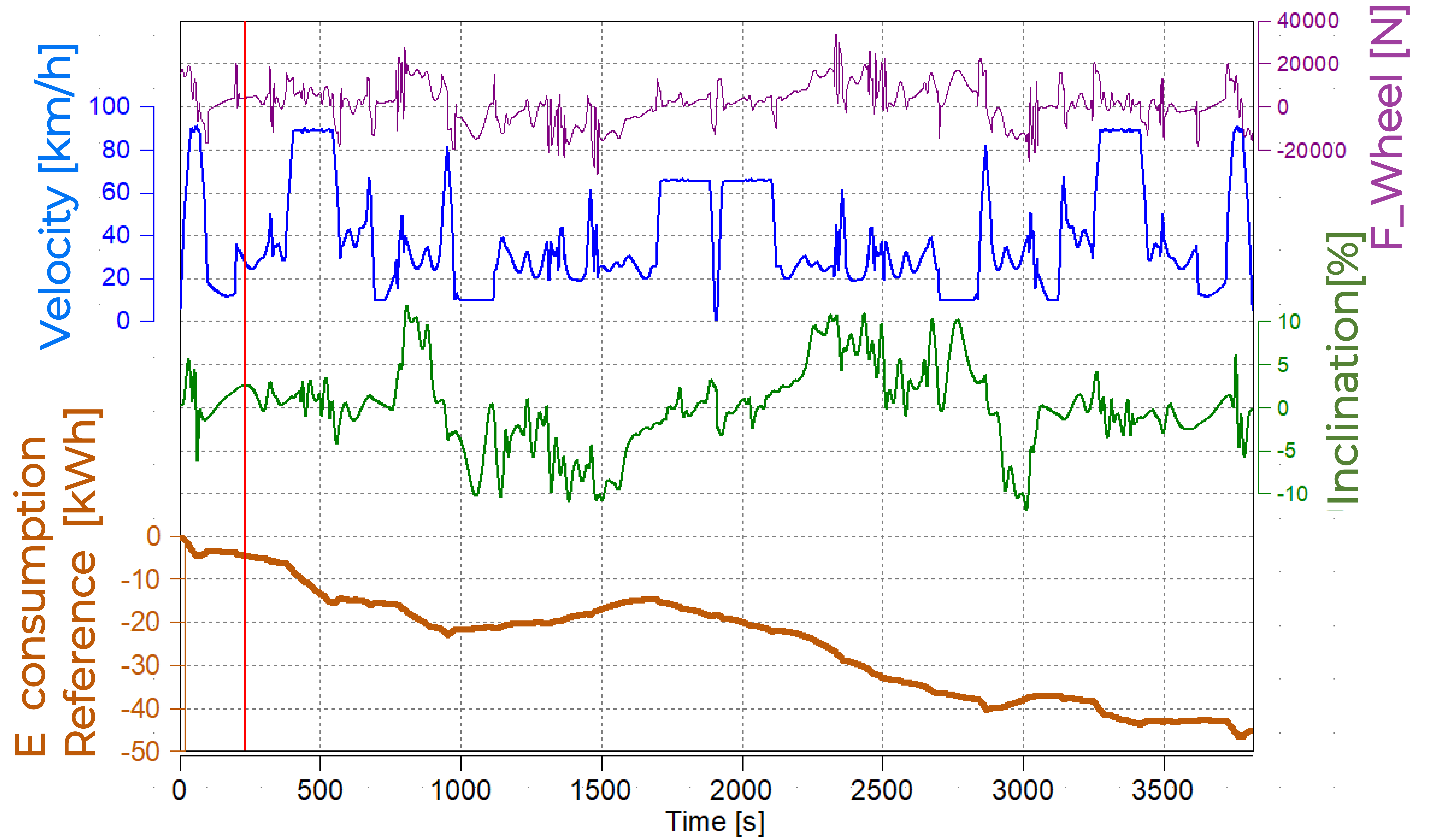
Energy consumption = F(Vehicle, Mass, Route, Traffic, Weather)

→ provided to be called **via the cloud**

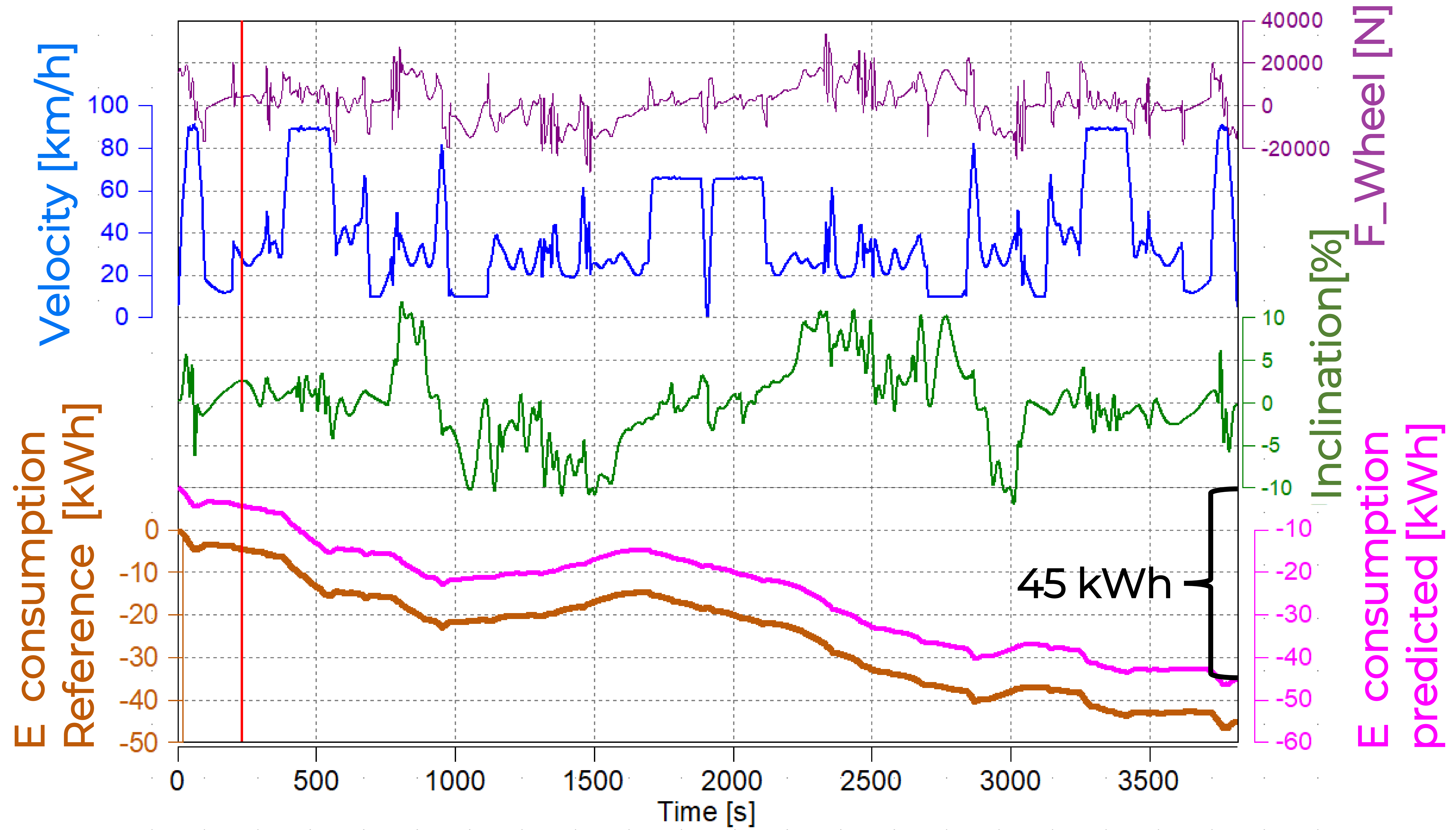
→ Identify Physical Informed NN as Fast DGT



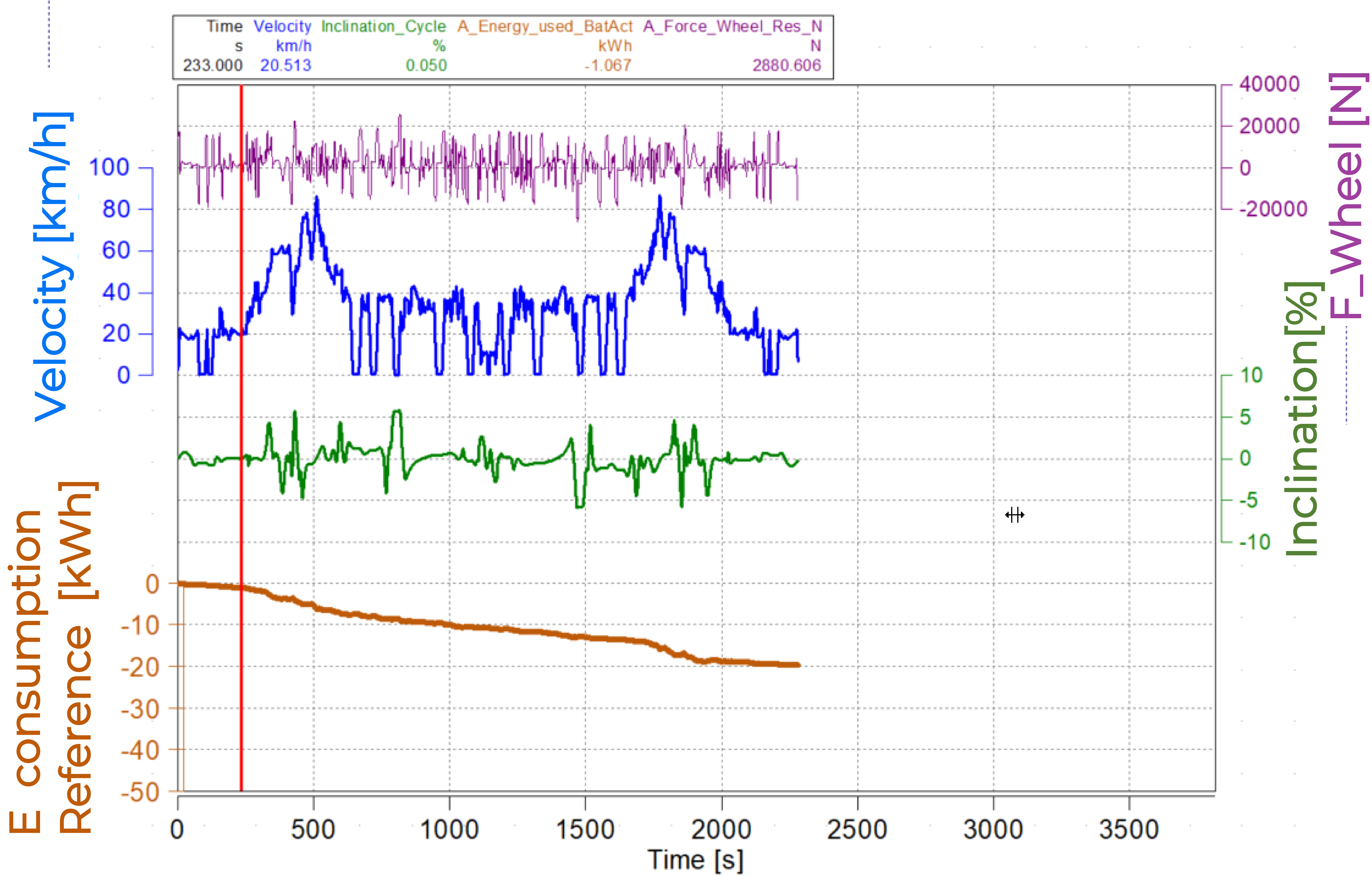
Istanbul unlucky:



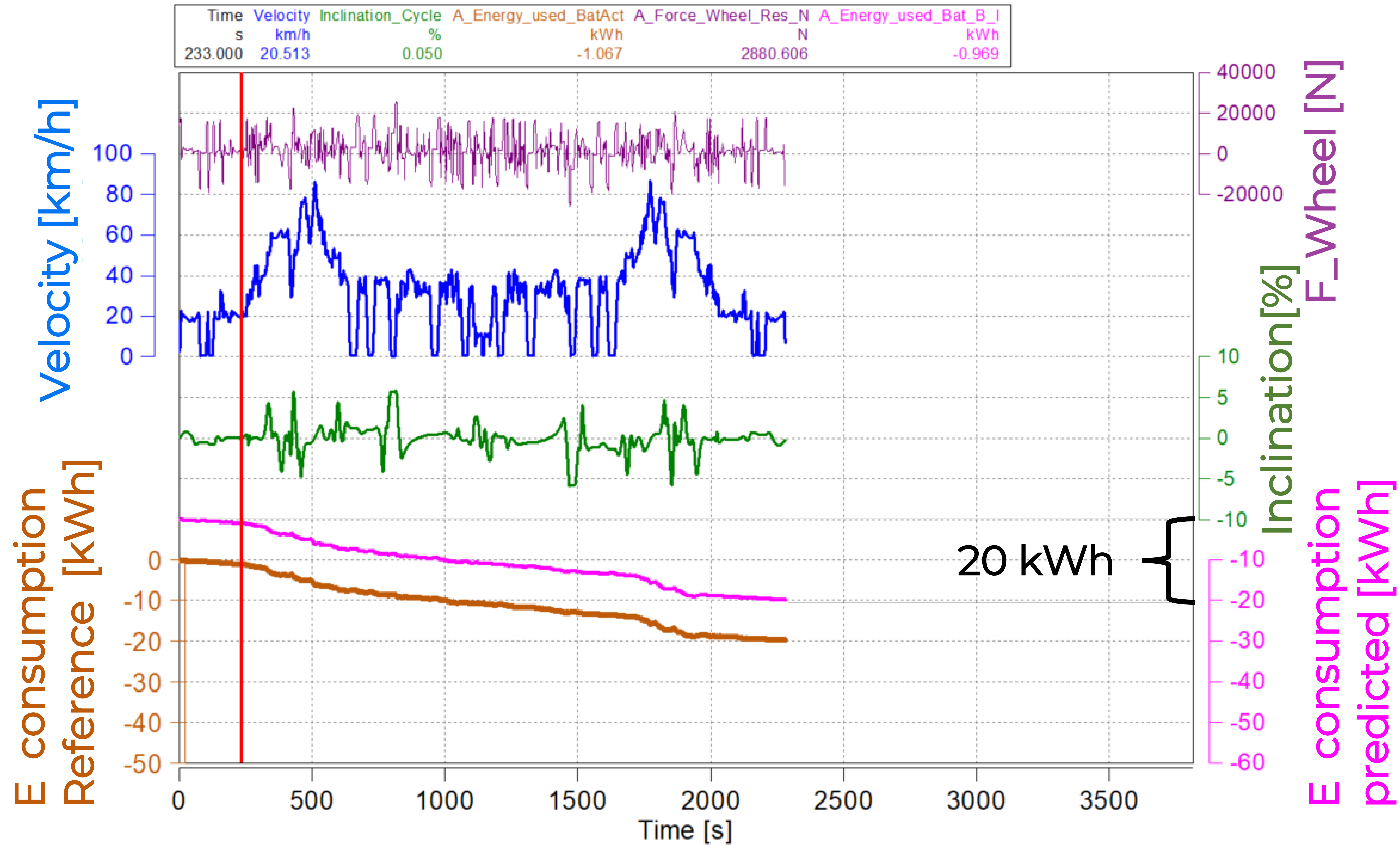
Istanbul
unlucky:



Barcelona lucky:



Barcelona lucky:



Conclusions

We see a shift towards **SiL, HiL, Component-** and **Integration test beds**

– All using proper **Digital Twins**.

A **Standard** is precondition for industrialization: **FMI / FMU**
+ Calibration Data Management as established for ECU-calibration.

Digital Twins are needed **in Development** and **beyond SoP**

Fast calculating **1000x Real Time DGT to Predict Energy consumption**
is an upcoming Future potential in order to **reduce Fleet Operation Cost**

THANK YOU!

Looking forward to Your questions



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