



# Efficient use of time and budget with modular measurement data acquisition

CSM web seminars

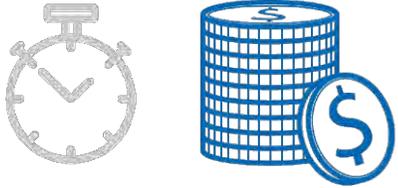
**CSM** **Xplained**  
measurement technology

**VECTOR** 

Innovative Measurement and Data Technology



# Time and Cost Pressure in vehicle developments



Transformation  
to e-mobility

New components

New measurement  
technology required

New players in the  
competition

Simulations  
insufficient

Procurement crisis

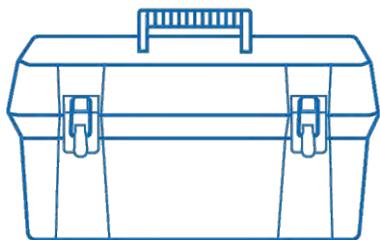
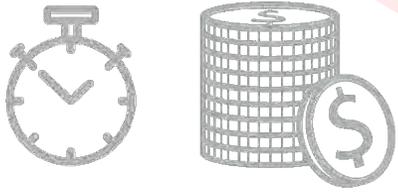
General shortage  
of skilled workers

Increased  
complexity  
of the vehicles

Higher personnel  
and energy costs

# Increase Efficiency

by saving time and costs with a suitable measurement system



Transition to e-mobility

New players in the competition

Generation of new players

New competitors

Simulations efficient

Increase complexity of the vehicles

New measurement technology required

Procurement crisis

Higher personnel and energy costs

Efficiency

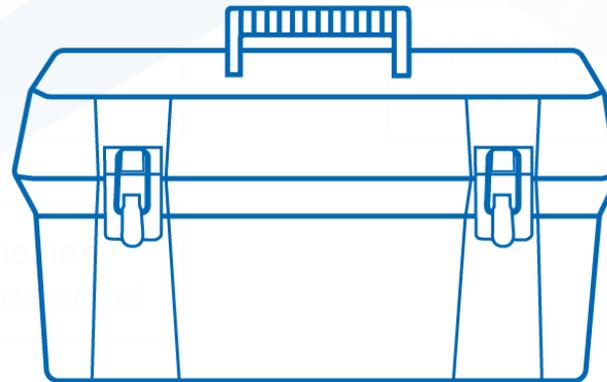
Resources

# Increase Efficiency

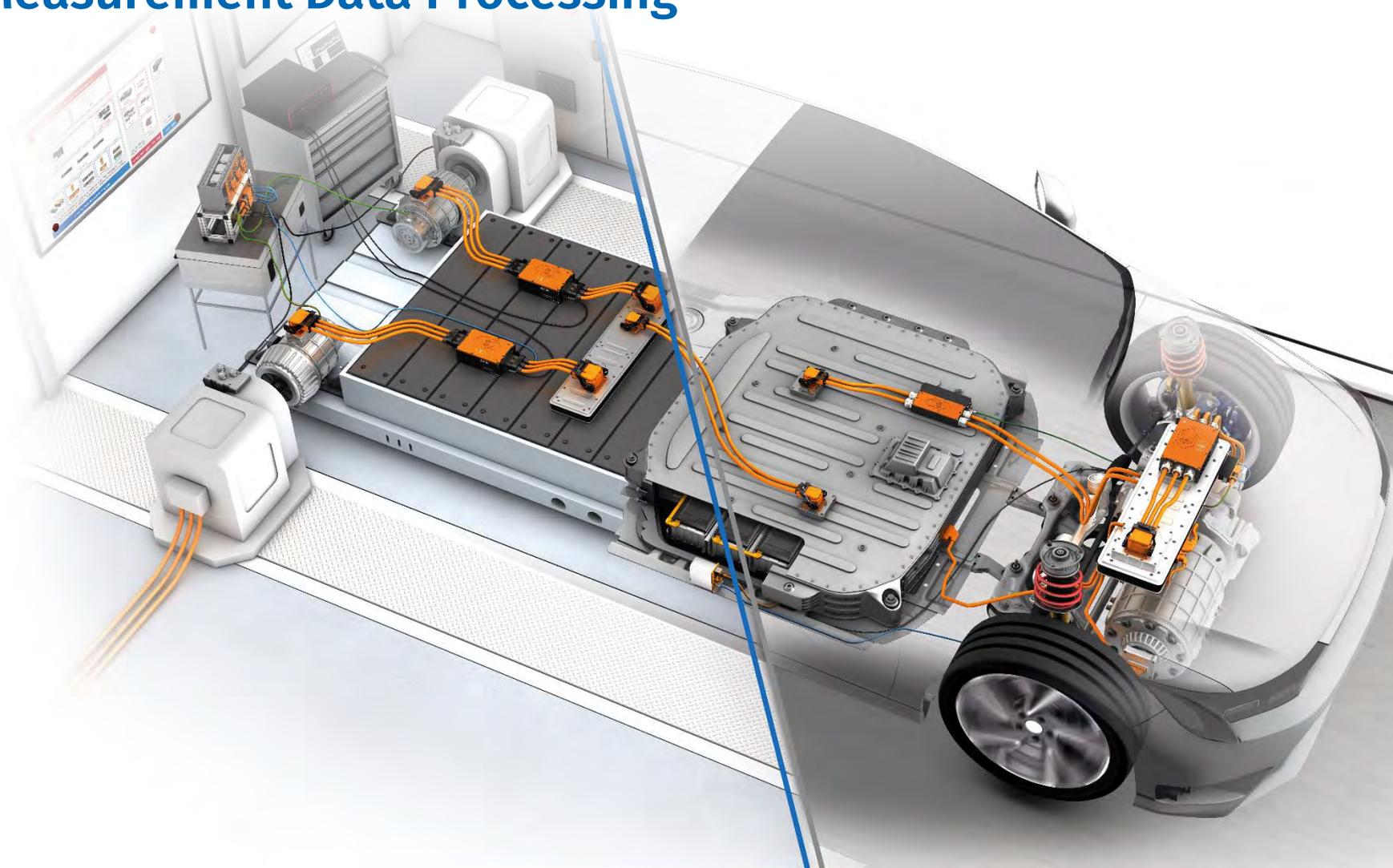
by saving time and costs with a suitable measurement system



## What requirements must the measurement system meet?



# The Measurement Data Processing



# The Measurement Data Processing

## Scope of Investigation

- ▶ Test vehicle and/or test bench?
- ▶ What kind of tests?
- ▶ Single tests (sequential)?
- ▶ Multiple tests in parallel?

Optimization by:

A measurement system that can perform the most diverse examinations simultaneously

Scope of investigation

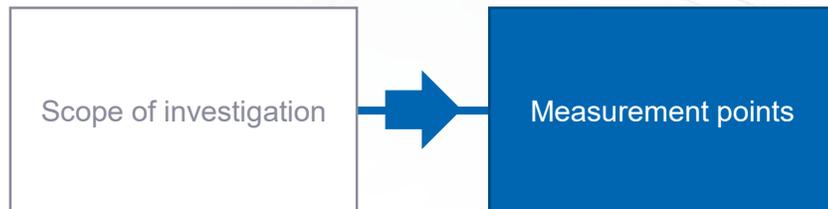
# The Measurement Data Processing

## Determine Measurement Points

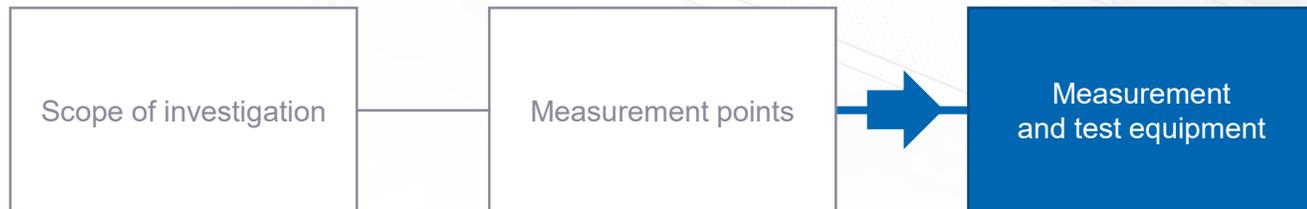
- ▶ Define measured values to be determined
- ▶ Define measurement points / measurement locations
- ▶ Select sensor types

Optimization by:

Measurement system that allows the simultaneous acquisition of a wide range of measured values and is suitable for the selected measurement locations



# The Measurement Data Processing



## Selection of Measurement and Test Equipment

- ▶ Are all measurement devices for the measurement task available?
  - ▶ Or does new equipment have to be procured?
- ▶ Versatile measurement system or stand-alone solutions?

Optimization by:  
Versatile, easy to expand measurement system

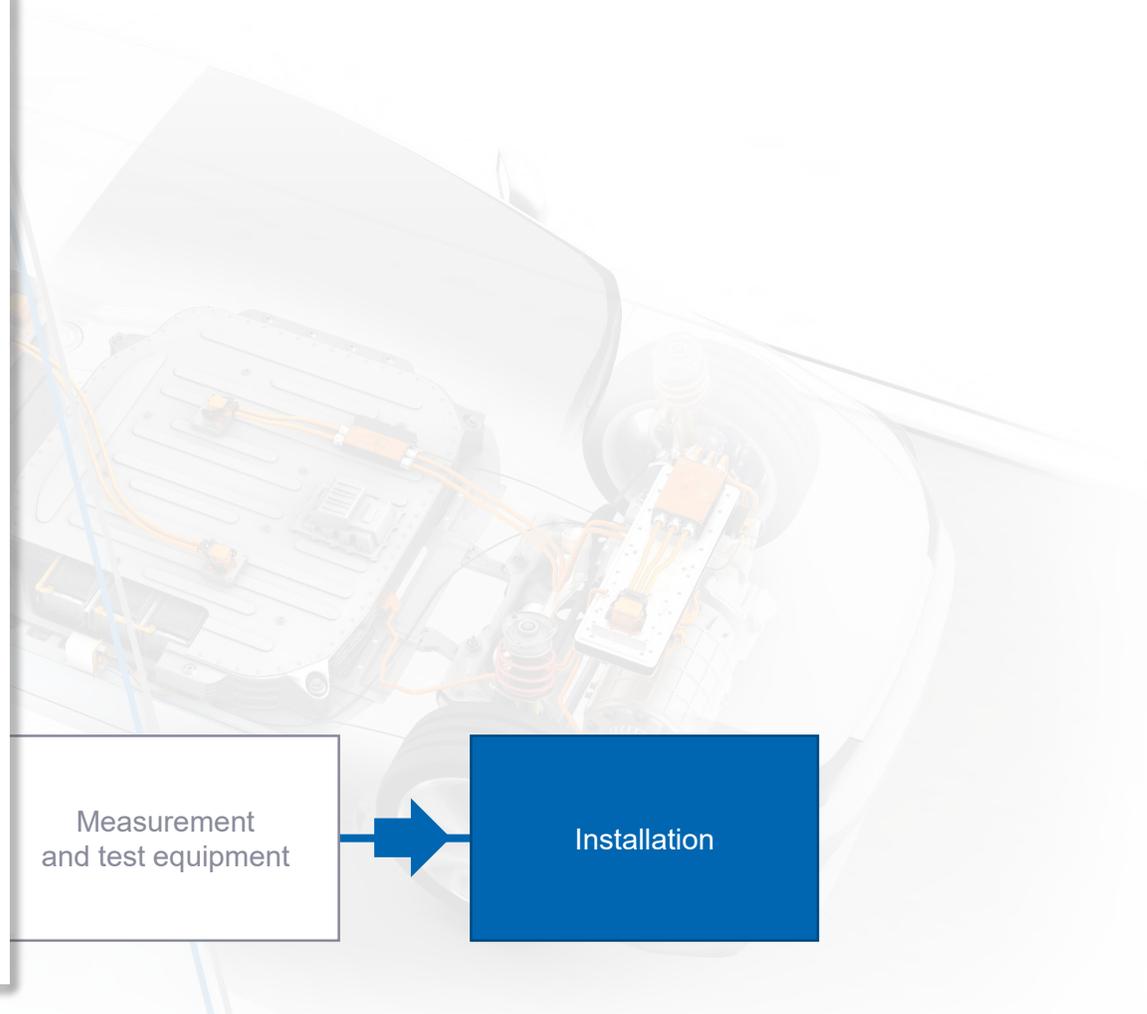
# The Measurement Data Processing

## Installation & Configuration

- ▶ Installation aids available on the measuring device?
- ▶ Simple configuration software?
  - ▶ TEDS, Signal-DB, Sensor-DB,...
- ▶ Or familiarization / training necessary again and again?

Optimization by:

Practice- and user-friendly software and hardware



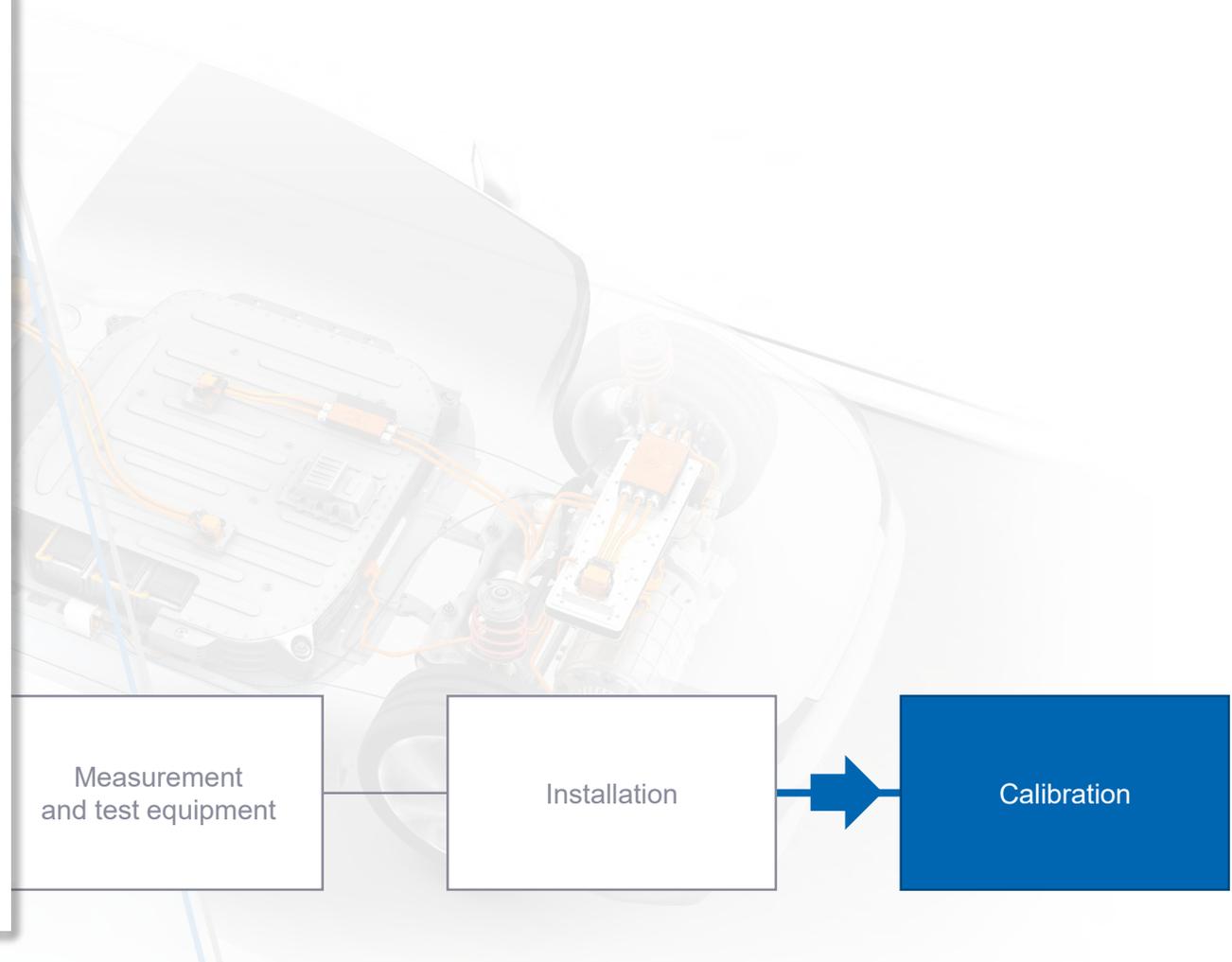
# The Measurement Data Processing

## Calibration

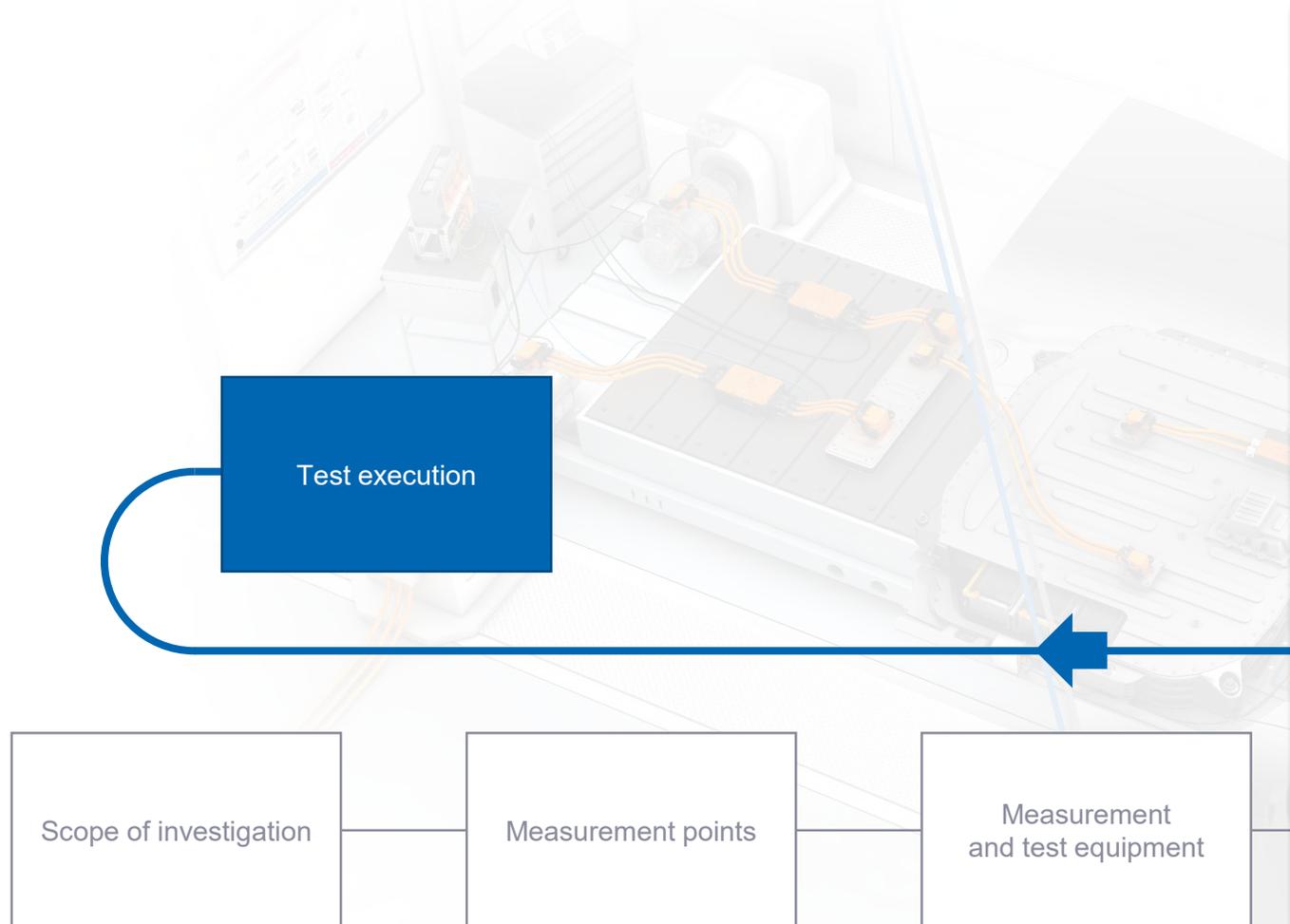
- ▶ Partial calibration possible in-house?
  - ▶ Or does the measurement technology always have to be calibrated off-site?
- ▶ Pre-calibrated measurement technology solutions?

Optimization by:

Solutions for calibration close to the customer (calibration station) as well as measurement technology with integrated sensor technology ( e.g. CSMs HV BM)



# The Measurement Data Processing



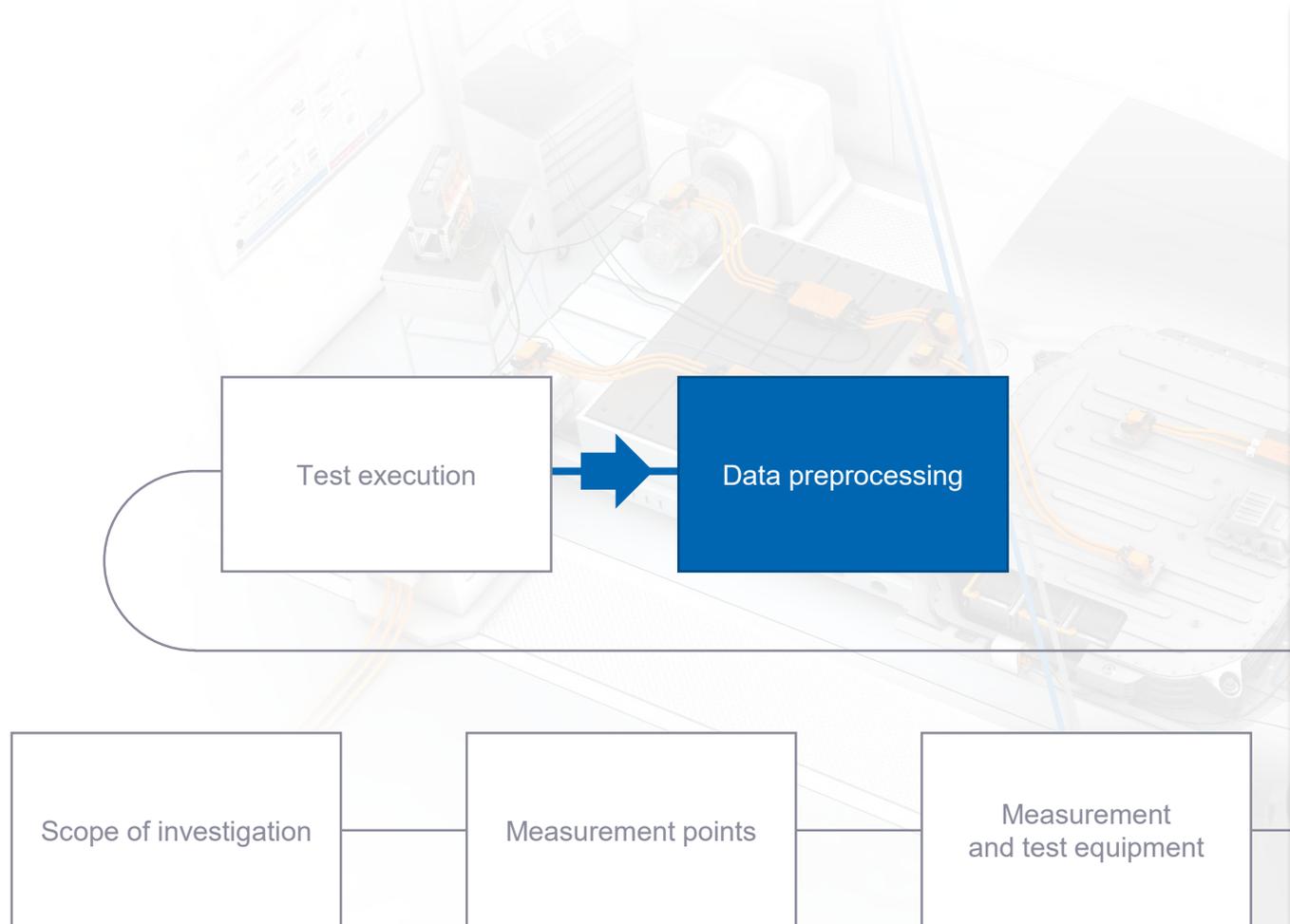
## Test Execution

- ▶ Run tests in parallel?
  - ▶ Use data synergies?
- ▶ Or run tests sequentially?

Optimization by:

Powerful data acquisition that can process measurement data from a wide variety of sources in parallel and synchronously

# The Measurement Data Processing



## Data Preprocessing (real time calculations)

- ▶ Evaluations and calculation of meaningful parameters already in real time?
  - ▶ Regulation to result variables on the test bench
  - ▶ Transmission of calculated variables instead of raw data -> immense data reduction
  - ▶ Immediately available knowledge to make decisions (e.g. test abort etc.)

Optimization by:

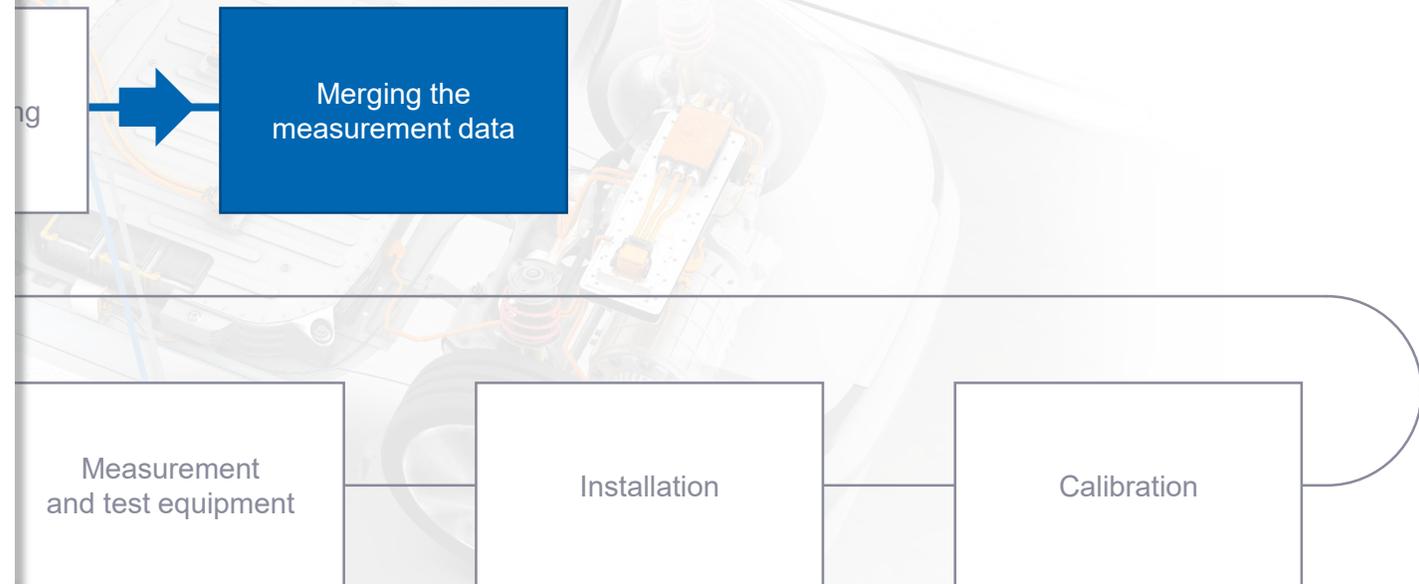
Online calculation functions at module and system level

# The Measurement Data Processing

## Merging the Measurement Data

- ▶ One data file or separate systems?
- ▶ Time synchronization?
- ▶ Compatibility systems / data formats?

Optimization by:  
Versatile measurement system allowing synchronized measurement of the most diverse signal sources



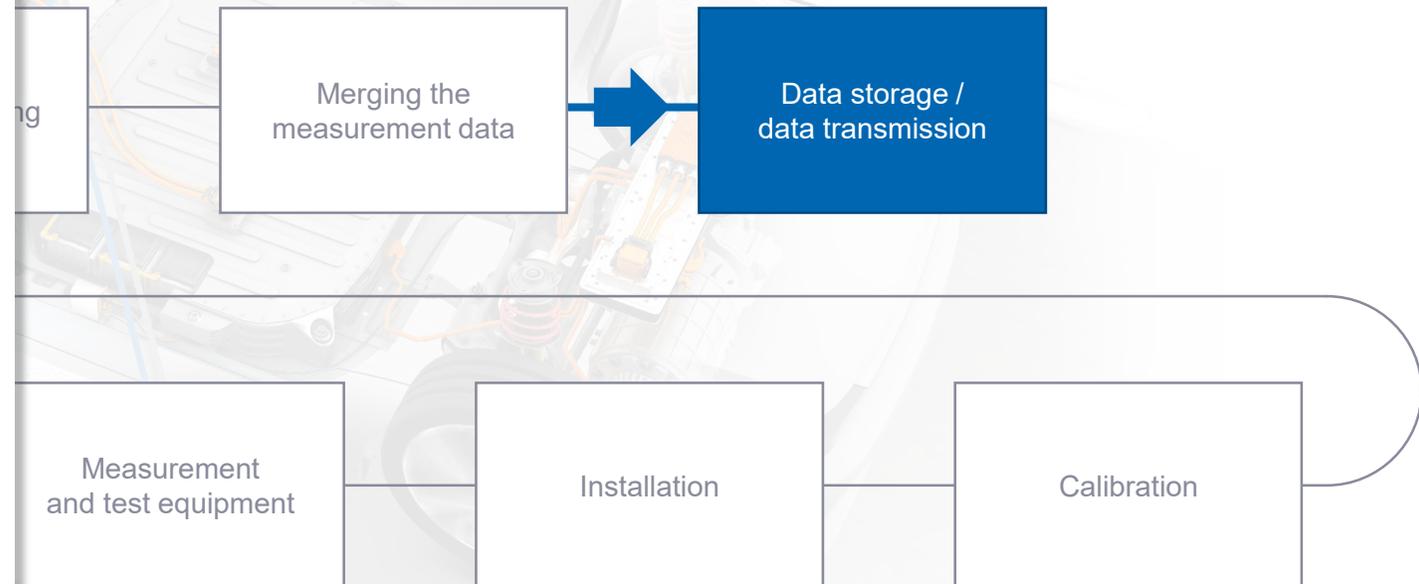
# The Measurement Data Processing

## Data Storage & Data Transmission

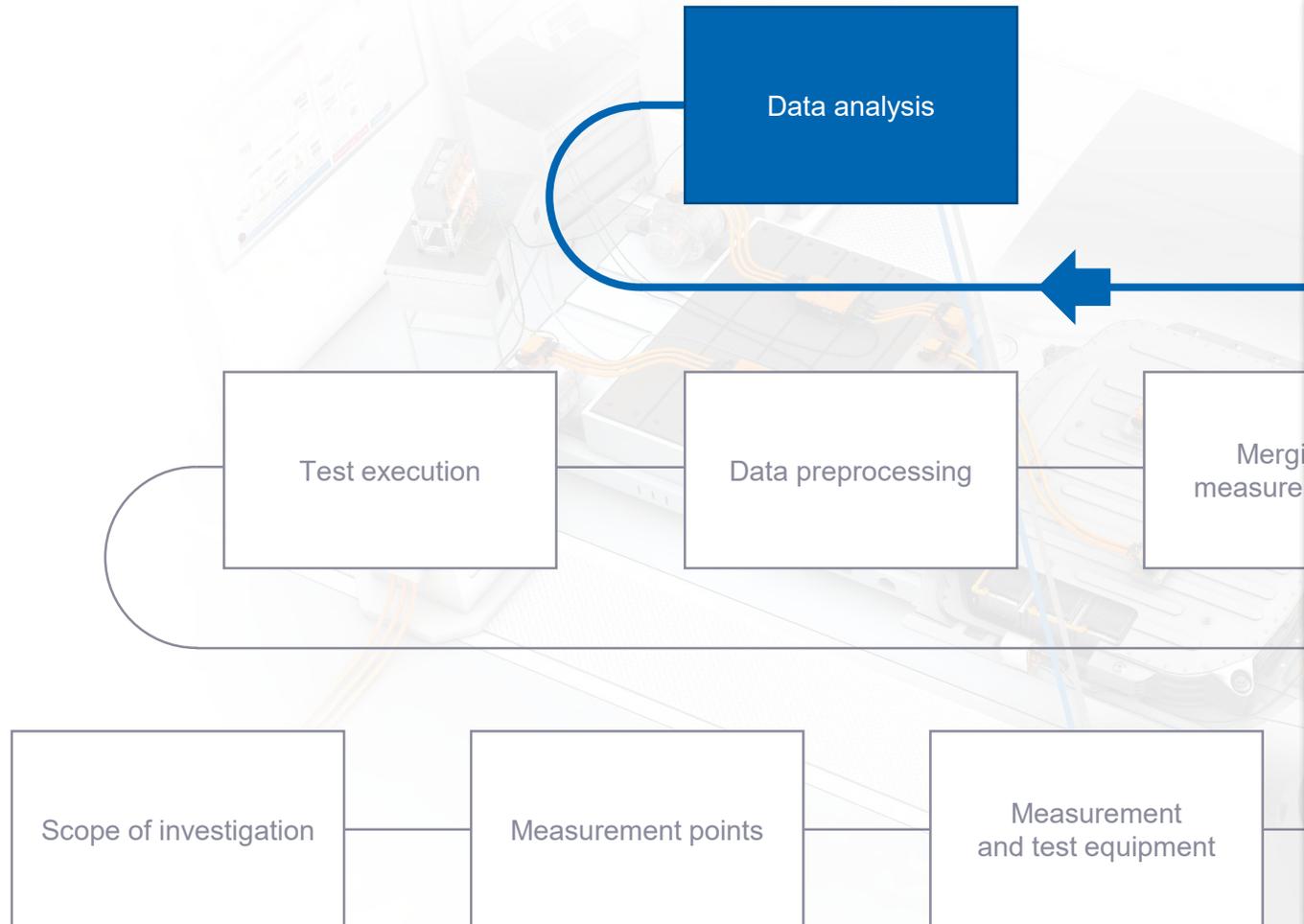
- ▶ Intelligent data storage?
  - ▶ Trigger, compression, target format,...
- ▶ Storage capacity?
- ▶ Remote data transmission via mobile radio or WLAN?

Optimization by:

Powerful data acquisition with smart data management  
and, if necessary, cellular modem / radio connection



# The Measurement Data Processing



## Data Analysis (offline)

- ▶ Evaluation that can be automated (scripts)?
- ▶ Evaluation of test series?
- ▶ Analysis of single aspects (e.g. "only" performance data)
  - ▶ Combined evaluations (performance data + NVH combined)

Optimization by:

Powerful offline analysis tools with connection to measurement databases and modular expandability, as well as open interfaces and use of standard formats

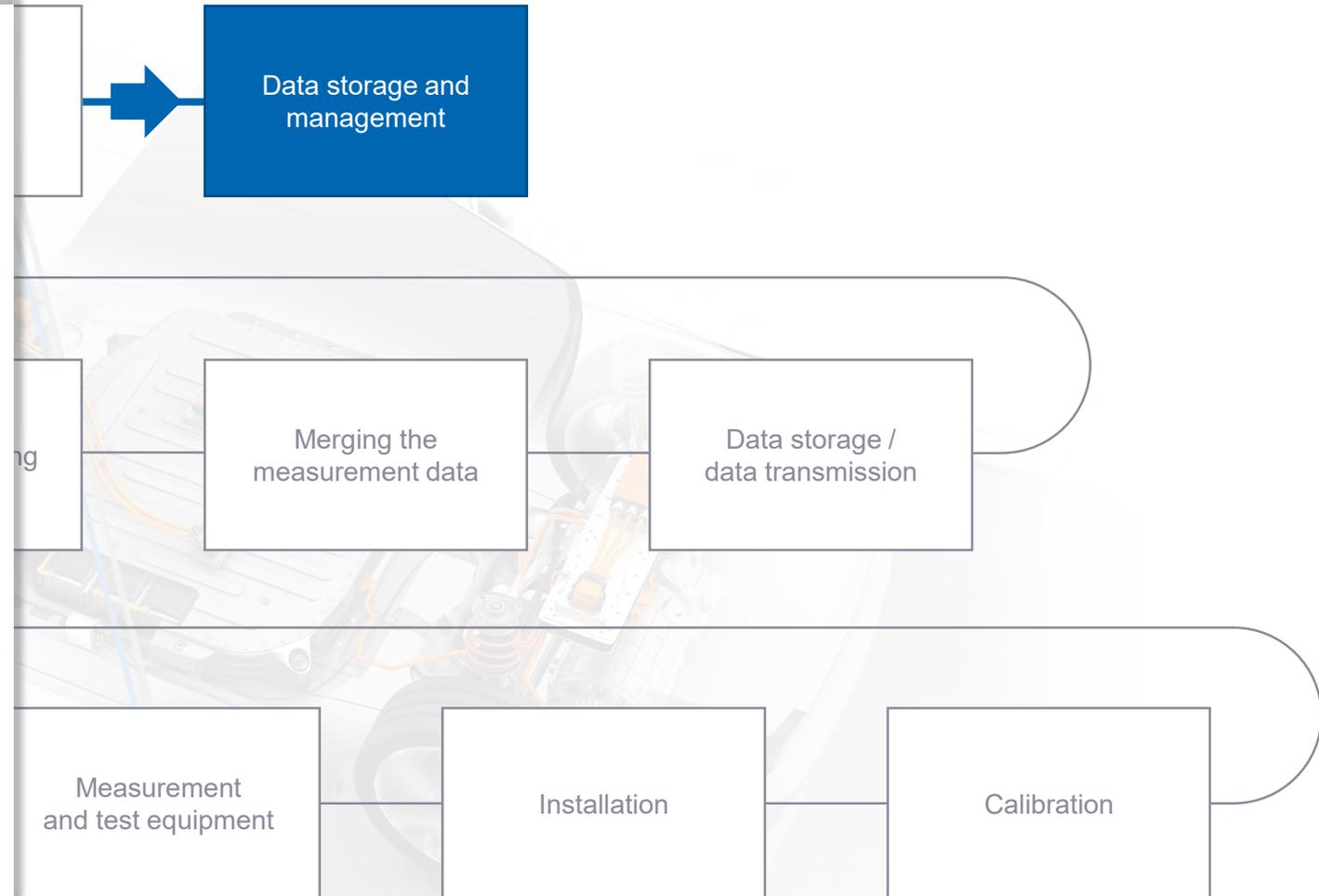
# The Measurement Data Processing

## Data Storage & Management

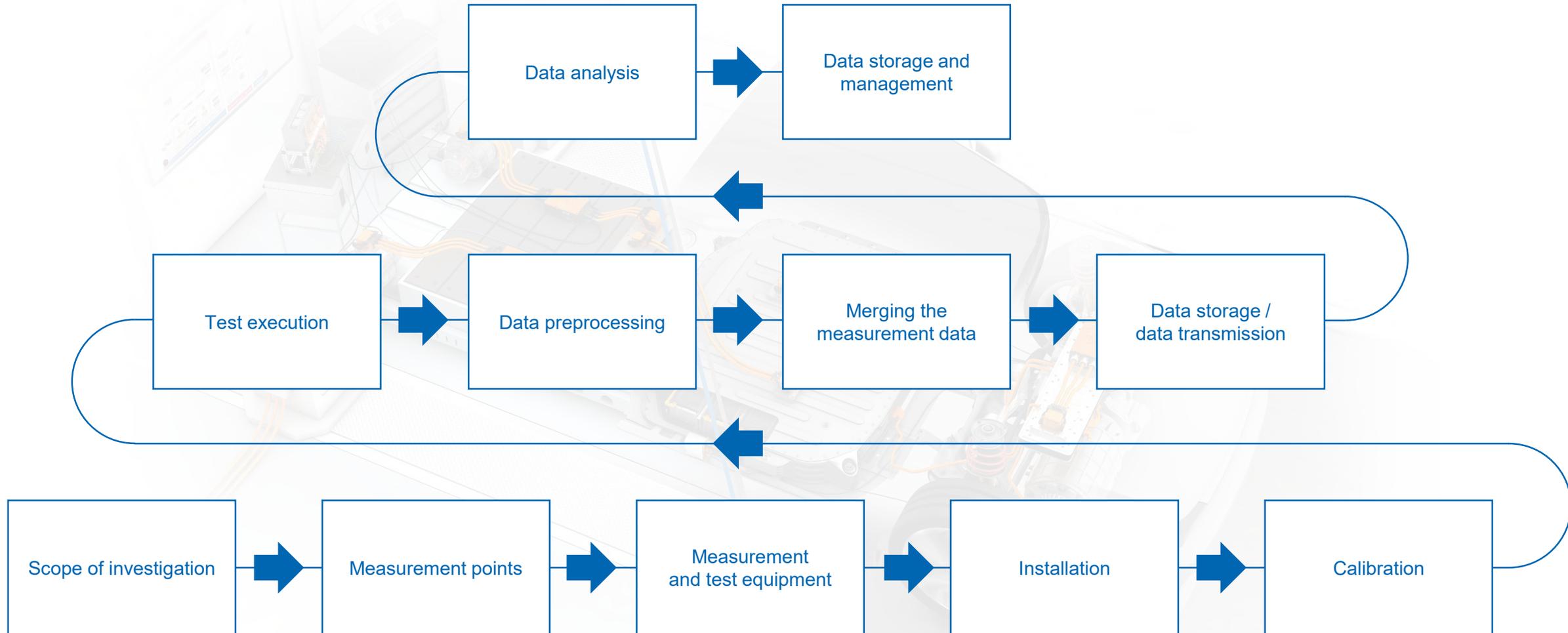
- ▶ Measurement database?
- ▶ Or folder storage?
- ▶ Server-based storage? Cloud connection / Big Data?
- ▶ Analysis options?

Optimization by:

Cloud-based measurement database with direct access to the offline analysis tool for rapid analysis of entire test series



# The Measurement Data Processing



# The Measurement System

## Requirements for maximizing efficiency

Flexible adaptation of the measurement system to different measurement tasks and in different combinations

**Versatility**

Easy expansion of the measurement setup with additional measurement technology for the acquisition of more measurement points

**Scalability**

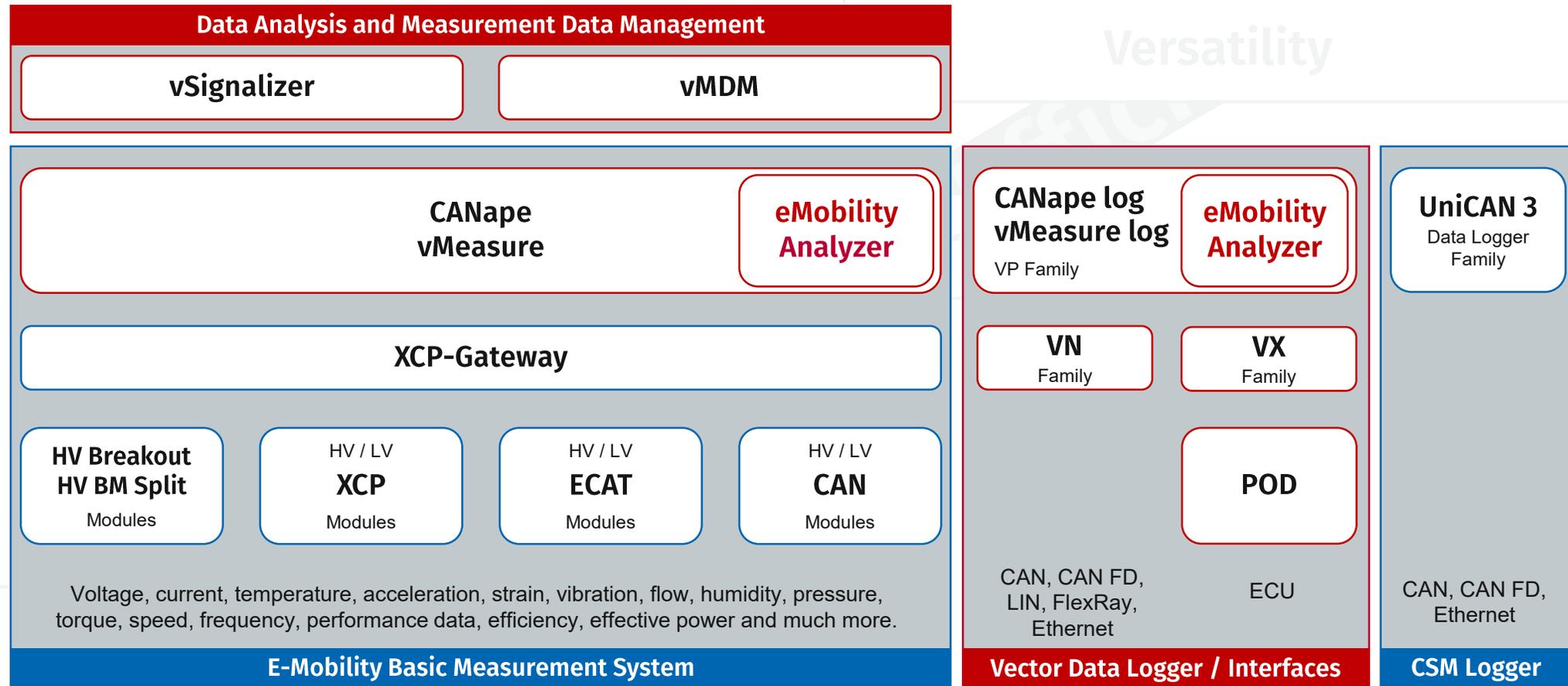
**Modularity**

Flexible combination of specialized measurement technology (with the appropriate number of channels)

**Connectivity**

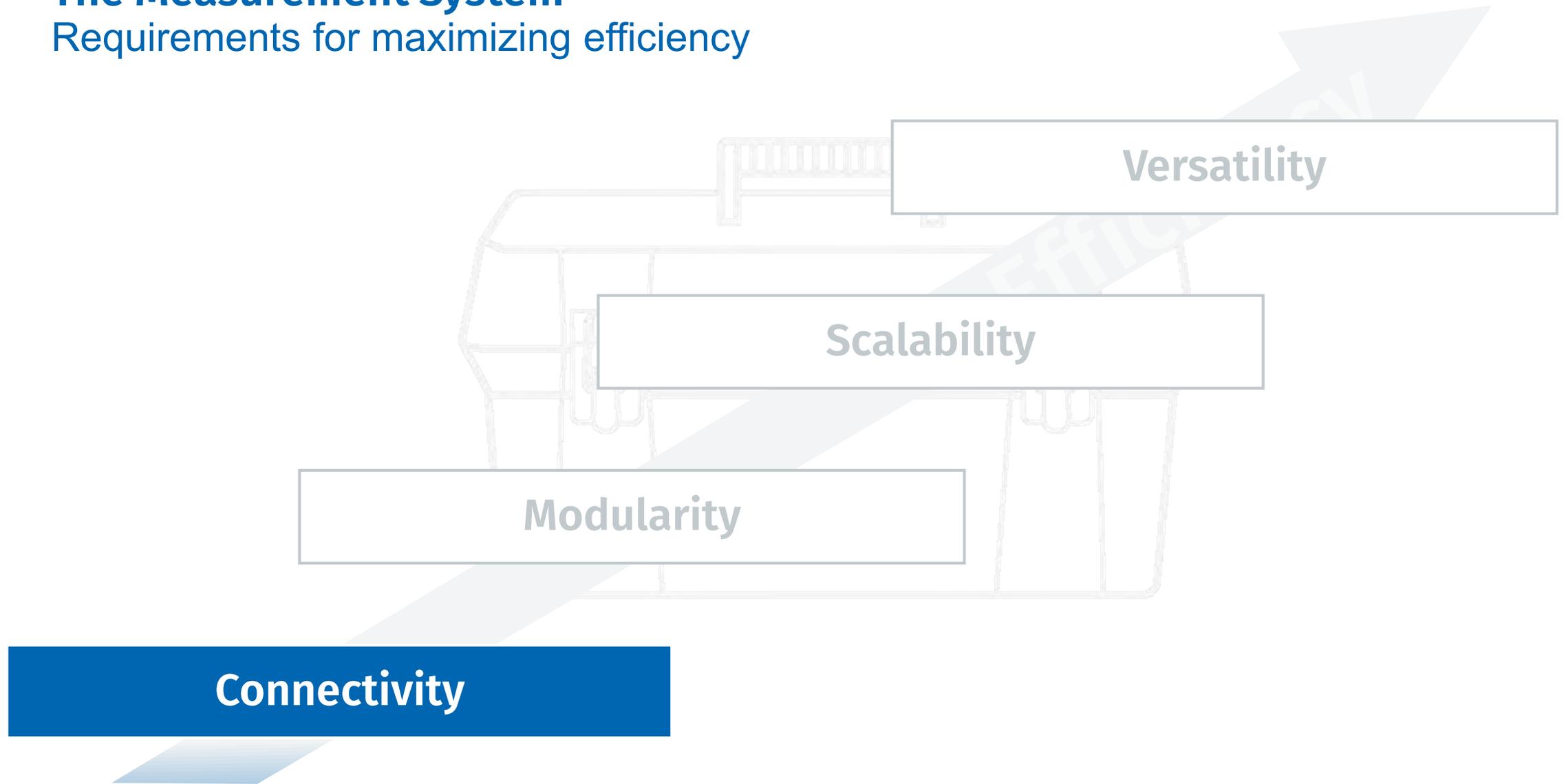
Utilization of compatible bus systems, suitable interfaces, synchronization mechanisms and file formats for easy connection of the measurement technology and the measurement data it generates

# The Vector CSM E-Mobility Measurement System



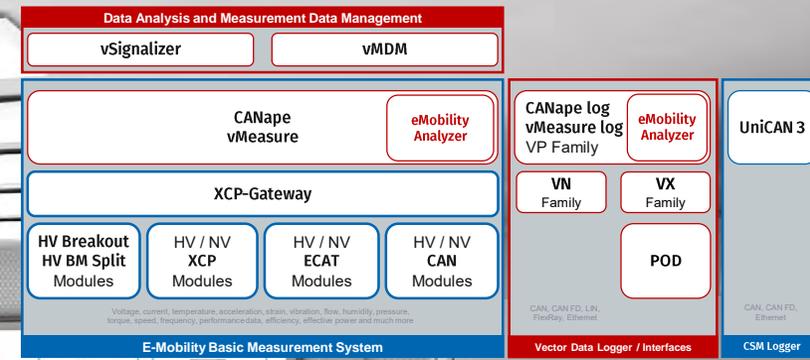
# The Measurement System

Requirements for maximizing efficiency



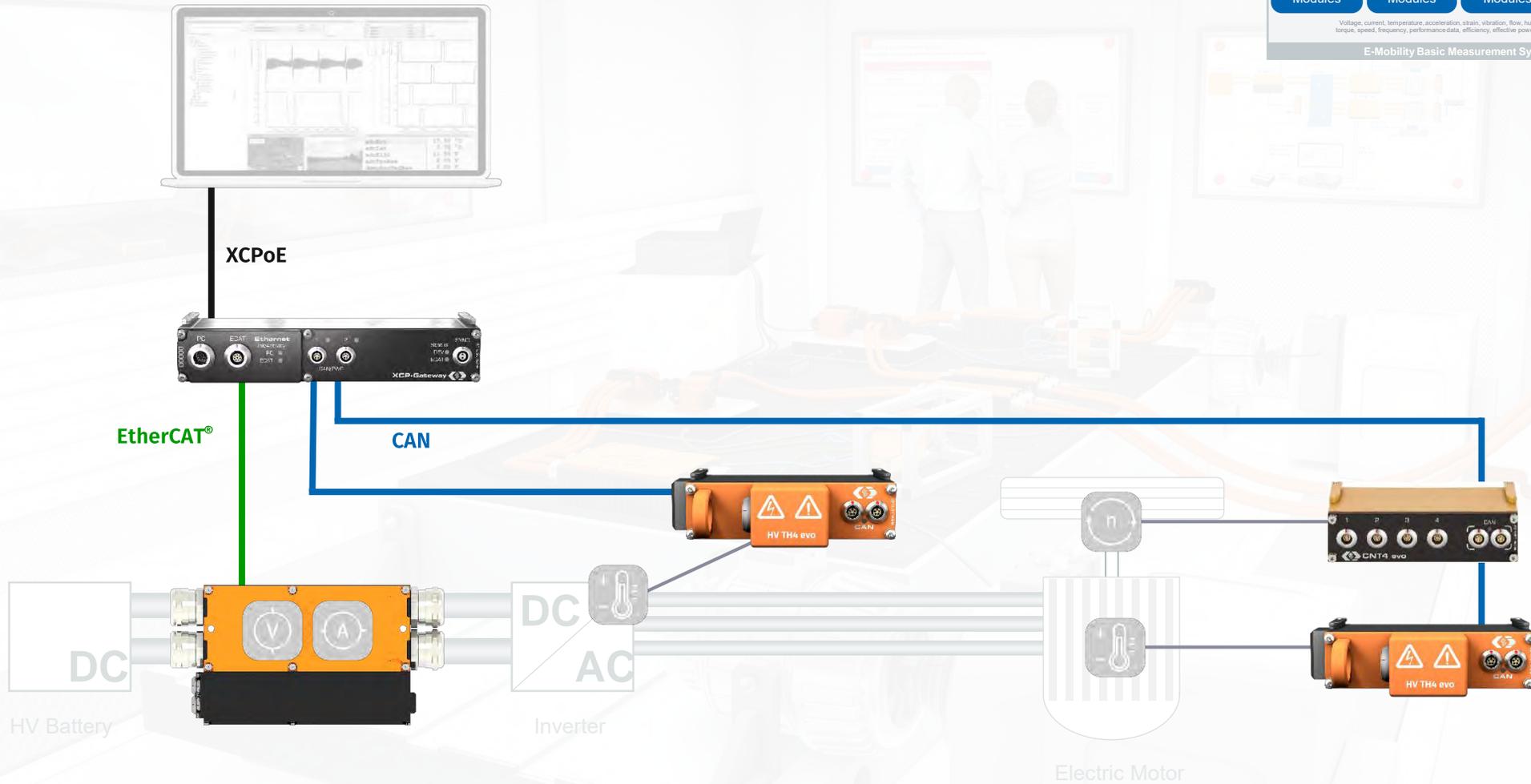
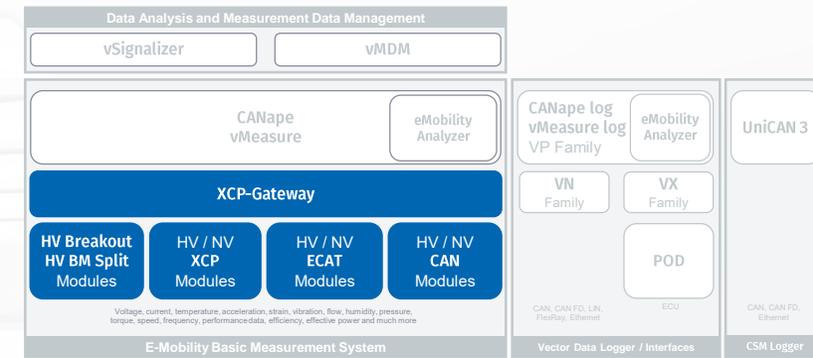
# Connectivity

Utilization of compatible bus systems, suitable interfaces, synchronization mechanisms and file formats for easy connection of the measurement technology and the measurement data it generates



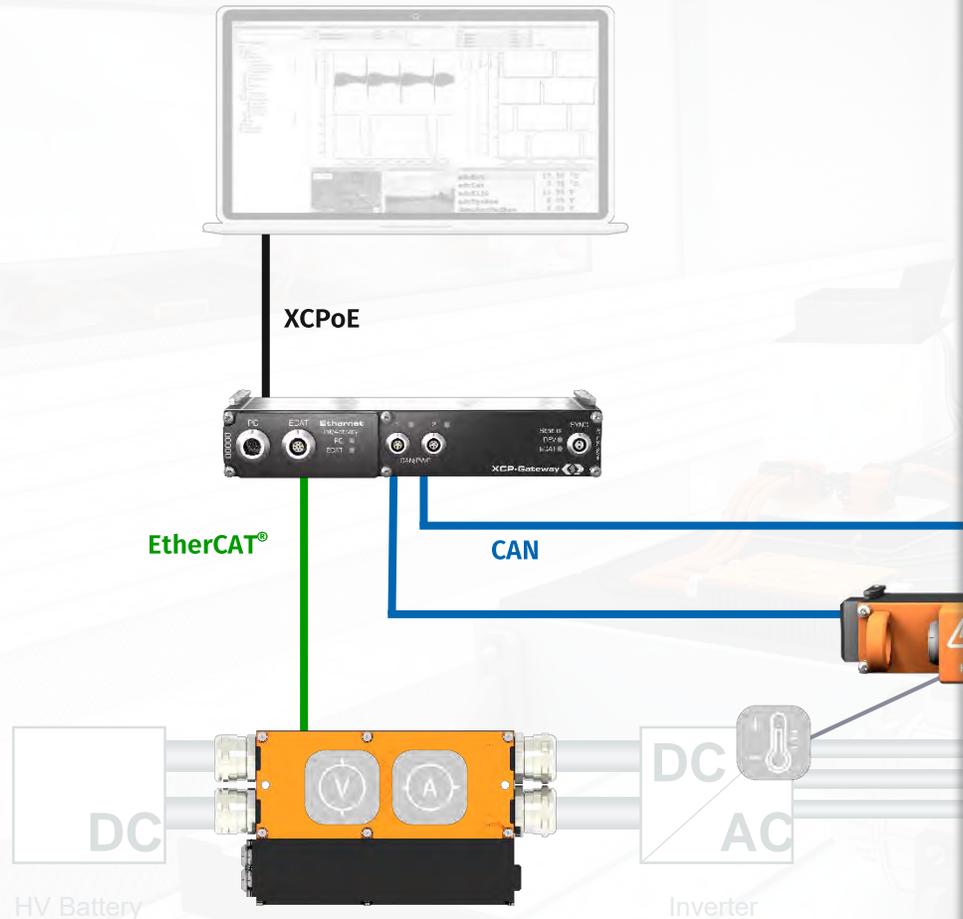
# Connectivity

## Power measurement on the electric powertrain



# Connectivity

Power measurement on the electric p



## Support of different bus systems and synchronization mechanisms

### XCP-on-Ethernet

- ▶ High-speed Interface
- ▶ PTP-Synchronisation (IEEE 1588)

### EtherCAT®

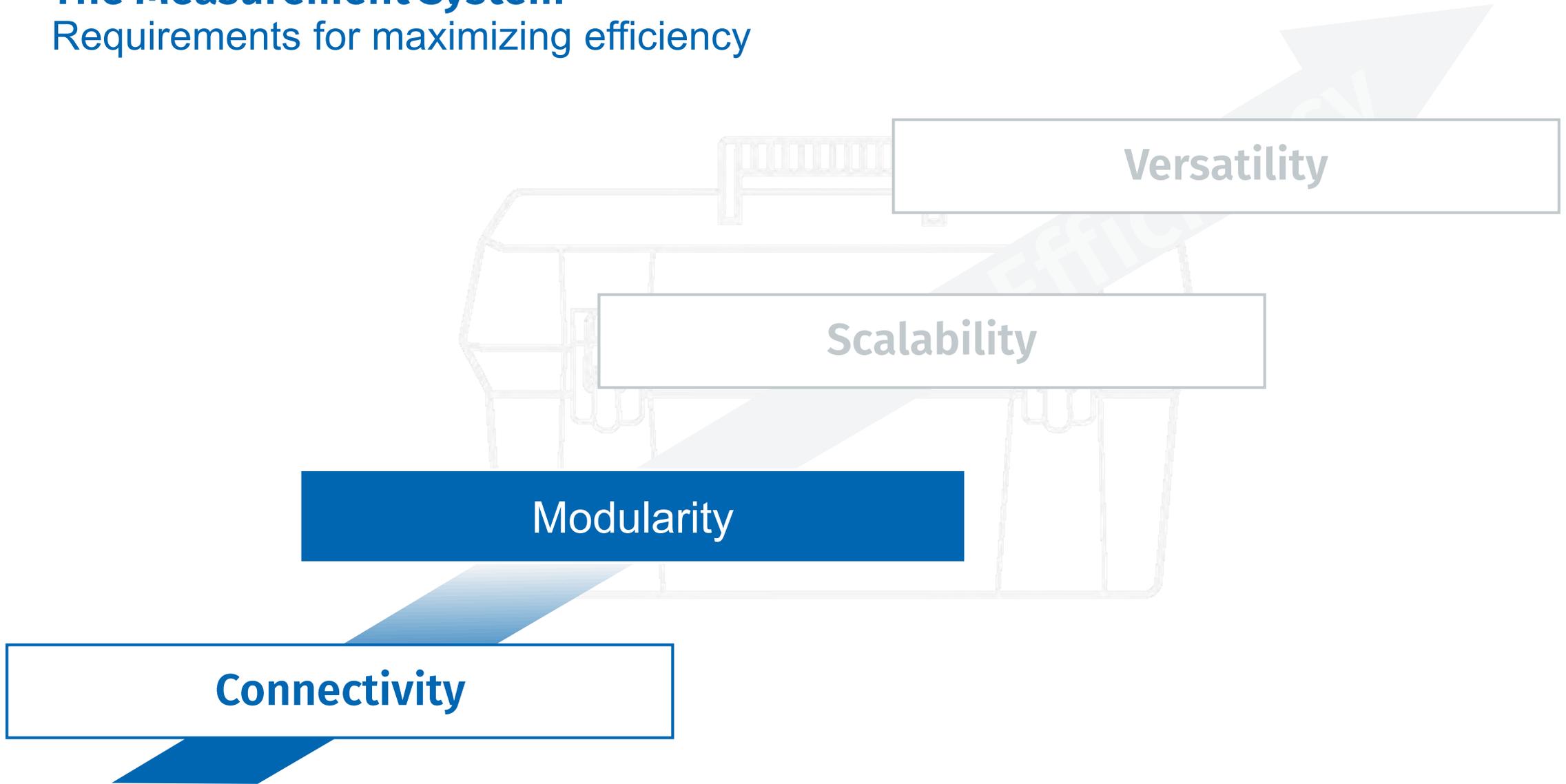
- ▶ Fast protocol for hundreds of measurement channels
- ▶ Synchronization via distributed clock

### CAN-Bus

- ▶ Slower signals
- ▶ Very easy handling

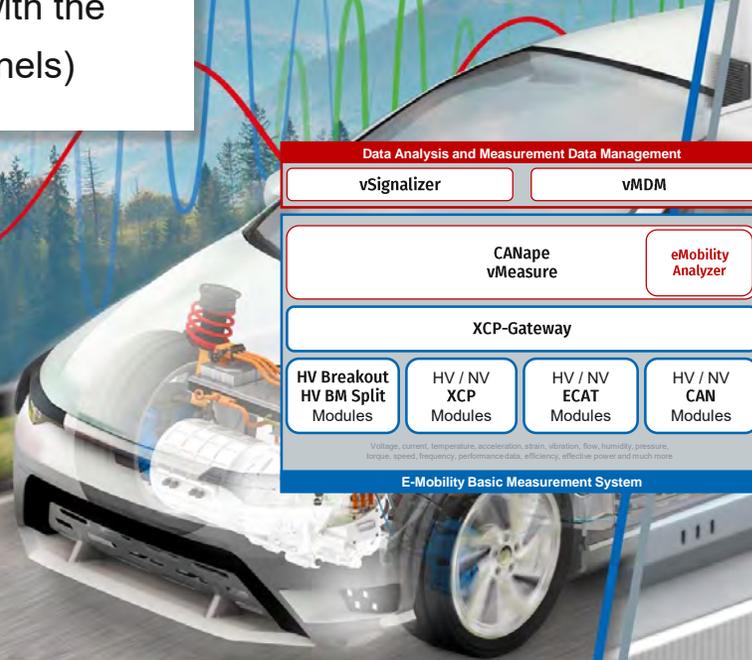
# The Measurement System

Requirements for maximizing efficiency



# Modularity

Flexible combination of specialized measurement technology (with the appropriate number of channels)



# Modularity

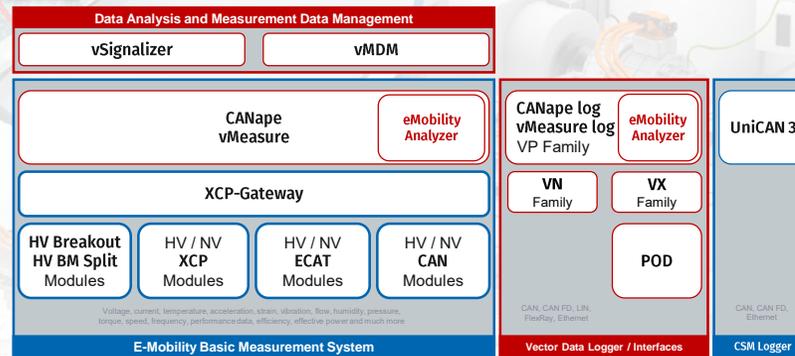
Test bench and road test

HV safe and conventional

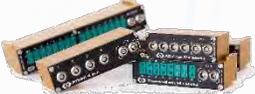
Robust measurement technology

Different measurement data rates

Various measured values



# CSM Measurement Technology Selection

		Current	Voltage	Temperature	Sensor voltages	Strain gauges	IEPE	Frequencies
								
HV-safe	XCPoE							
	EtherCAT							
	CAN							
Conventional	EtherCAT							
	CAN							

# Modularity

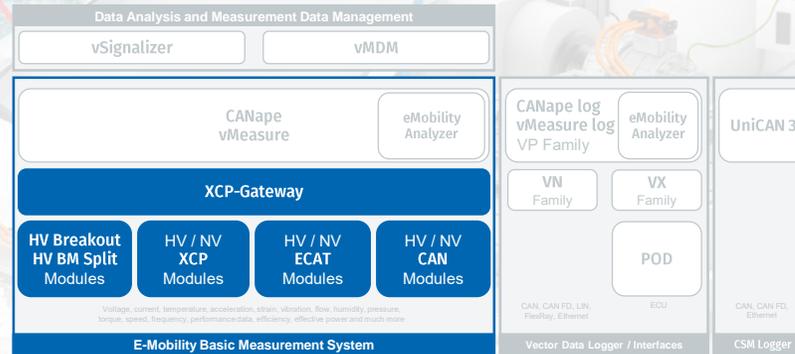
Test bench and road test

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# Modularity

Test bench and road test

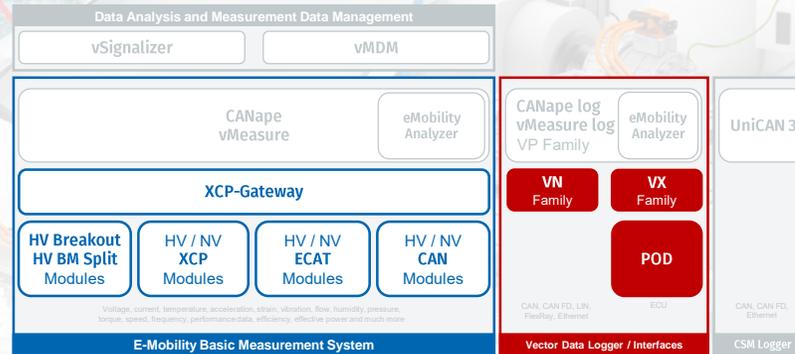
HV safe and conventional

Integration of ECU data

Robust measurement technology

Different measurement data rates

Various measured values



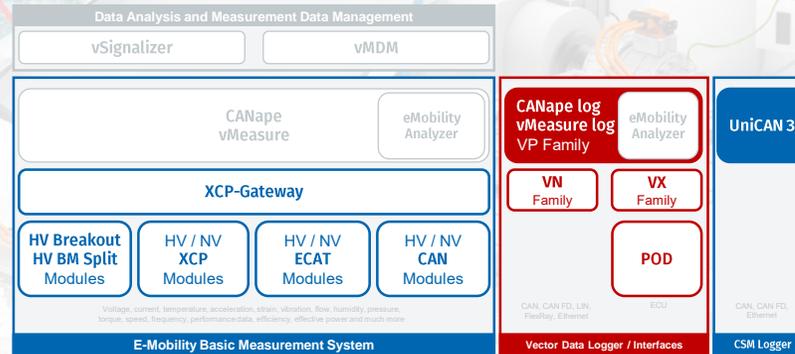
# Modularity

Test bench and road test

HV safe and conventional

Integration of ECU data

Robust measurement technology



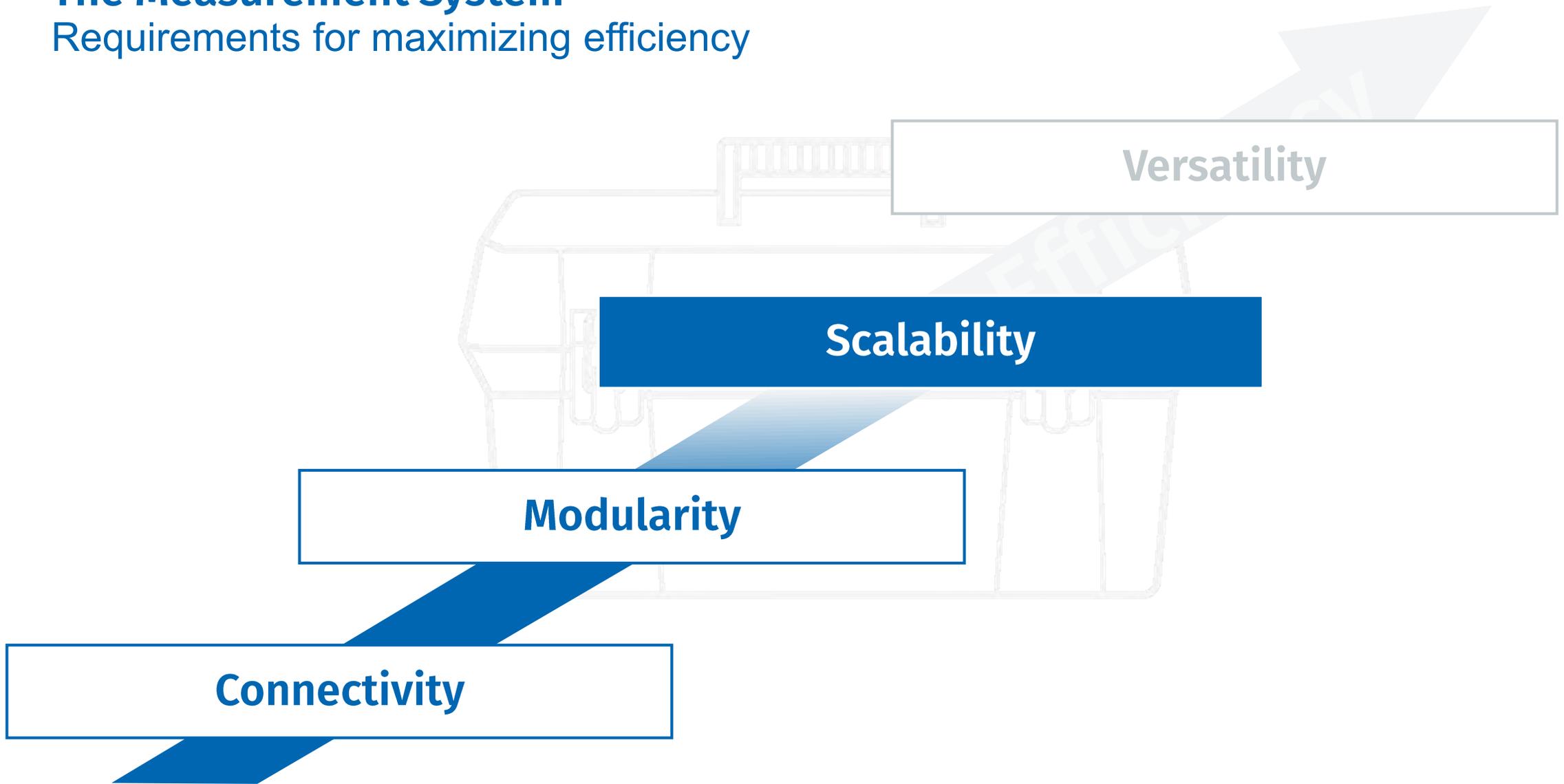
Different measurement data rates

Date logger solutions

Various measured values

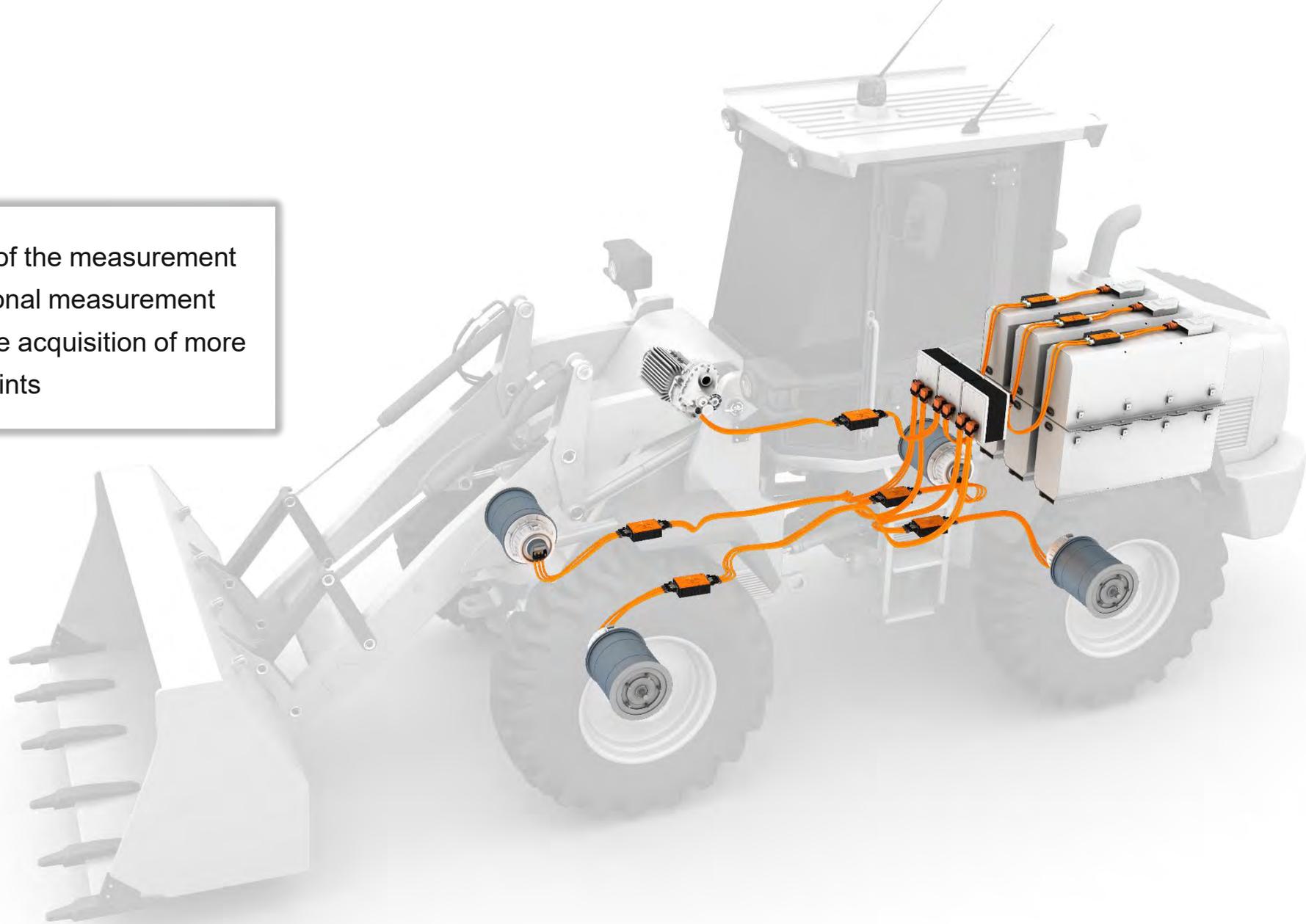
# The Measurement System

Requirements for maximizing efficiency



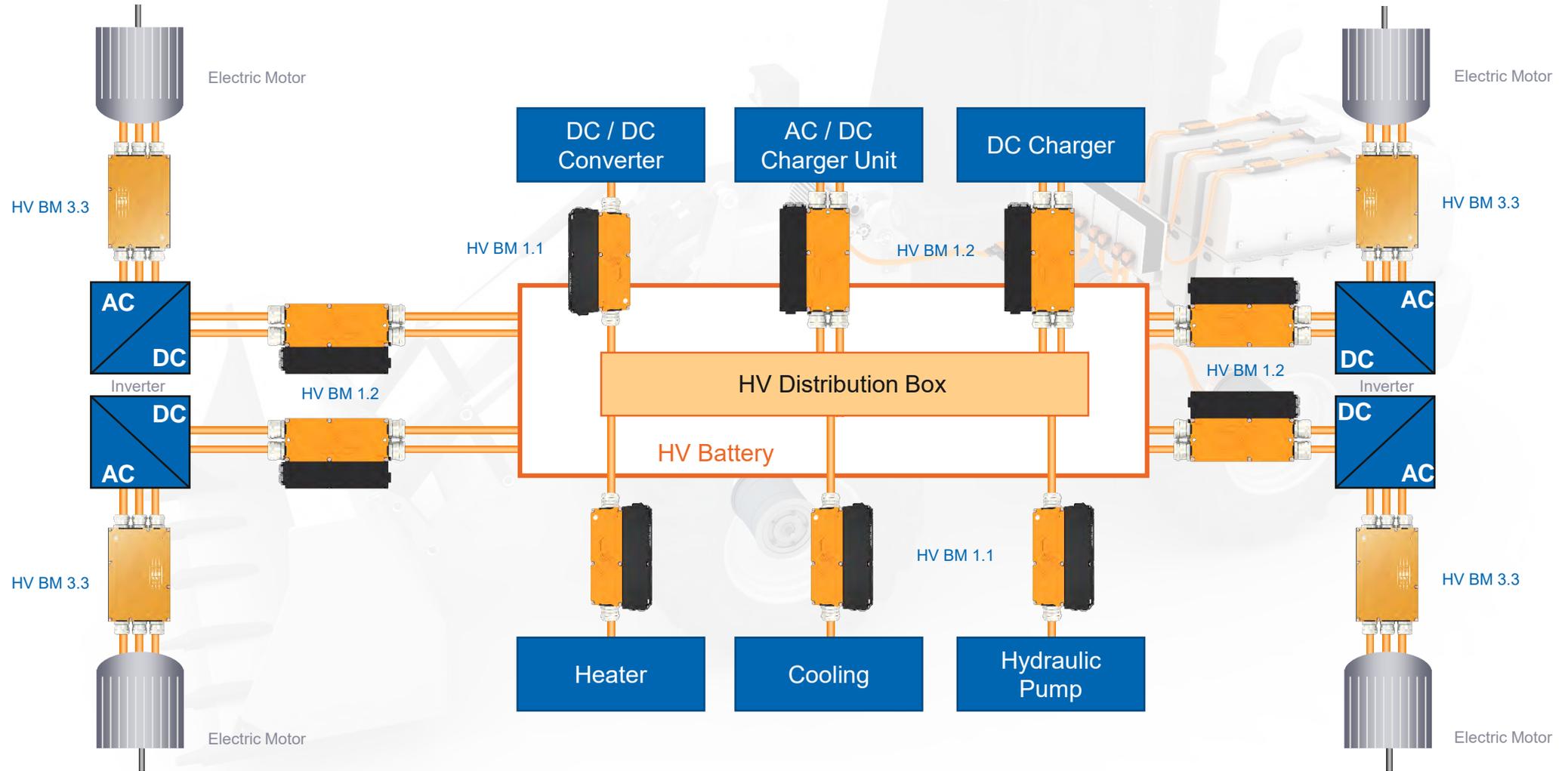
# Scalability

Easy expansion of the measurement setup with additional measurement technology for the acquisition of more measurement points



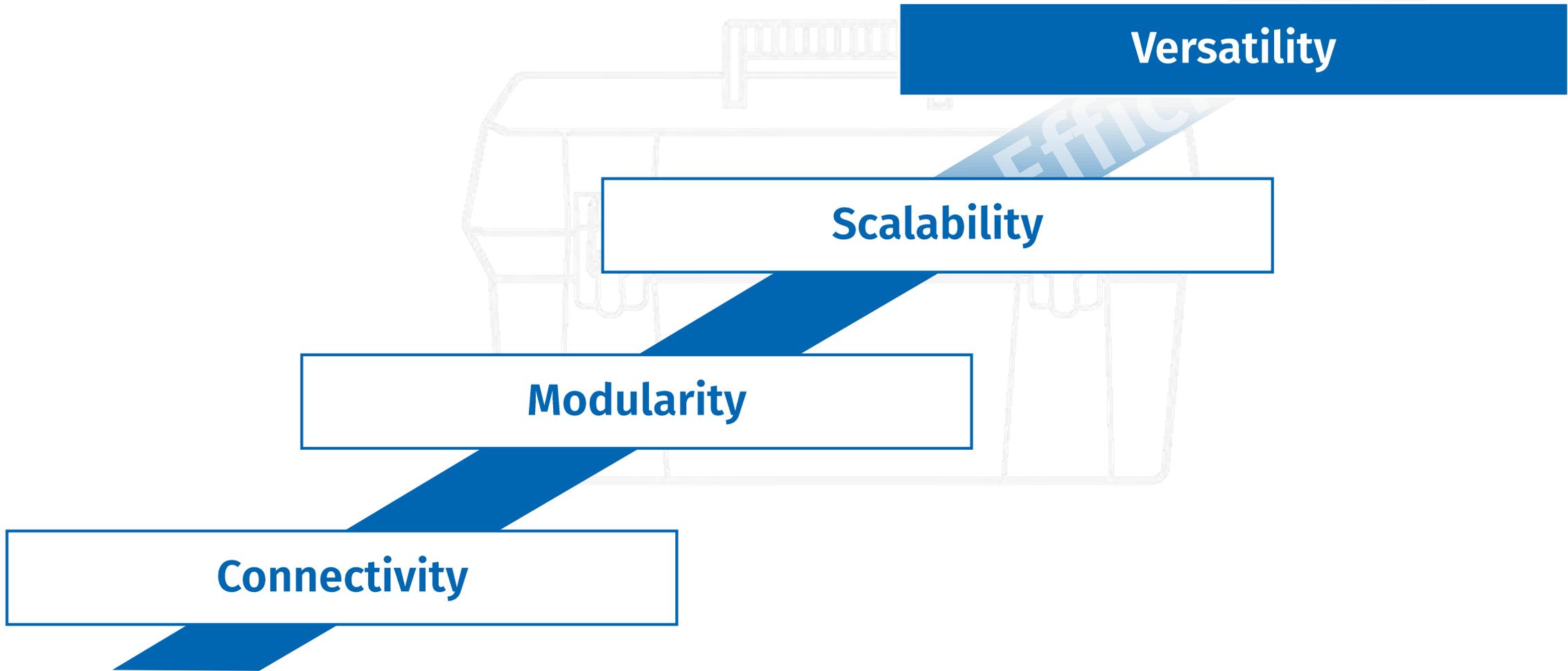
# Scalability

## Power measurement on the electric drive train



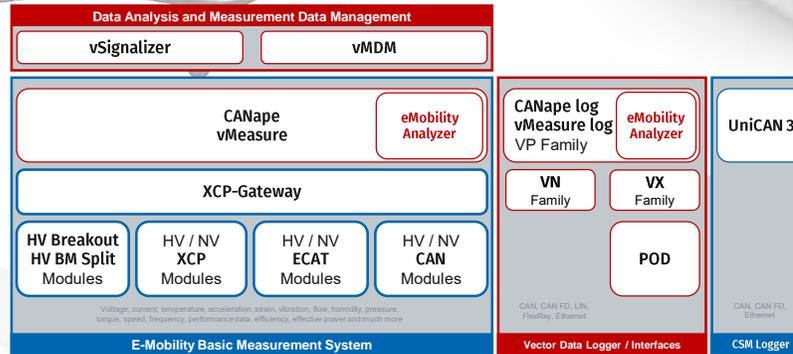
# The Measurement System

Requirements for maximizing efficiency



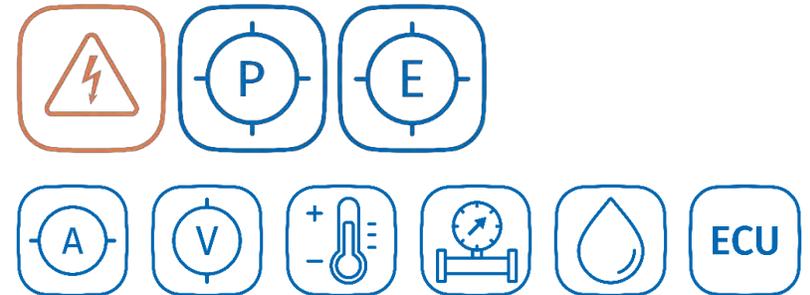
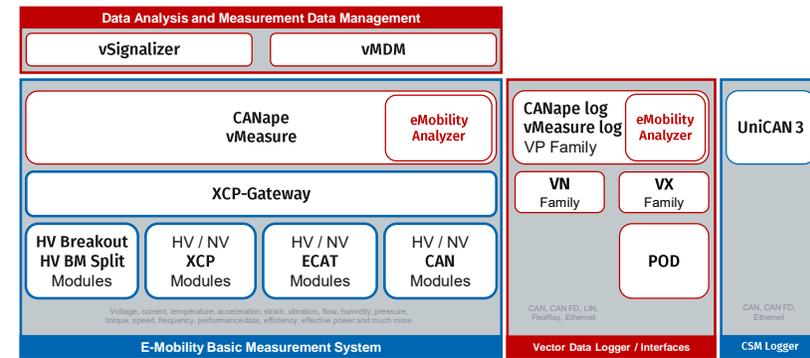
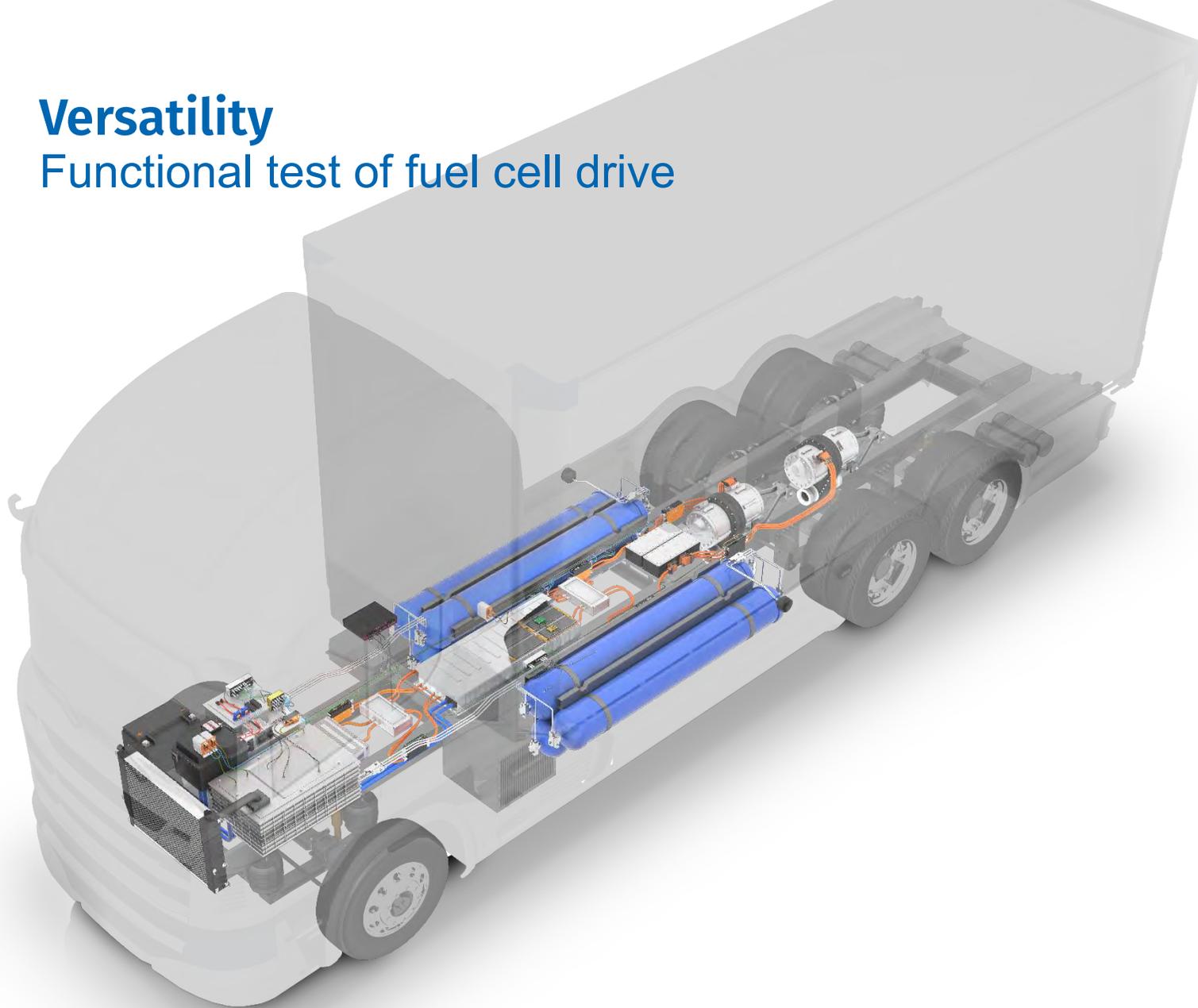
# Versatility

Flexible adaptation of the measurement system to different measurement tasks and in different combinations



# Versatility

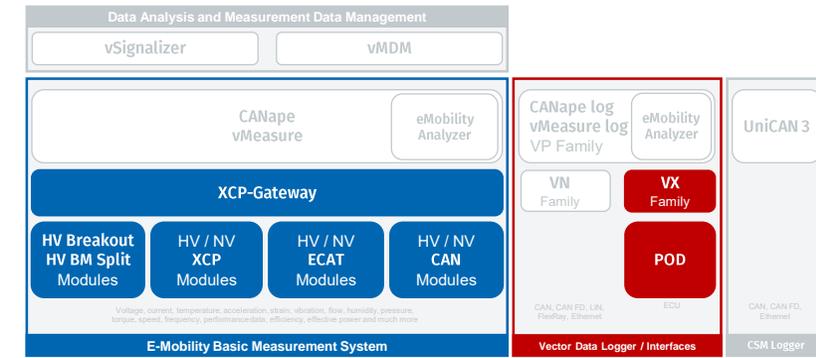
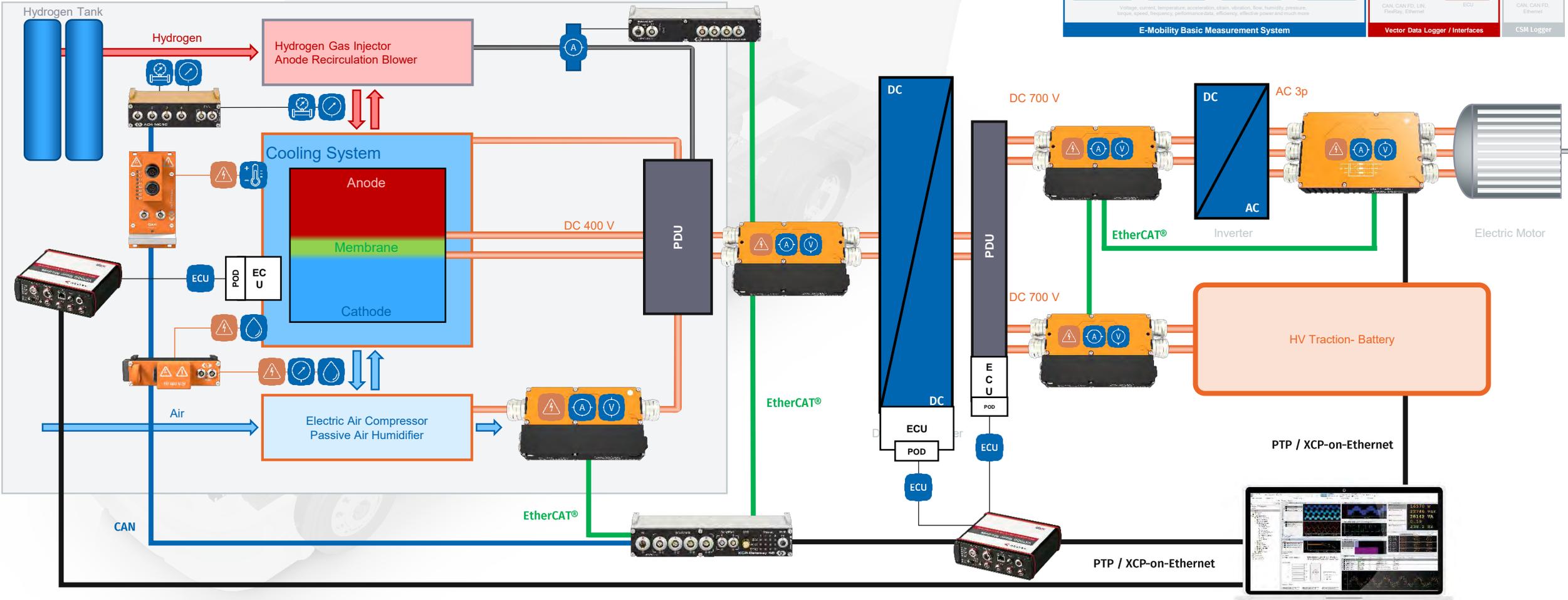
## Functional test of fuel cell drive



Acquisition of various measured values in the fuel cell stack as well as in the electric powertrain

# Versatility

## Functional test of fuel cell drive





# About CSM

CSM has been setting technological standards for decentralized measurement technology in vehicle development for over 35 years. Our CAN bus and EtherCAT® measurement devices support worldwide renowned vehicle manufacturers, suppliers and service providers in their developments.

Continuous innovation and long-term satisfied customers are our guarantee for success. Together with our partner Vector Informatik, we have developed an easily scalable and powerful E-Mobility Measurement System for hybrid and electric vehicles and are constantly expanding the areas of application. With our high-voltage safe measurement systems designed for fast and synchronous measurements and power analyses, we actively accompany the change to **E-Mobility**.

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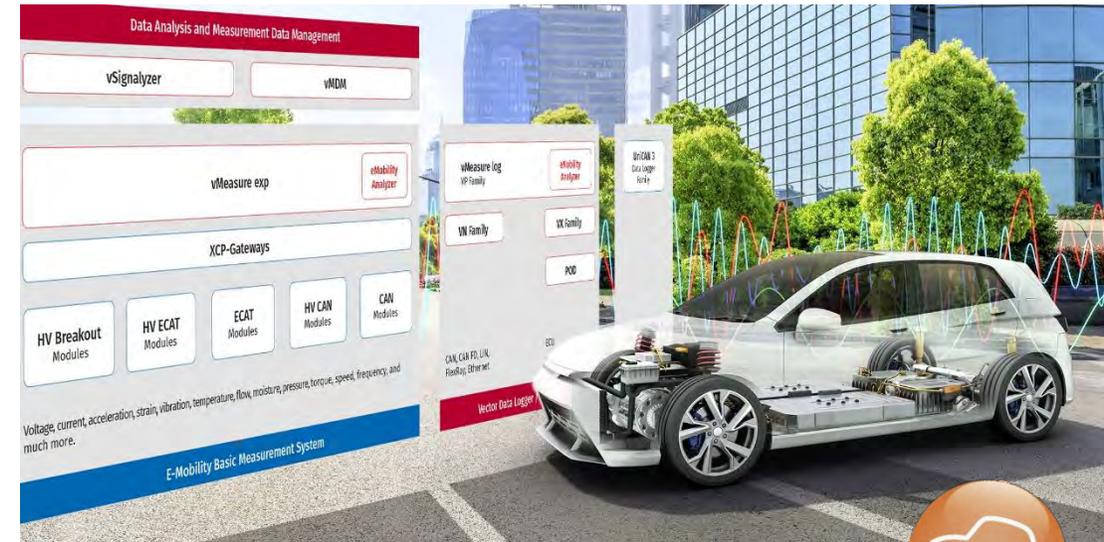
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