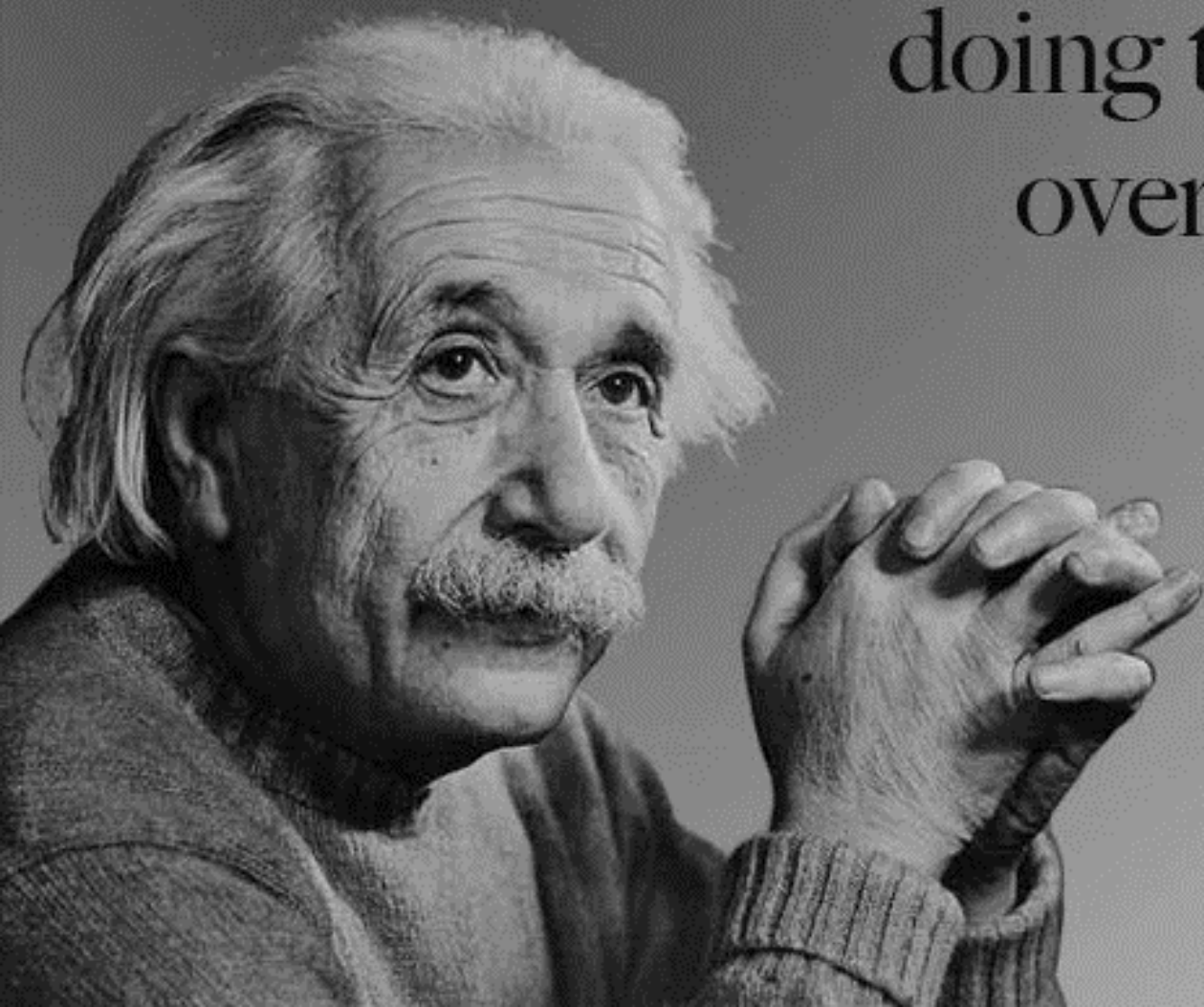


# INSANITY:

doing the same thing over and  
over again and expecting  
different results.

*~ Albert Einstein*





# Mobius Virtual Engineering

Faster, Smarter, Data-Driven

Nick Tebbutt / Puneet Mathur





# HORIBA MIRA

## *Trusted by Industry, Independent by Design*

HORIBA MIRA is an independent technical advisor & location:

- We combine 80 years of innovation & expertise with modern automotive technology-driven design thinking
- We work globally as a technical partner for OEM's, Regulators, new technology entrants and disruptors
- We built, operated and evolved our own mobility location – we understand real user needs
- We provide the independent view of the automotive industry to ensure robust and fit for purpose design
- Leveraging automotive technical consultancy in parallel industries such as defence, water & life science





A global-leader in engineering, research and development

**HORIBA**MIRA



Vehicle Engineering  
Consultancy



Test Engineering  
Services



Technology  
Park

# Traditional development methods can't keep up

**HORIBA**MIRA



Vehicle systems are more complex than ever — especially EVs and SDVs



Calibrating for optimal energy use, safety, and compliance is slow and costly

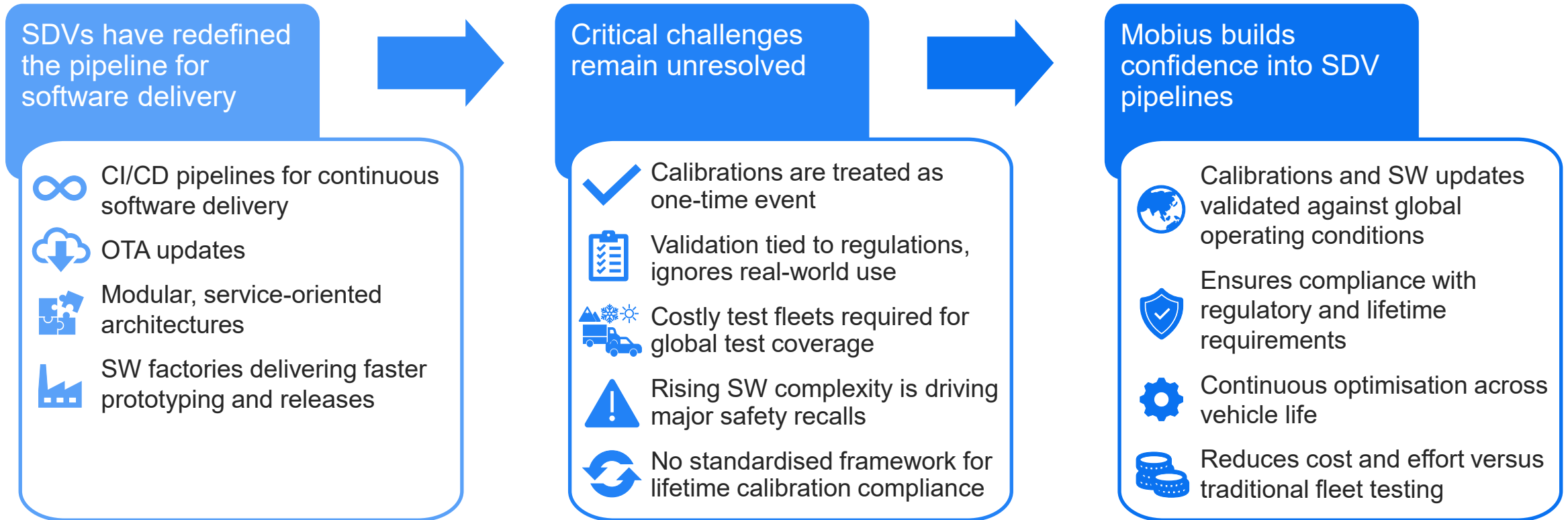


Real-world conditions are unpredictable and hard to model in a lab



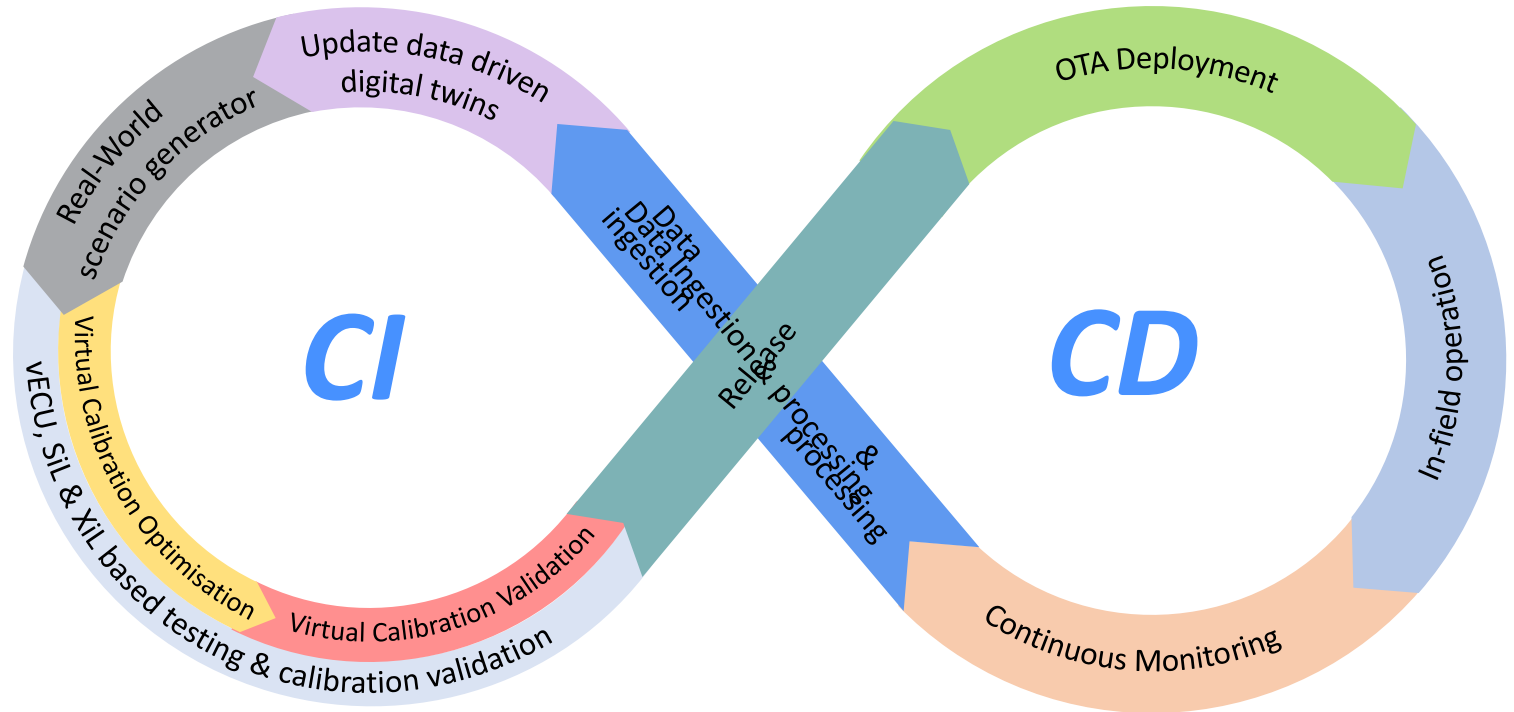
Regulators will soon demand lifetime compliance, not just Type Approval





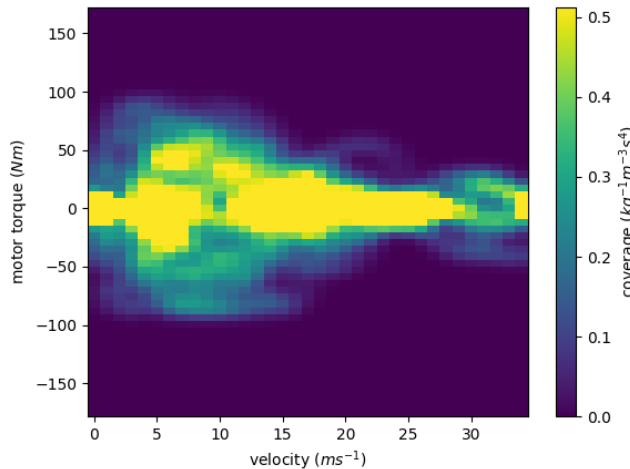
***SDVs create the pipeline. Mobius solutions ensure what flows through it is safe, compliant, and optimised — for life.***

- Digital tools, machine learning and data integration enable virtualised workflows
- Calibration can now be continuous
  - Learning from the real world never stops...
- OTA updates mean calibration is a lifecycle process, not a one-time event

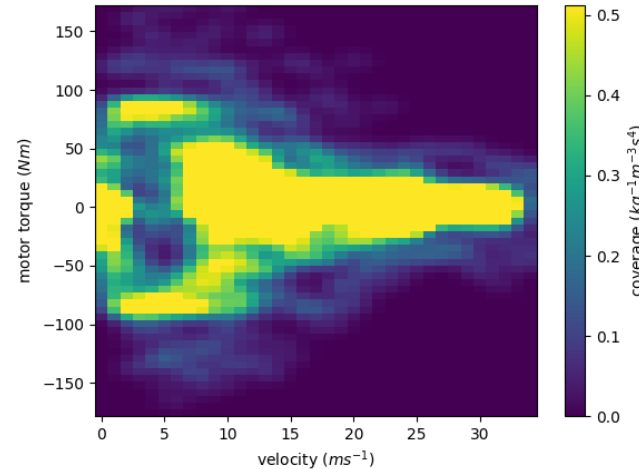


# Regulatory testing miss real-world coverage

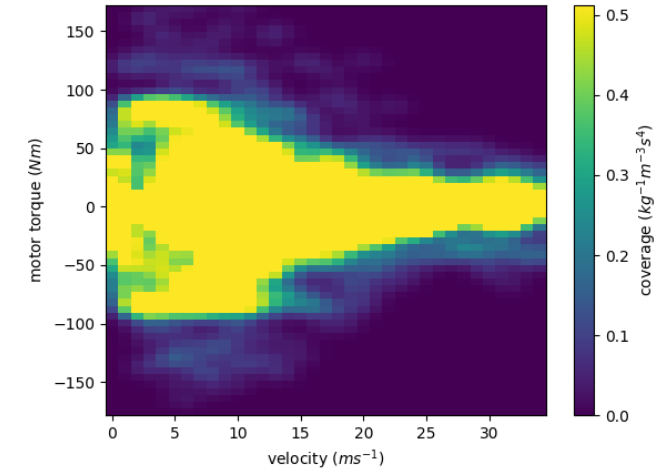
## *e-Motor operating torque points*



*WLTP*



*EPA 5-Cycle*



*EPA 5-Cycle + WLTP*

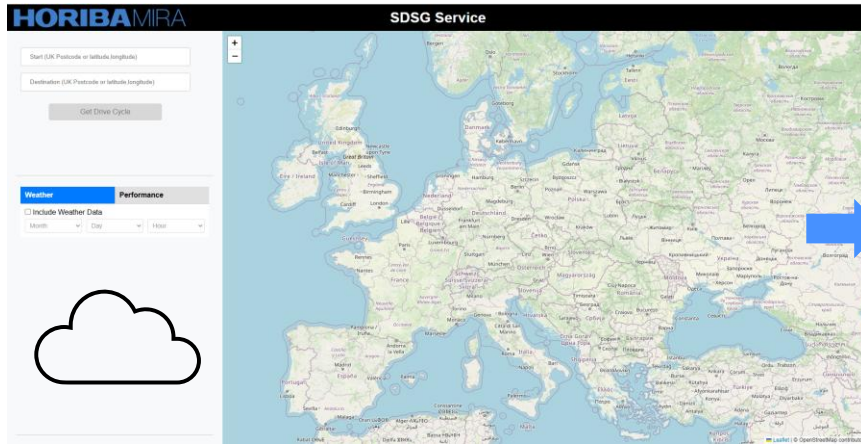
## Challenge

- **Calibration optimised and tested to Regulatory drive cycles may not reflect true real-world performance**
- Mismatch between lab and real-world performance – issues in field, unhappy customers
- Edge cases missed - Calibration not robust in real-world conditions
- Poor global rollout readiness
- Traditional real-world testing is data-heavy, time-consuming, and resource-intensive

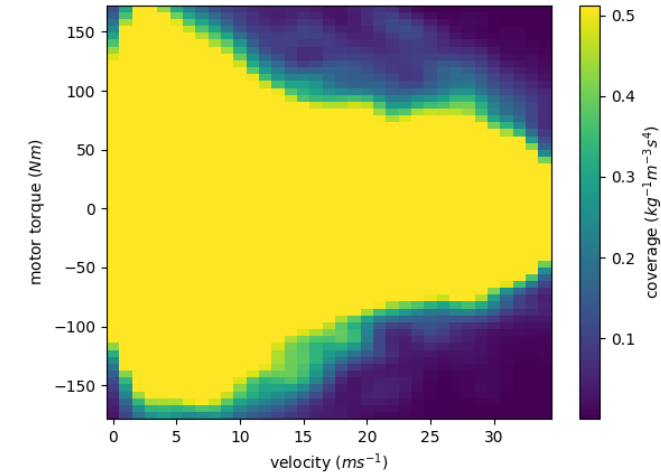
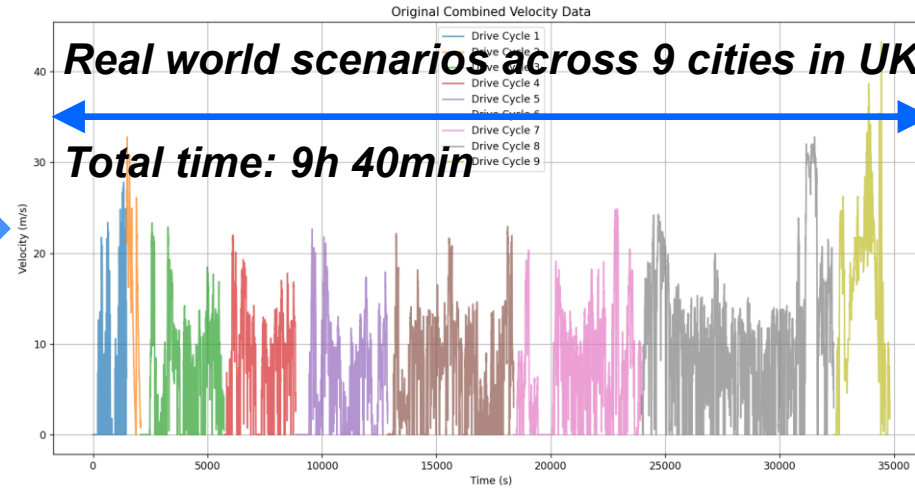


# Replicate real-world conditions – in minutes

**HORIBA**MIRA



**Generate 1000s of representative real-world drive cycles for target market, ensuring maximum coverage across vehicle performance window**



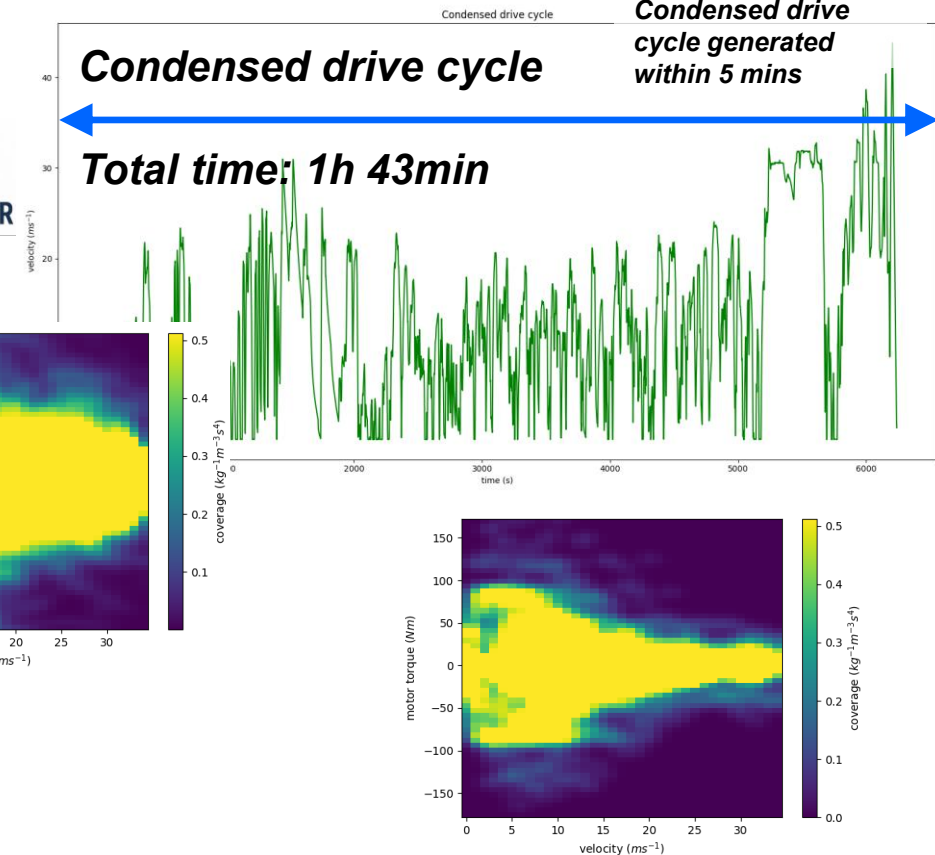
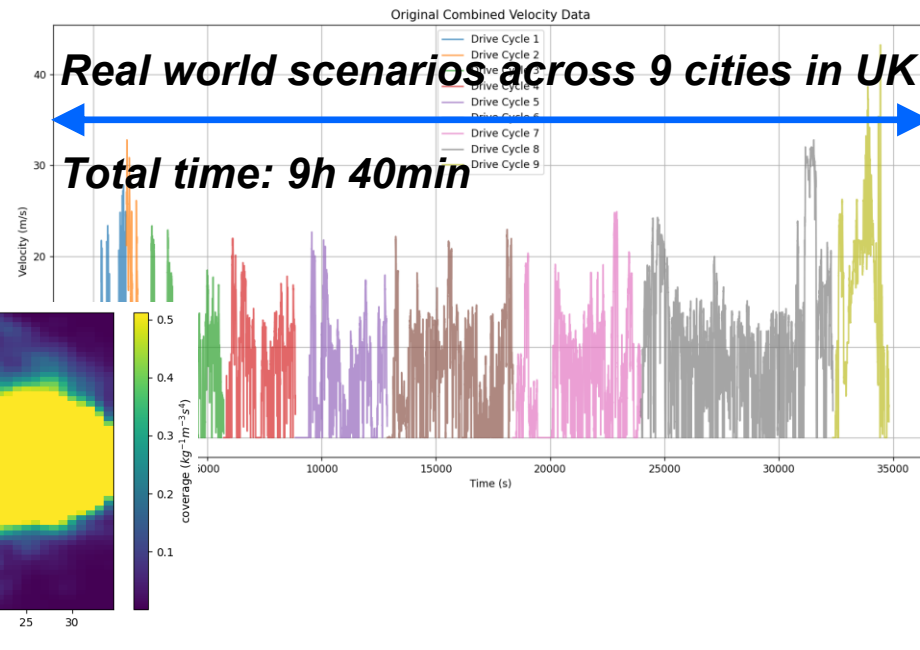
## Our Approach

### *Mobius Scenario: Global real-world scenario generation*

- **Any country. Any city. Any time.**
- Emulate road load, topography, traffic flow, and ambient temperature conditions, virtually in minutes
- No need for global prototype fleets or on-road testing
- Test one calibration across all regions - From Nordic cold to Delhi traffic, Peru mountains to Middle-East heat
- Global readiness, with minimal targeted physical regional testing

# Test smarter, not longer

**HORIBA**MIRA



## Benefits

- Extracts only unique real-world driving segments
- Ensure edge case inclusion
- **Cuts test time by up to 70%**
- Short scenario-rich drive cycles with realistic transitions
- Stronger correlation with real-world performance

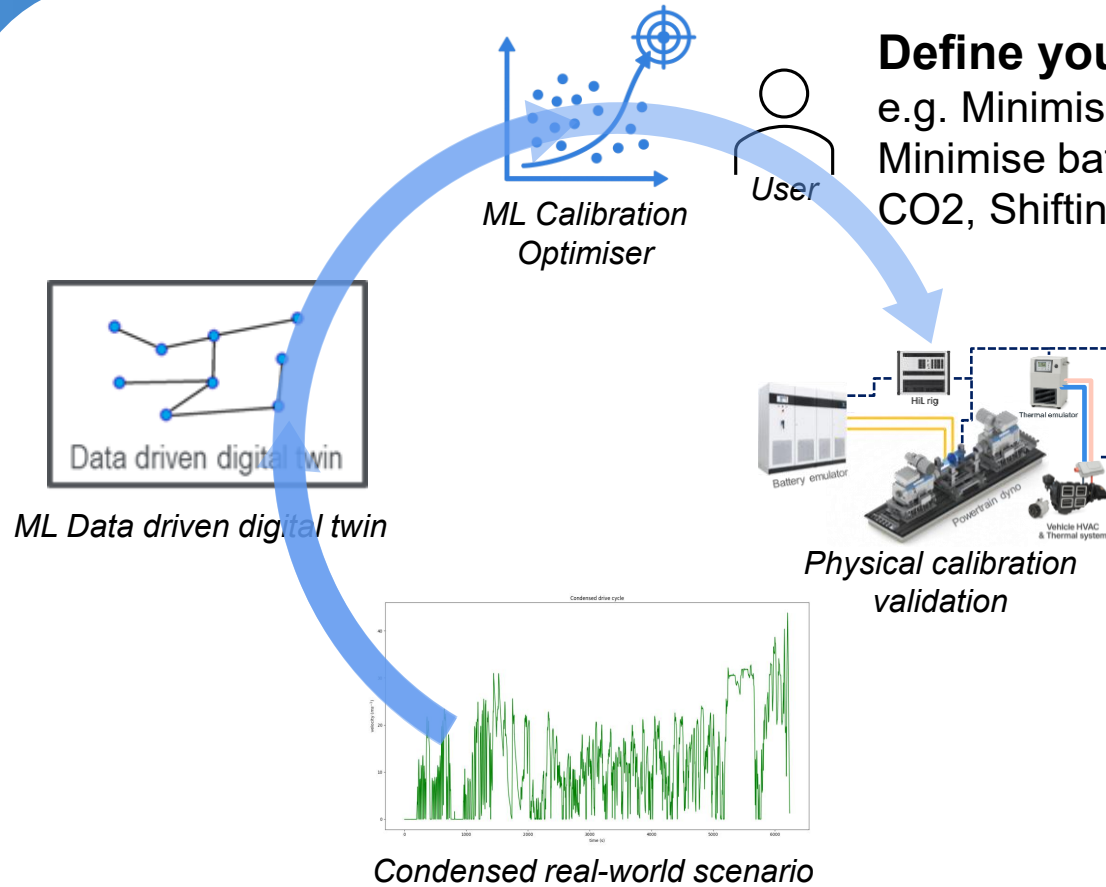
*Condensed Drive cycle*  
**1h 43min**

*EPA 5 Cycle + WLTP*  
**2h 5min**

*Significantly increased coverage compared to regulatory drive cycles, in a shorter time duration*

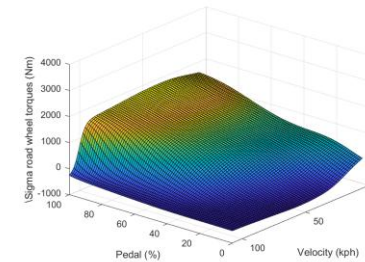


# Smarter Calibration starts with Smarter Models

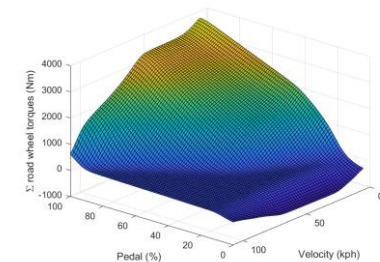


*ML-powered loop continuously learns and adapts to converge on optimal calibration*

**Define your target, let ML do the rest**  
e.g. Minimise losses, Maximise acceleration,  
Minimise battery charging time, Minimise  
CO2, Shifting strategy, etc.



*ML optimised wheel torque request map –  
**Minimise losses***



*ML optimised wheel torque request map –  
**Maximise acceleration***

## Why Machine learning

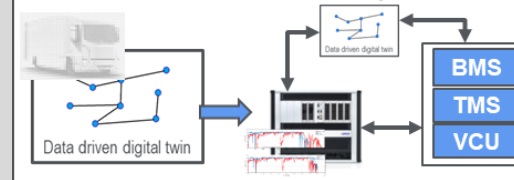
- Too many variables, too many interactions
- Learns system behaviour under real-world conditions
- Uncovers interactions no human can calibrate manually
- Converges faster to more accurate, robust calibrations
- One calibration. Globally validated. Minimal targeted region-specific calibration refinement

## Virtual engineering with Digital Twins: Savings (20-30% in cost &/or time)

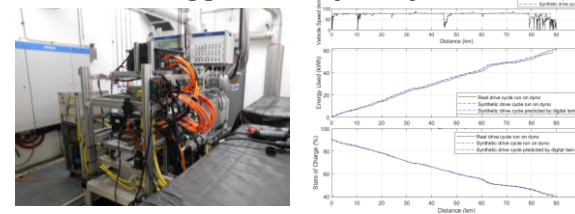
- High accuracy data driven digital twins accelerate calibration and validation, enabling faster iteration cycles and reducing overall testing time and associated costs.
- Scenario generator further reduces the need for in-field data collection for virtual development.

## Case study 1: EV Truck battery pack development & integration

### Training data based digital twin generation & offline VCU + BMS calibration optimisation



### XiL testing & performance validation with real world logged drivecycle by customer



Optimising BMS calibration in parallel to pack build **saved ~4mo** overall  
Allowed calibration of **90% useable energy** to be ready once pack available

**Battery charge rate strategies optimised** using simulated real-world ambient temperature and driving scenarios

Achieved **>97% simulation accuracy** vs. measured physical energy use, enabling high-confidence that virtual development & validation approach would deliver under real-world scenarios

## Prototype vehicle savings (15-25% in cost)

Reducing the need for multiple physical prototypes due to increased virtual development. **Several vehicles** can be **removed** from early prototype fleets

## Field Trials Savings (15-25%)

Virtual and XiL based testing allows OEMs to reduce the number of real-world fleet tests and the logistics costs/ CO2 involved in conducting these tests across multiple conditions, globally.

## Performance Validation Savings (20-30%)

Performance validation benefits from scenario generators and digital twins, simulating and emulating global conditions in virtual and XiL environment, cutting down on the time and costs associated with real-world performance validation and calibration optimisation.

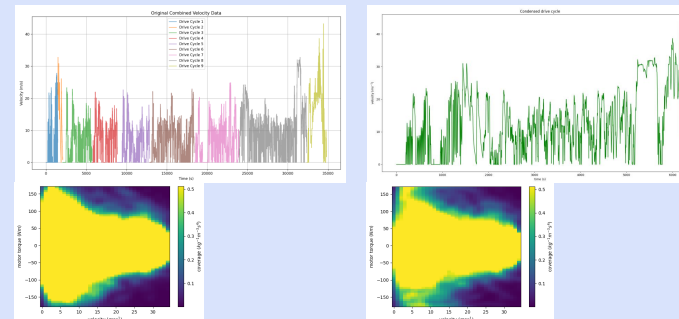
## Case study 2: Whole vehicle efficiency optimisation



High fidelity digital twin generated using data collected from instrumented vehicle via dyno, track and on-road testing

Mobius SG and drive-cycle condenser derived test profile achieved **75% time saving** to create equivalent data coverage through physical testing with climatic dyno

Digital twin showed **<5% deviation** from real-world data before further refinement.



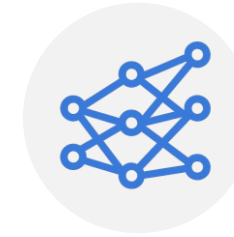




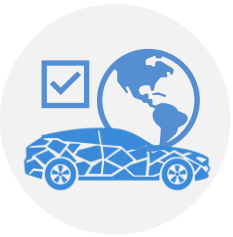
*Replicate scenario-rich  
global conditions in lab  
for any powertrain*



*Reduce test time by  
up to 70% without  
cutting coverage*



*ML uncovers system  
interactions humans  
can't tune manually*



*Fewer prototypes, faster  
development, globally  
validated performance*



*Smarter  
calibration, lower  
development cost*



*Cloud native,  
secure &  
OTA-ready*



## Puneet Mathur

MSc Automotive Eng.

Chief Engineer  
Powertrain Optimisation

Direct T: +44 (0)24 7635 5299  
M: +44 (0)7841 047487  
E: puneet.mathur@horiba-mira.com

HORIBA MIRA Ltd.  
Watling Street  
Nuneaton  
Warwickshire  
CV10 0TU  
United Kingdom

[www.horiba-mira.com](http://www.horiba-mira.com)



## Nick Tebbutt

Head of Global Strategic Sales  
Vehicle Technologies

Direct T: +44 (0)24 7635 8021  
M: +44 (0)7540 300854  
E: nick.tebbutt@horiba-mira.com

HORIBA MIRA Ltd.  
Watling Street  
Nuneaton  
Warwickshire  
CV10 0TU  
United Kingdom

[www.horiba-mira.com](http://www.horiba-mira.com)