



# Data logging of analog signals in worldwide fleet testing

CSM Web Seminars



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

Innovative Measurement and Data Technology

# Data logging

## Component testing

## Validation

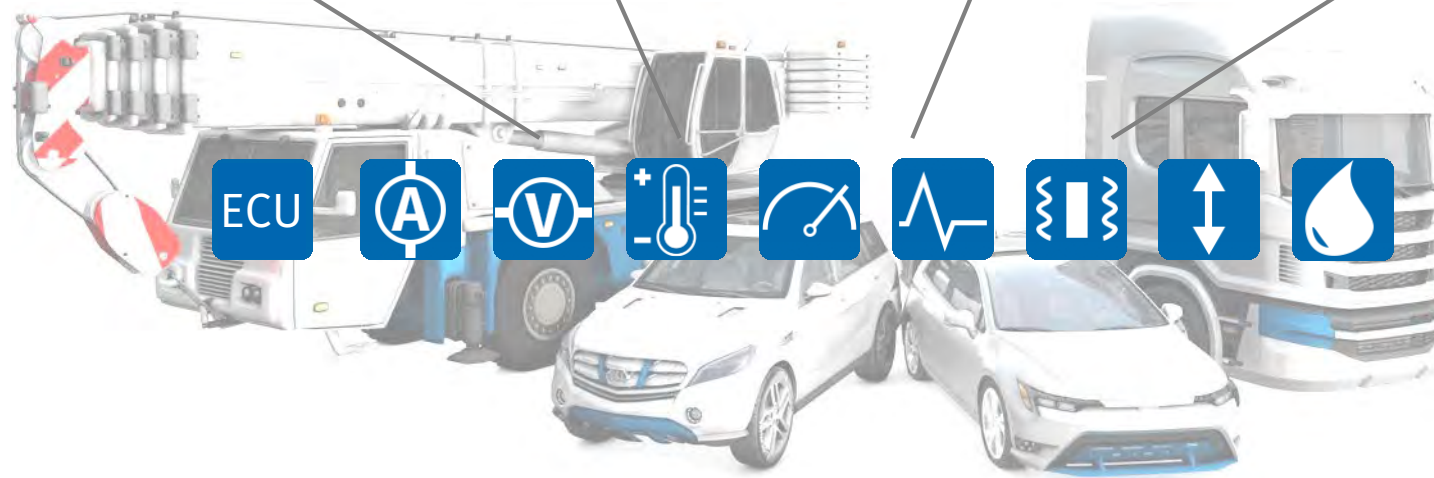
## Driving characteristics

## Benchmarks

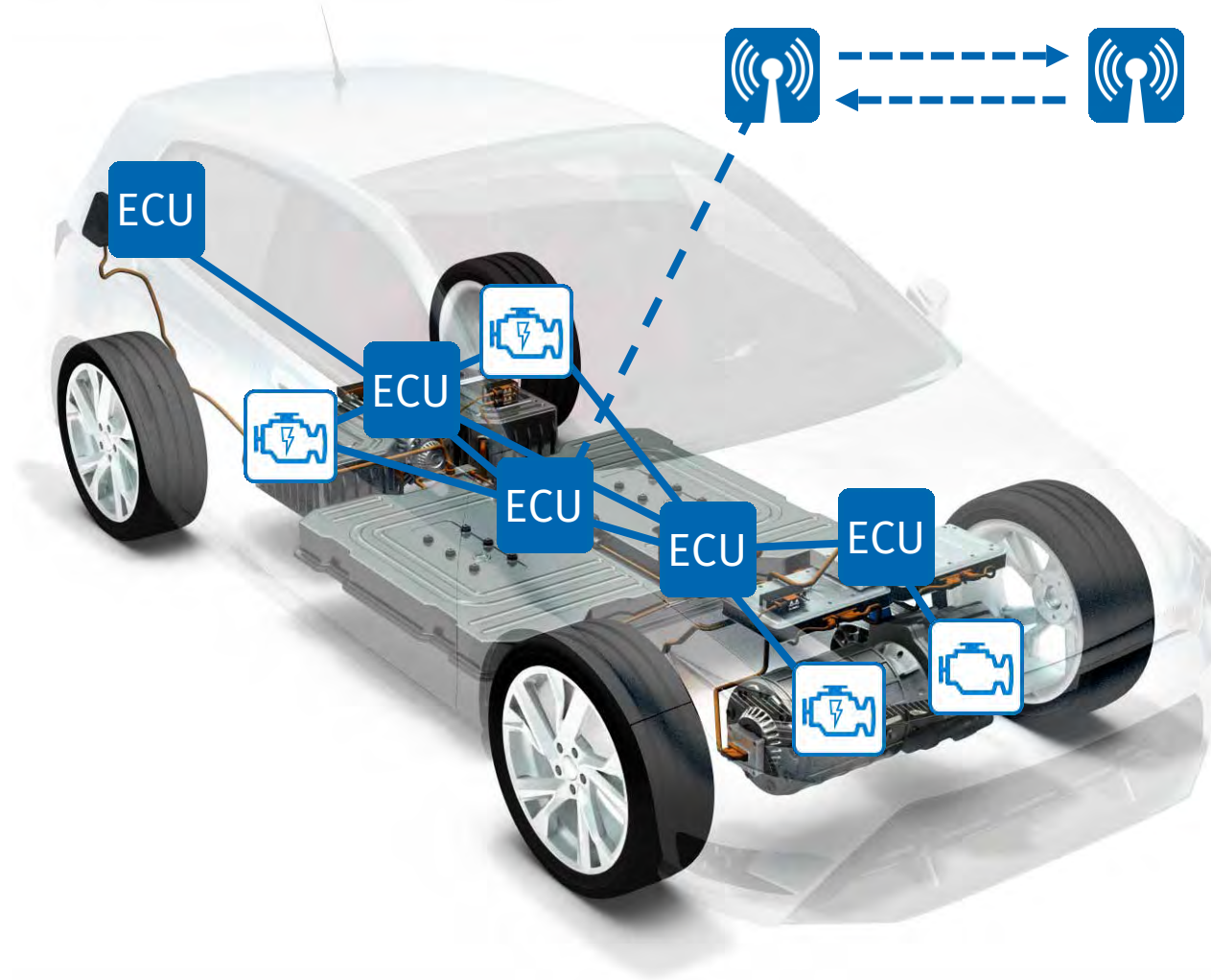
User analysis

Development results

Competitive analyses



# Electromobility as a complexity driver



- ▶ Number of bus systems and signals increases
- ▶ Multiple engines (combustion and electric)
- ▶ Increasing digitalization
- ▶ Data exchange with external data sources
- ▶ **Data volume in vehicles is increasing rapidly**

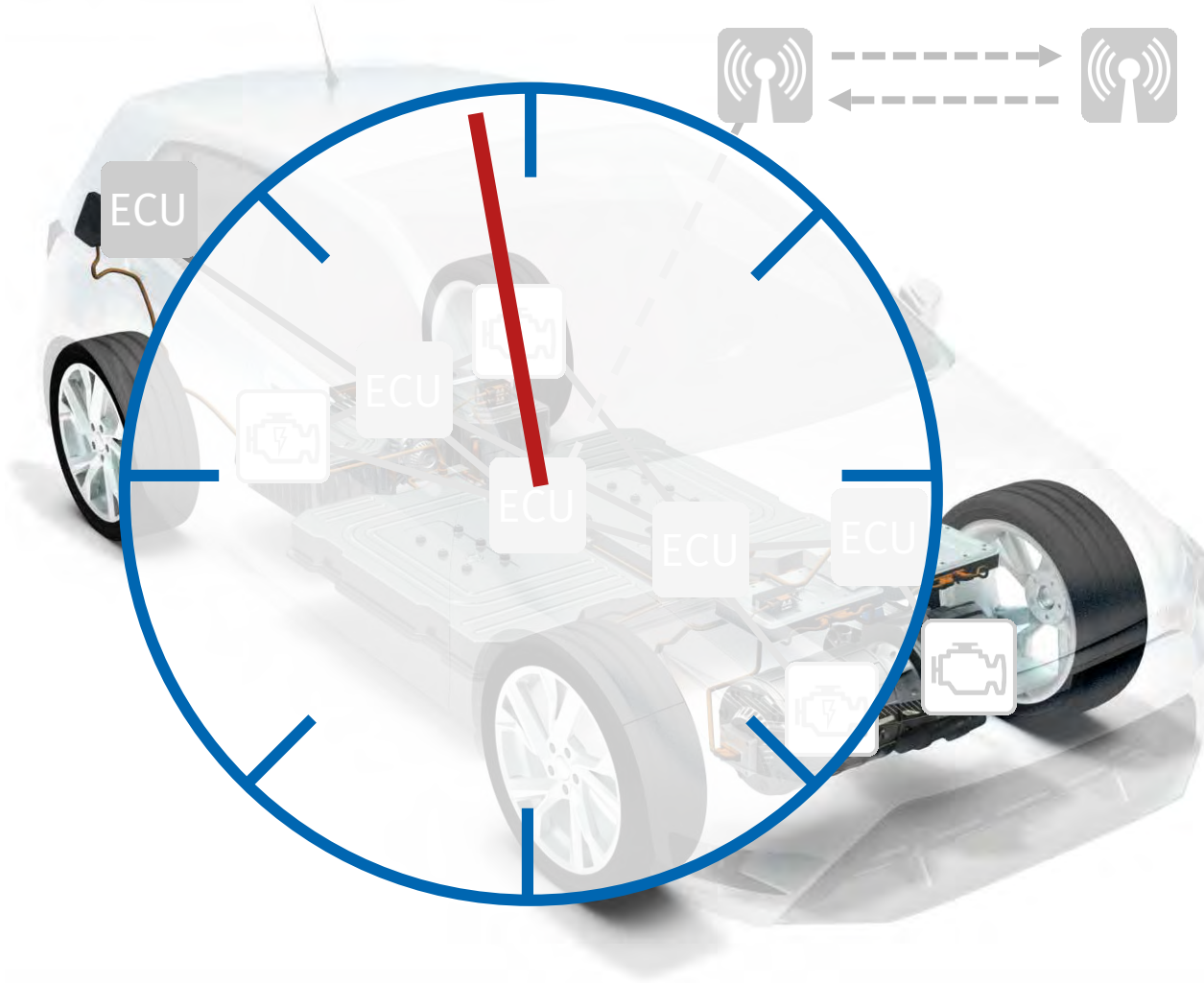
# Electromobility as a complexity driver

*"In some cases, we have to collect up to 100 times as much bus data as we did a few years ago."*

*(Development engineer, German OEM)*



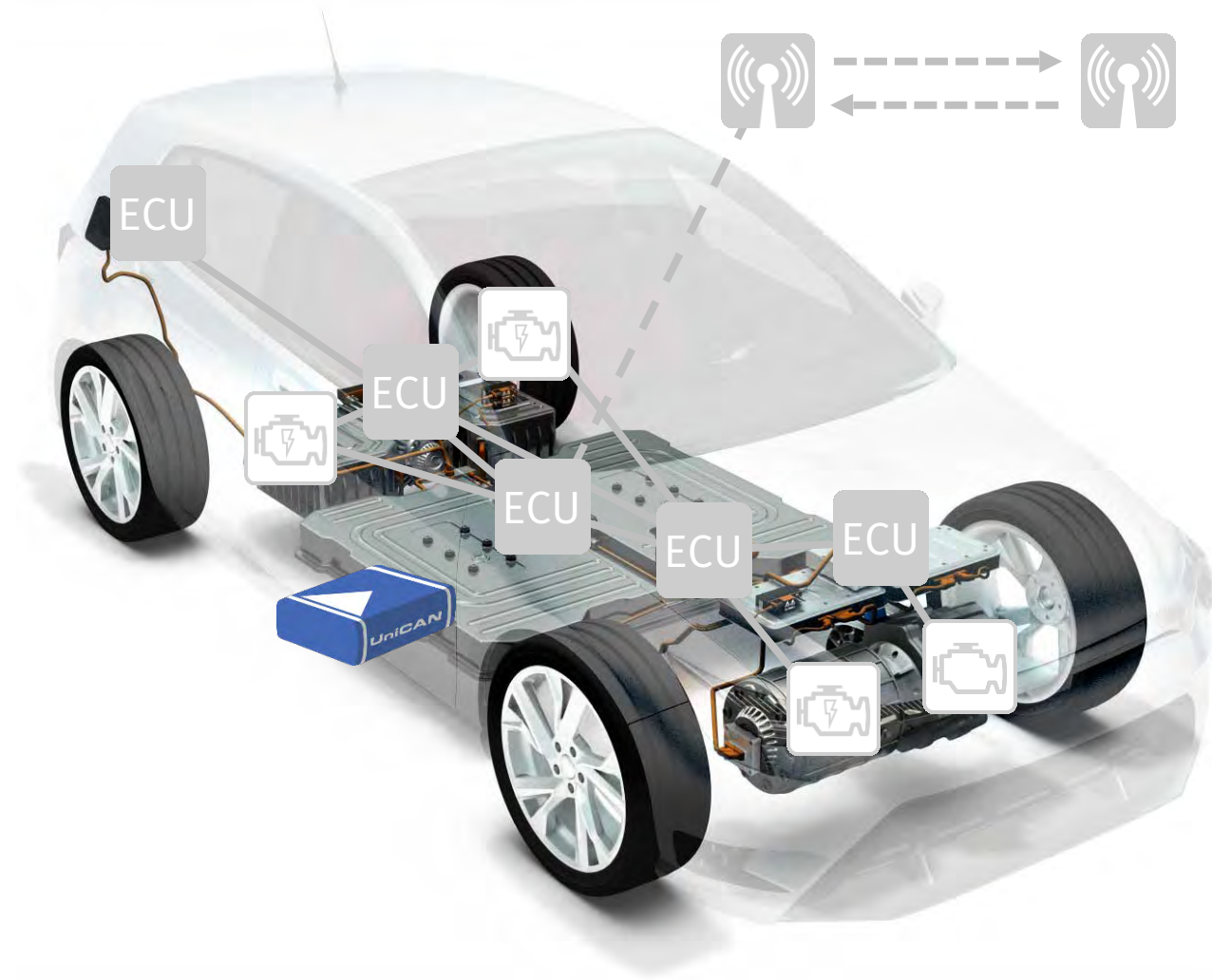
# Electromobility as a complexity driver



- ▶ Number of bus systems and signals increases
- ▶ Multiple engines (combustion and electric)
- ▶ Increasing digitalization
- ▶ Data exchange with external data sources
- ▶ Data volume in vehicles is increasing rapidly
- ▶ **Less time for development**

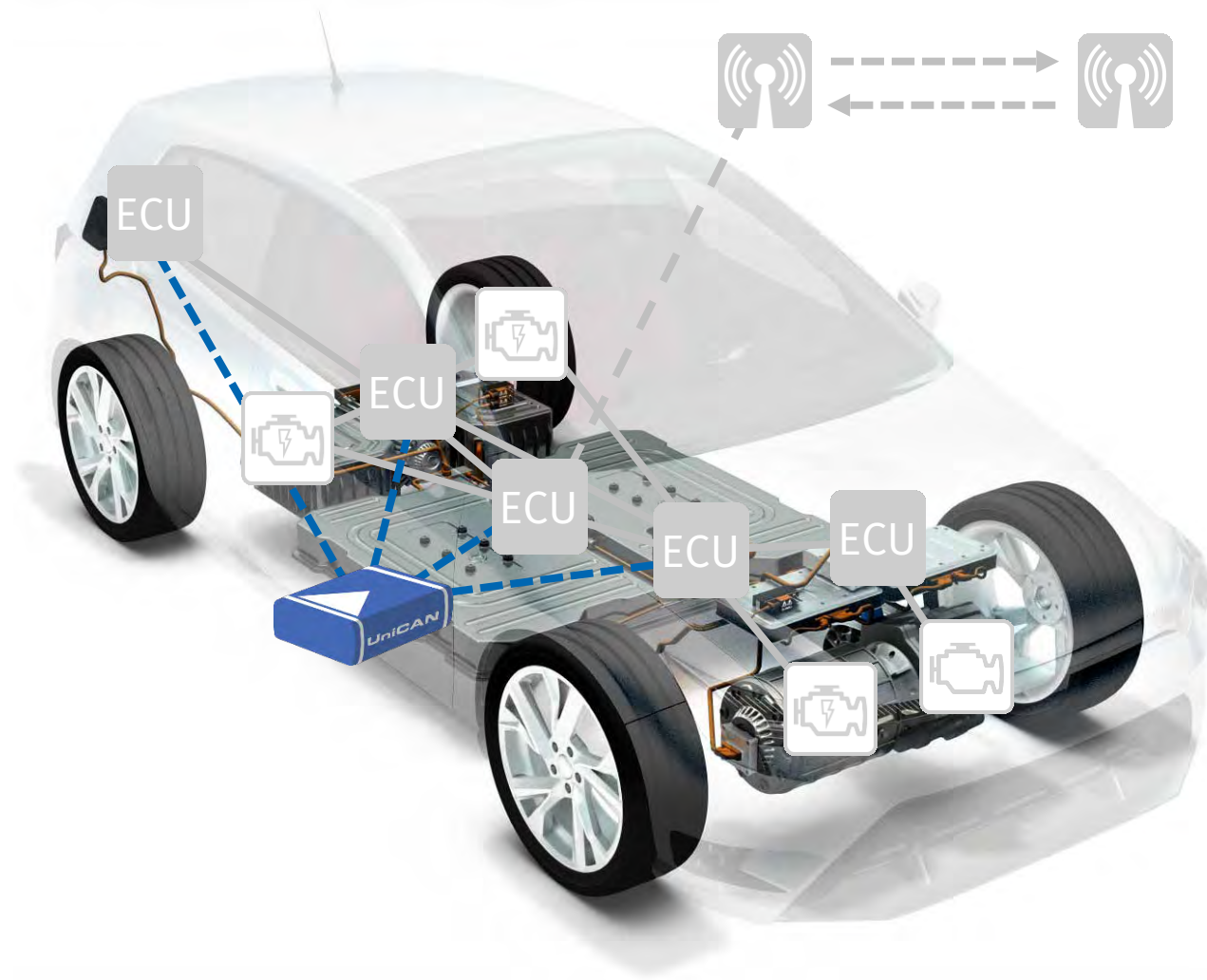
# Data logger requirements

## ► Autonomous operation



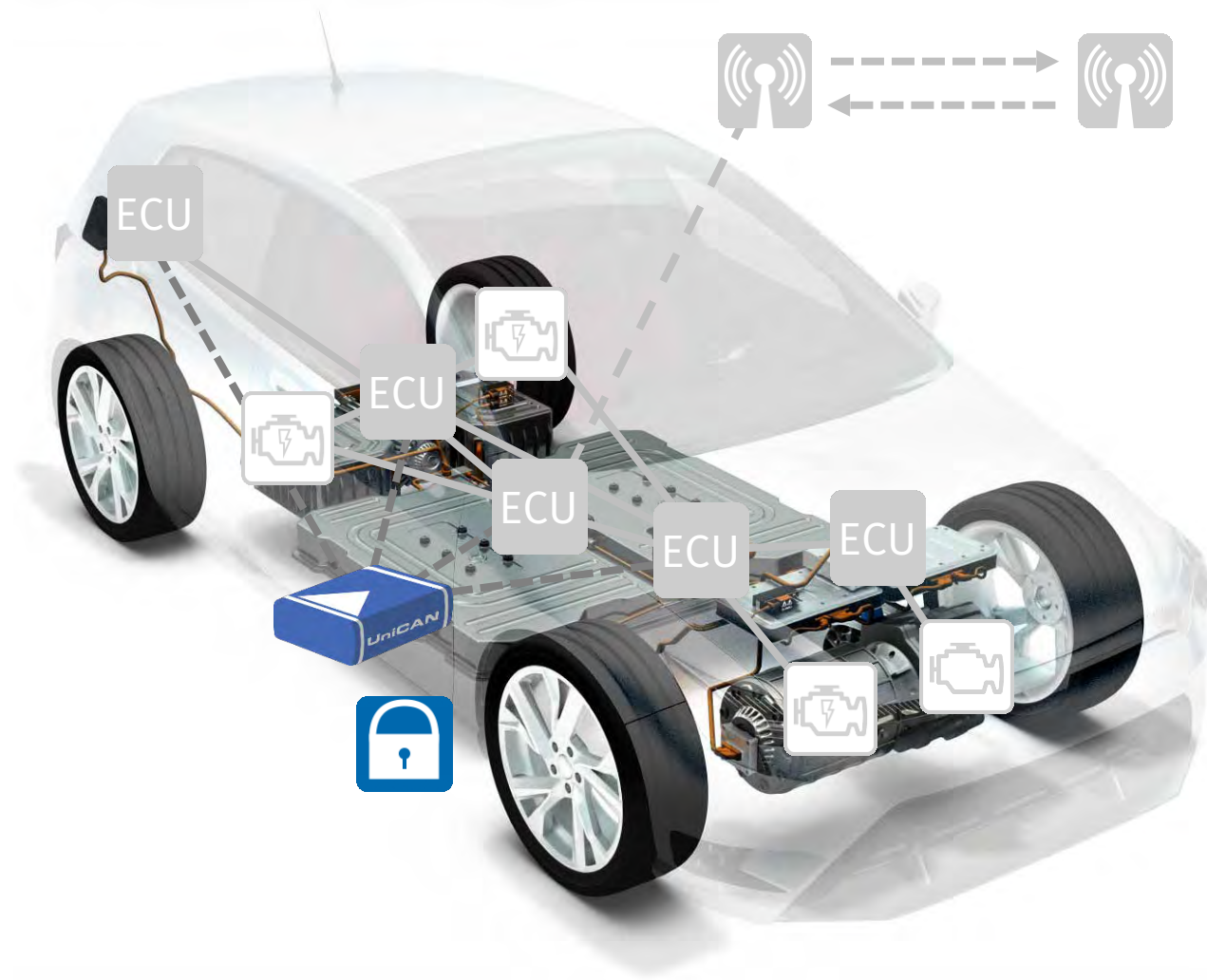
# Data logger requirements

- ▶ Autonomous operation
- ▶ **Efficient data acquisition**



# Data logger requirements

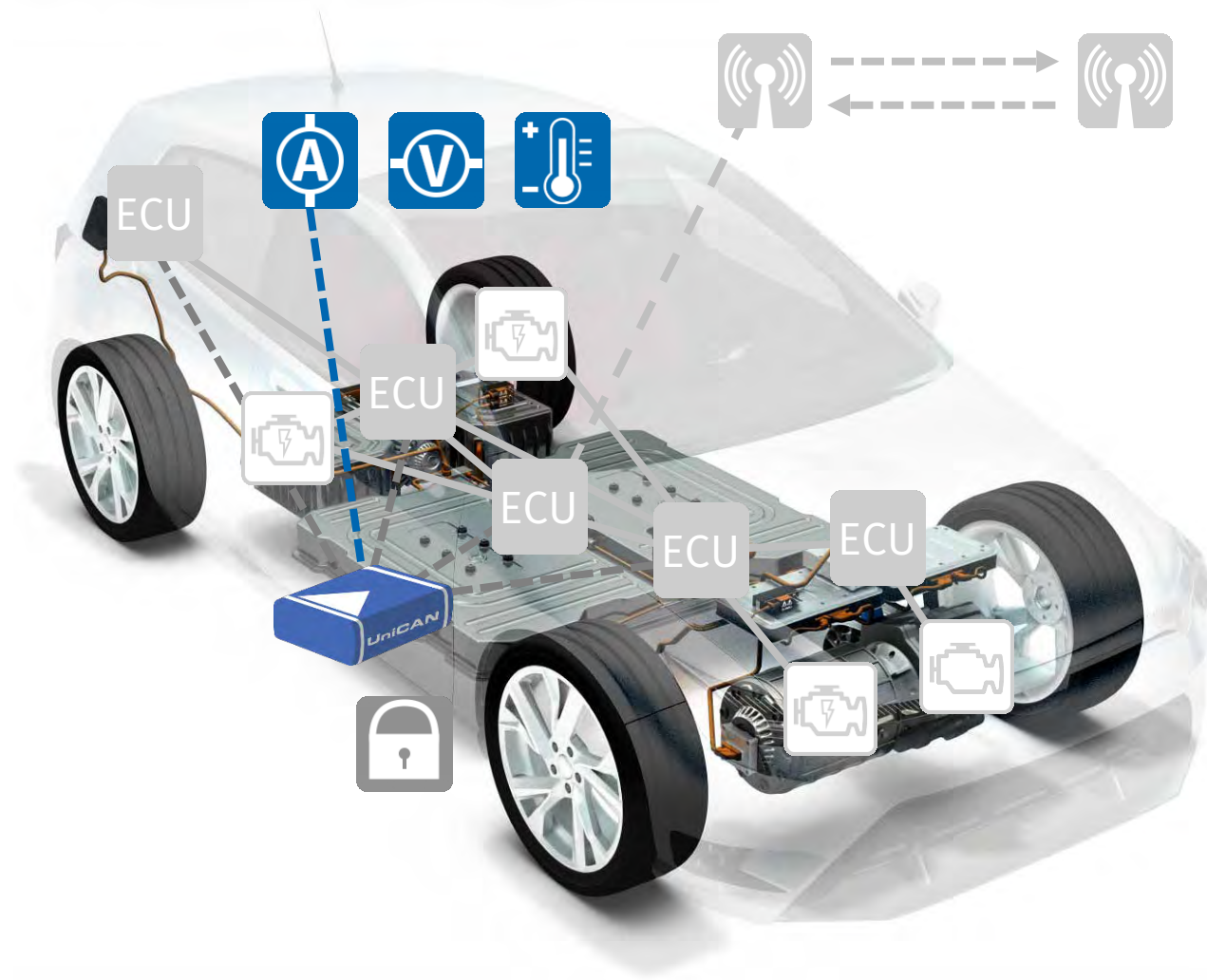
- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ **Secure data storage**





# Data logger requirements

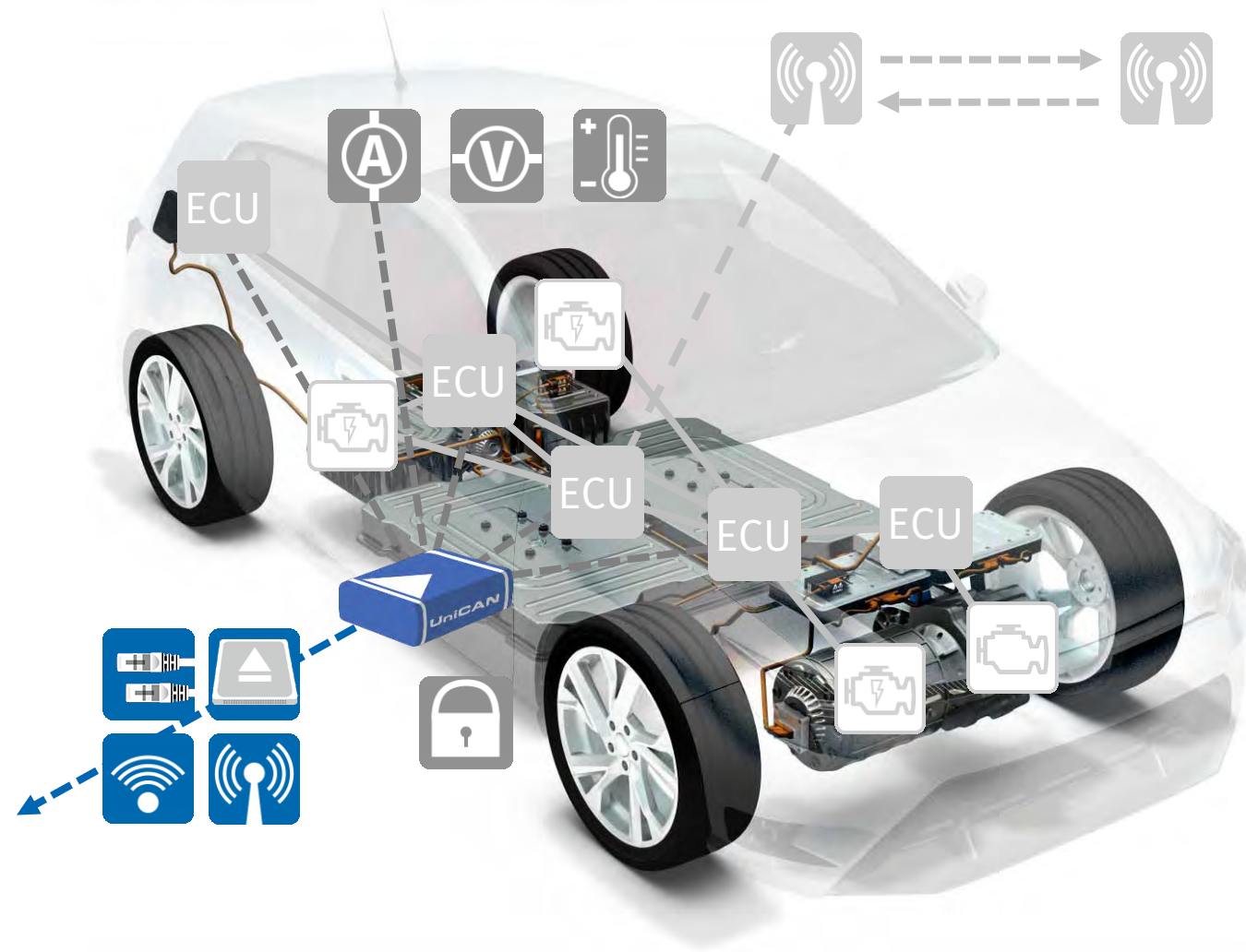
- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ Secure storage
- ▶ **Integration of analog measurement data**





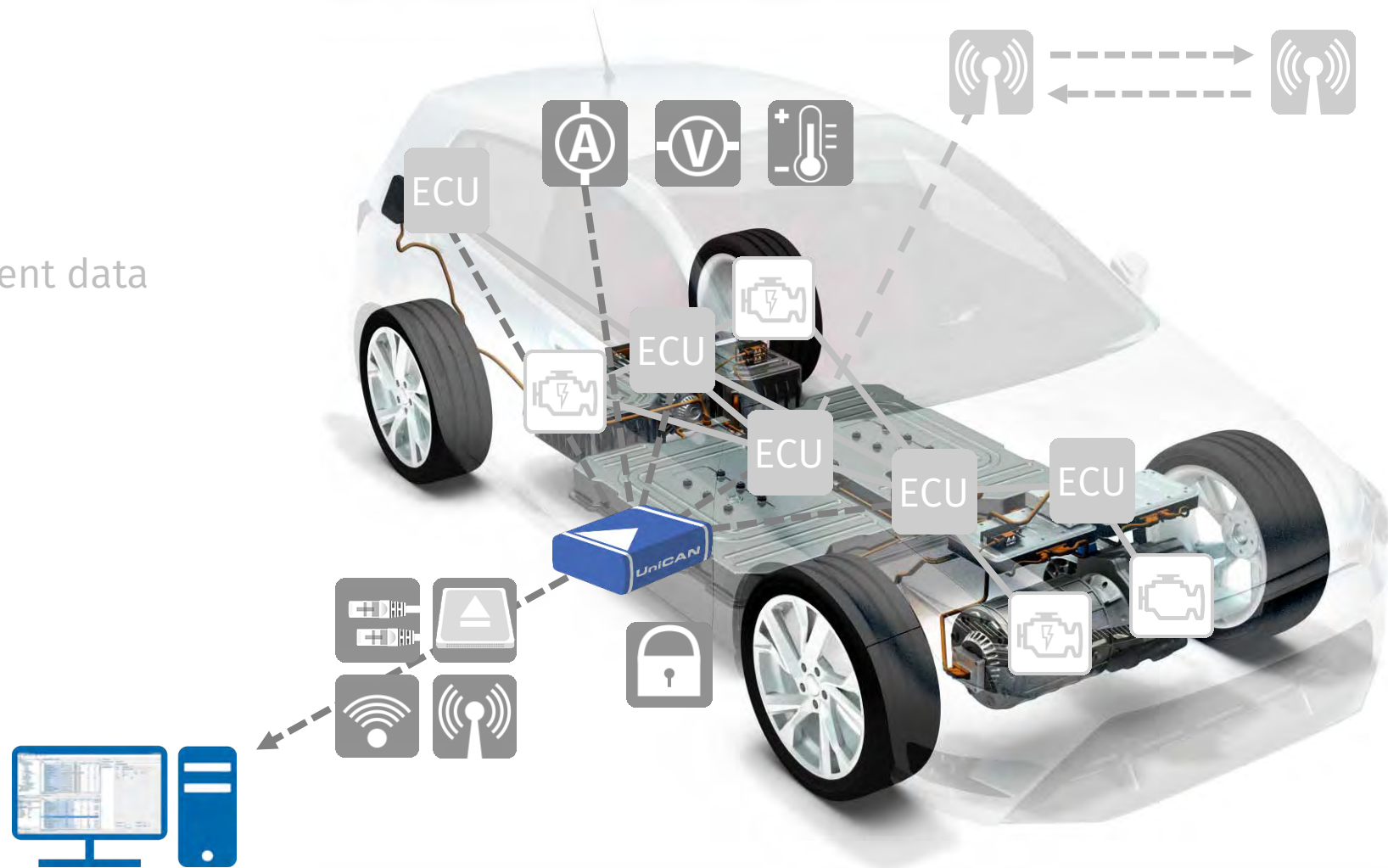
# Data logger requirements

- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ Secure storage
- ▶ Integration of analog measurement data
- ▶ **Flexible data transmission**



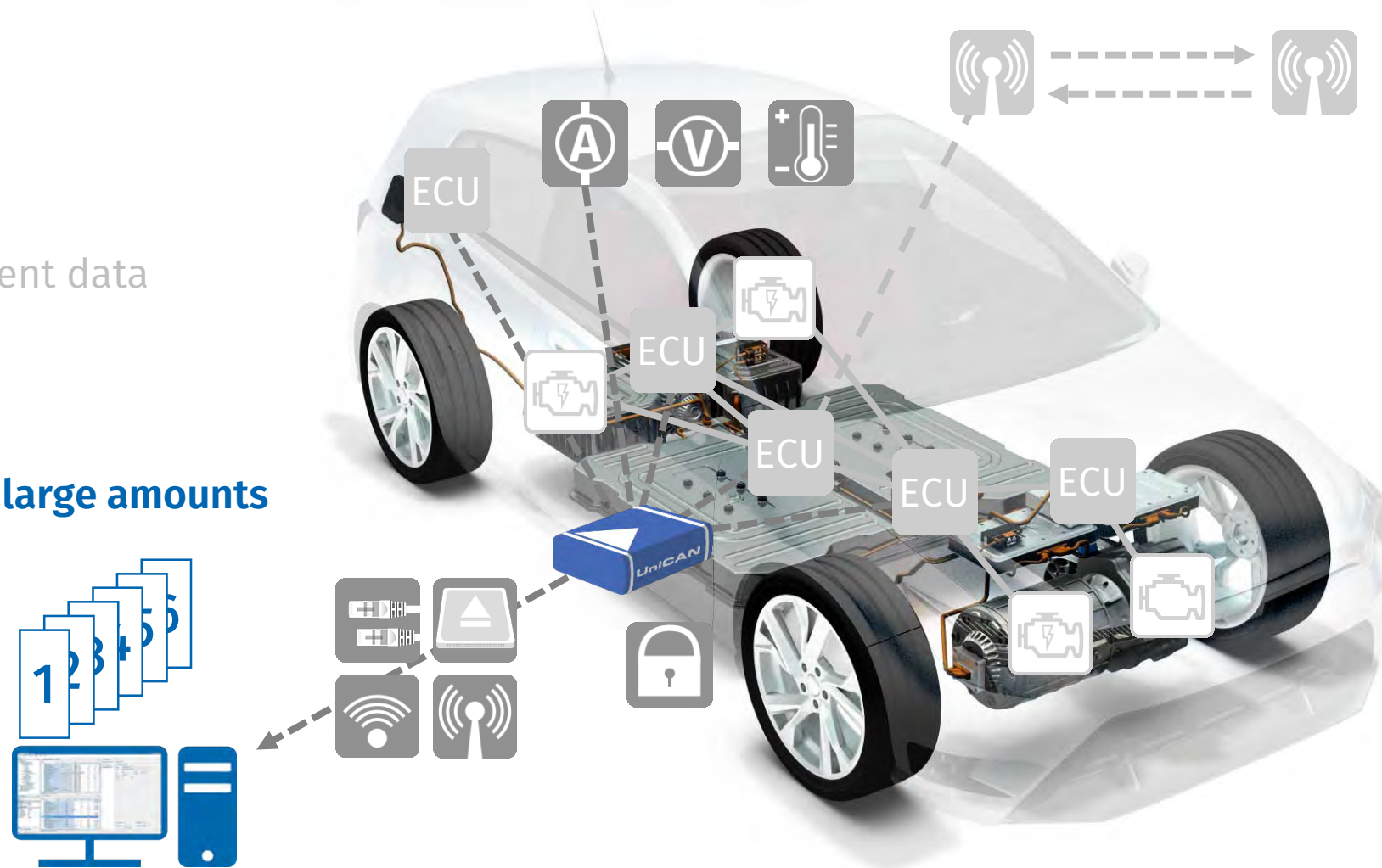
# Data logger requirements

- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ Secure storage
- ▶ Integration of analog measurement data
- ▶ Flexible data transmission
- ▶ **Trigger configuration**



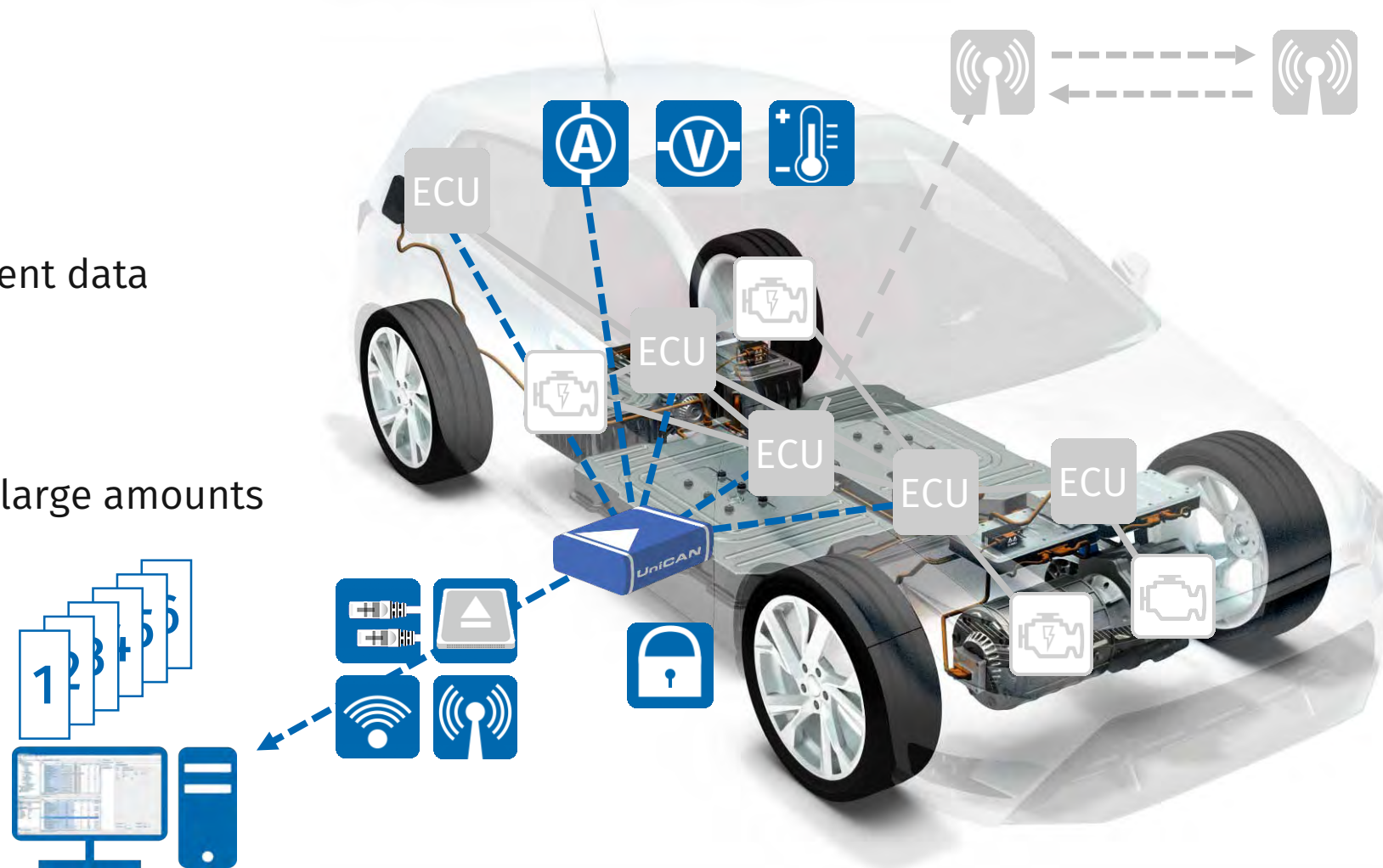
# Data logger requirements

- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ Secure storage
- ▶ Integration of analog measurement data
- ▶ Flexible data transmission
- ▶ Trigger configuration
- ▶ **Acquisition and management of large amounts of data**



# Data logger requirements

- ▶ Autonomous operation
- ▶ Efficient data acquisition
- ▶ Secure storage
- ▶ Integration of analog measurement data
- ▶ Flexible data transmission
- ▶ Trigger configuration
- ▶ Acquisition and management of large amounts of data





# Test scenarios





# A trip to the Alps



## Scenario 1

Behavior of the engine control unit during mountain pass drives

### General conditions

- ▶ Vehicle fleet: 20 cars
- ▶ Duration: 2 weeks

### Challenges

- ▶ Deadline pressure: Deadline for zero series approaching
- ▶ Problems with unresolved power fluctuations jeopardize project deadlines

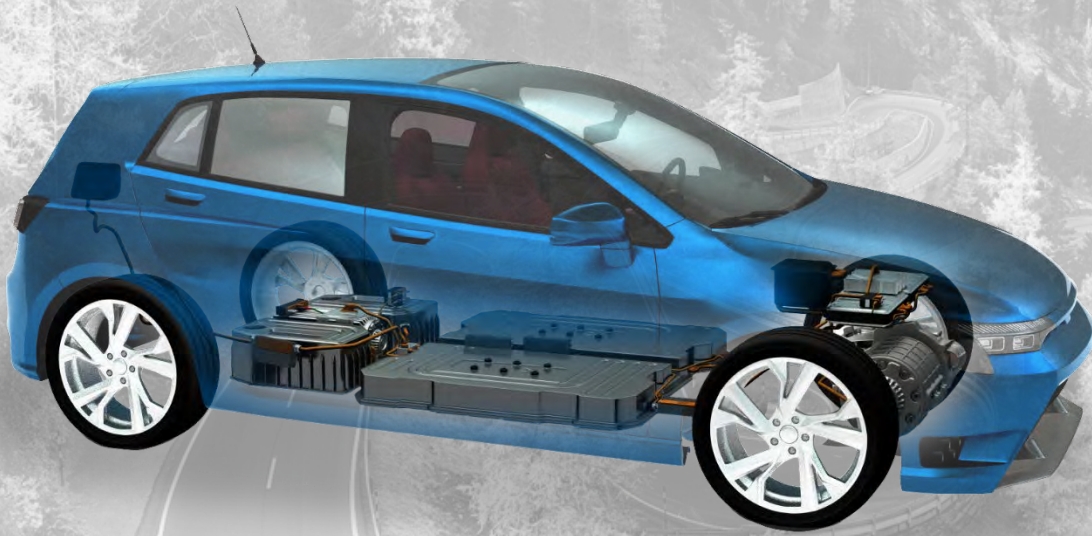


# A trip to the Alps

## Challenges

ECU

ECU data



### ► ECU data acquisition

# A trip to the Alps

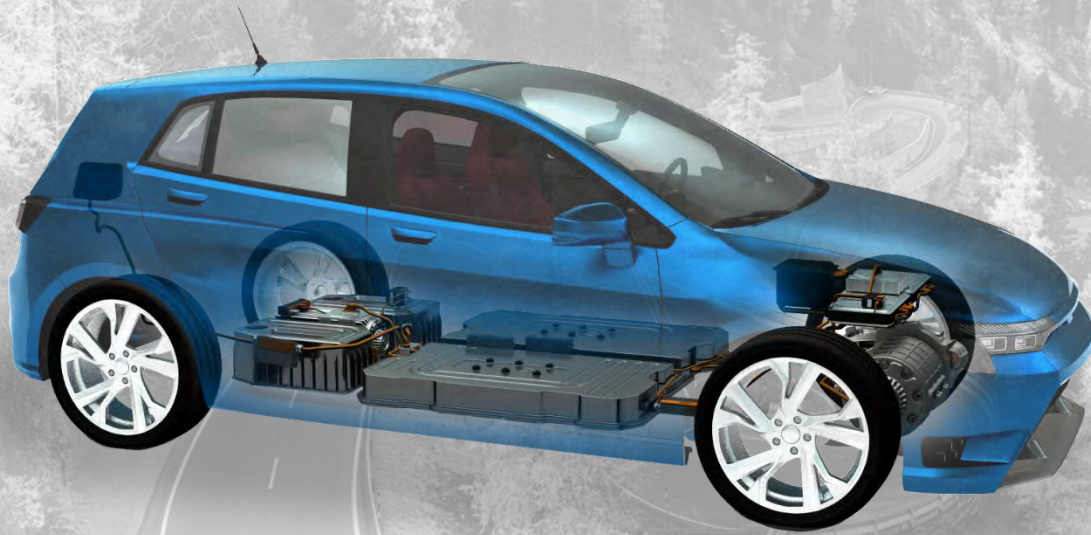
## Challenges



ECU data



Current  
measurement



- ▶ ECU data acquisition
- ▶ **Additional current measurement**
  - Verification ECU data



# A trip to the Alps

## Challenges



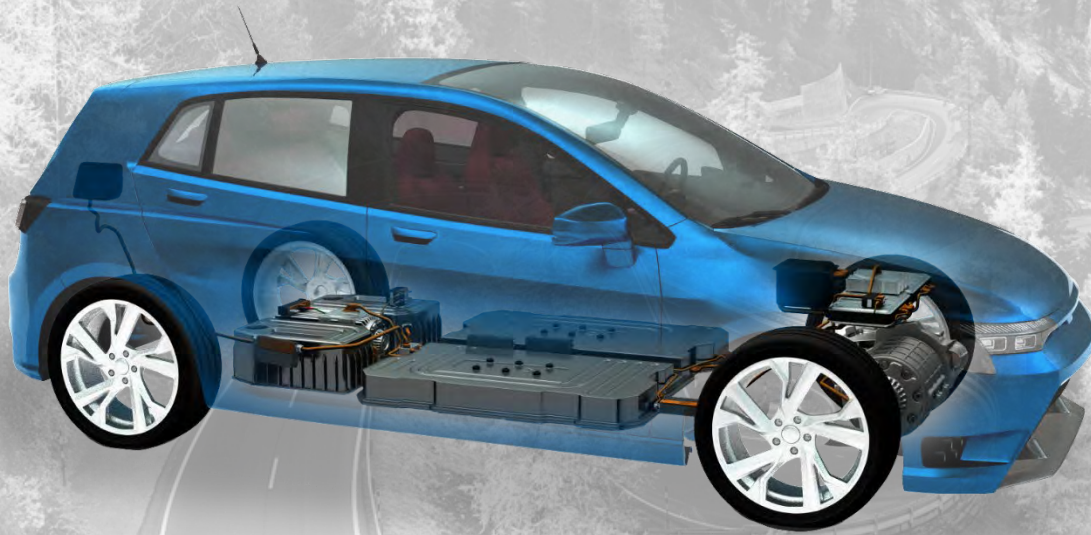
ECU data



Current  
measurement



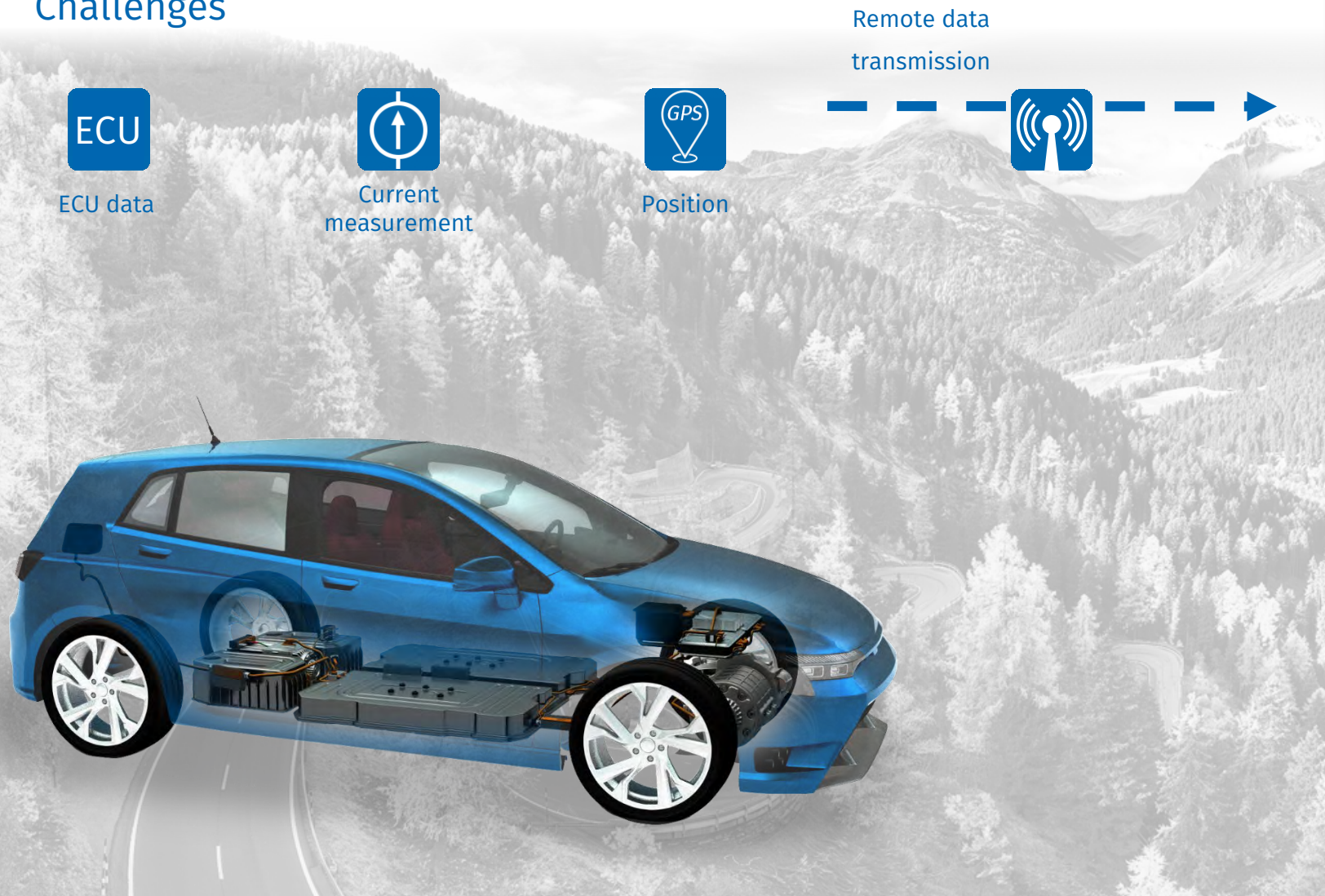
Position



- ▶ ECU data acquisition
- ▶ Additional current measurement
  - Verification ECU data
- ▶ **Position data**
  - Current fluctuations occur at full load (uphill driving)

# A trip to the Alps

## Challenges

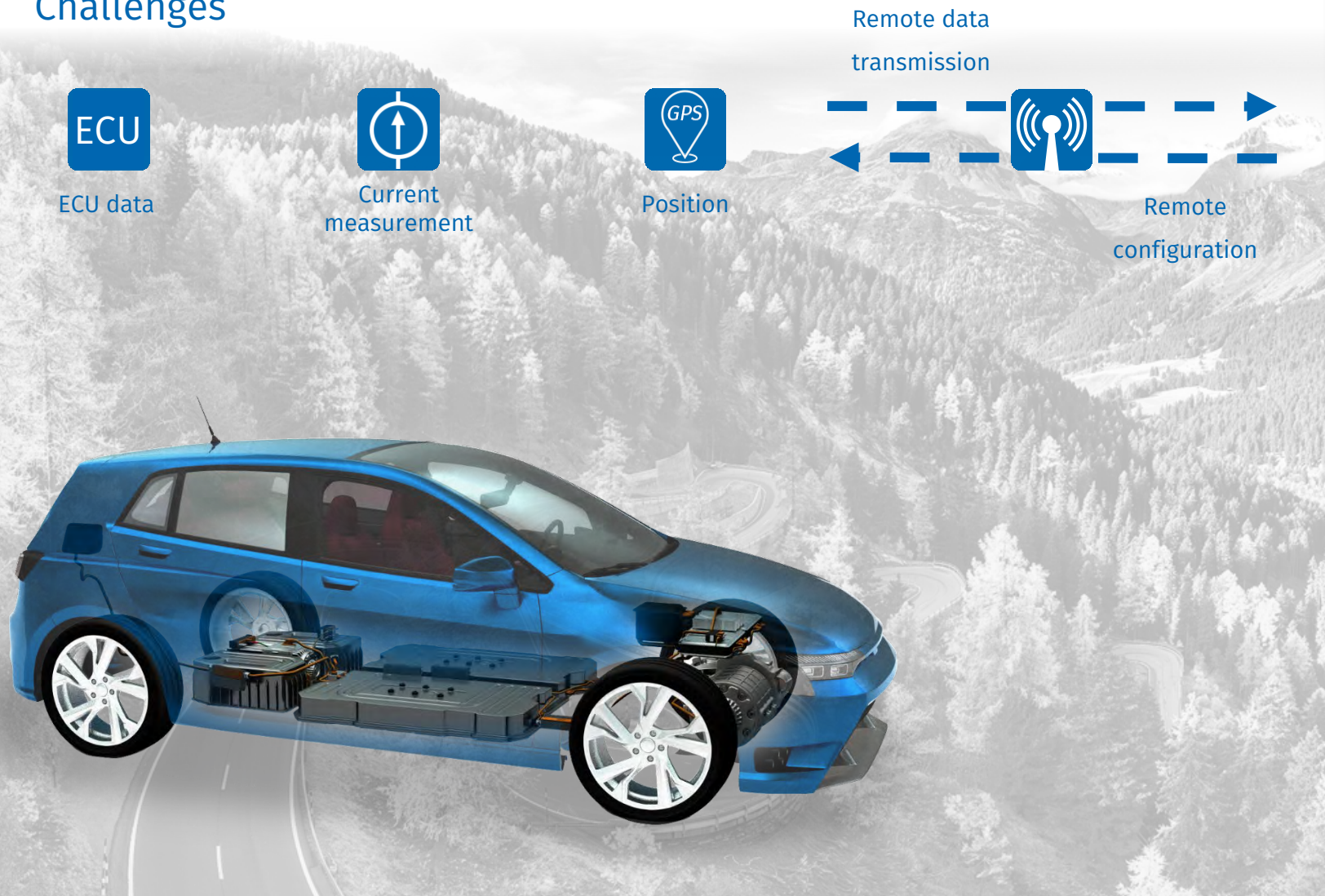


- ▶ ECU data acquisition
- ▶ Additional current measurement
  - Verification ECU data
- ▶ Position data
  - Current fluctuations occur at full load (uphill driving)
- ▶ **Transmission of measurement data while driving**
  - Fast analysis of the data



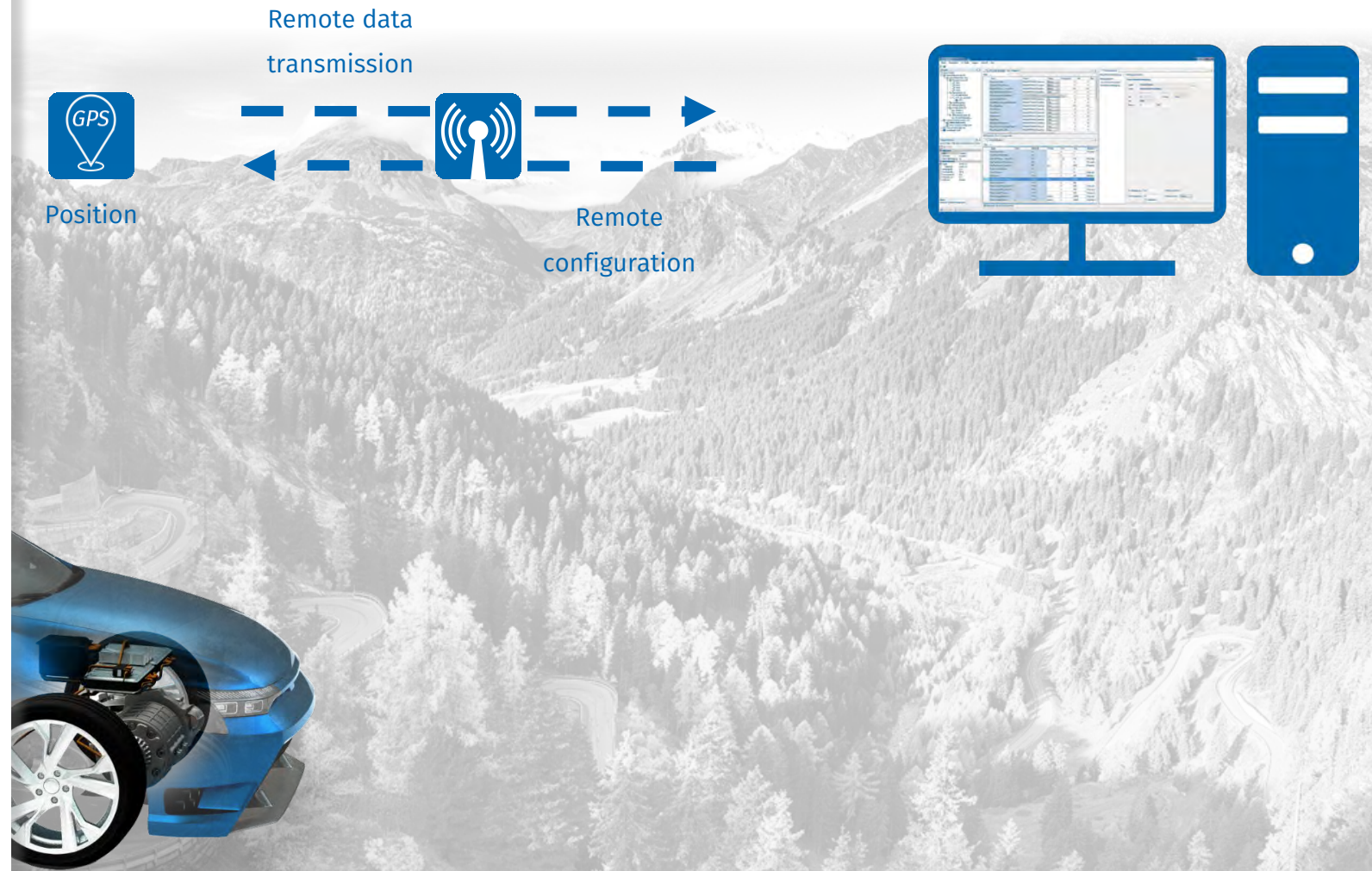
# A trip to the Alps

## Challenges



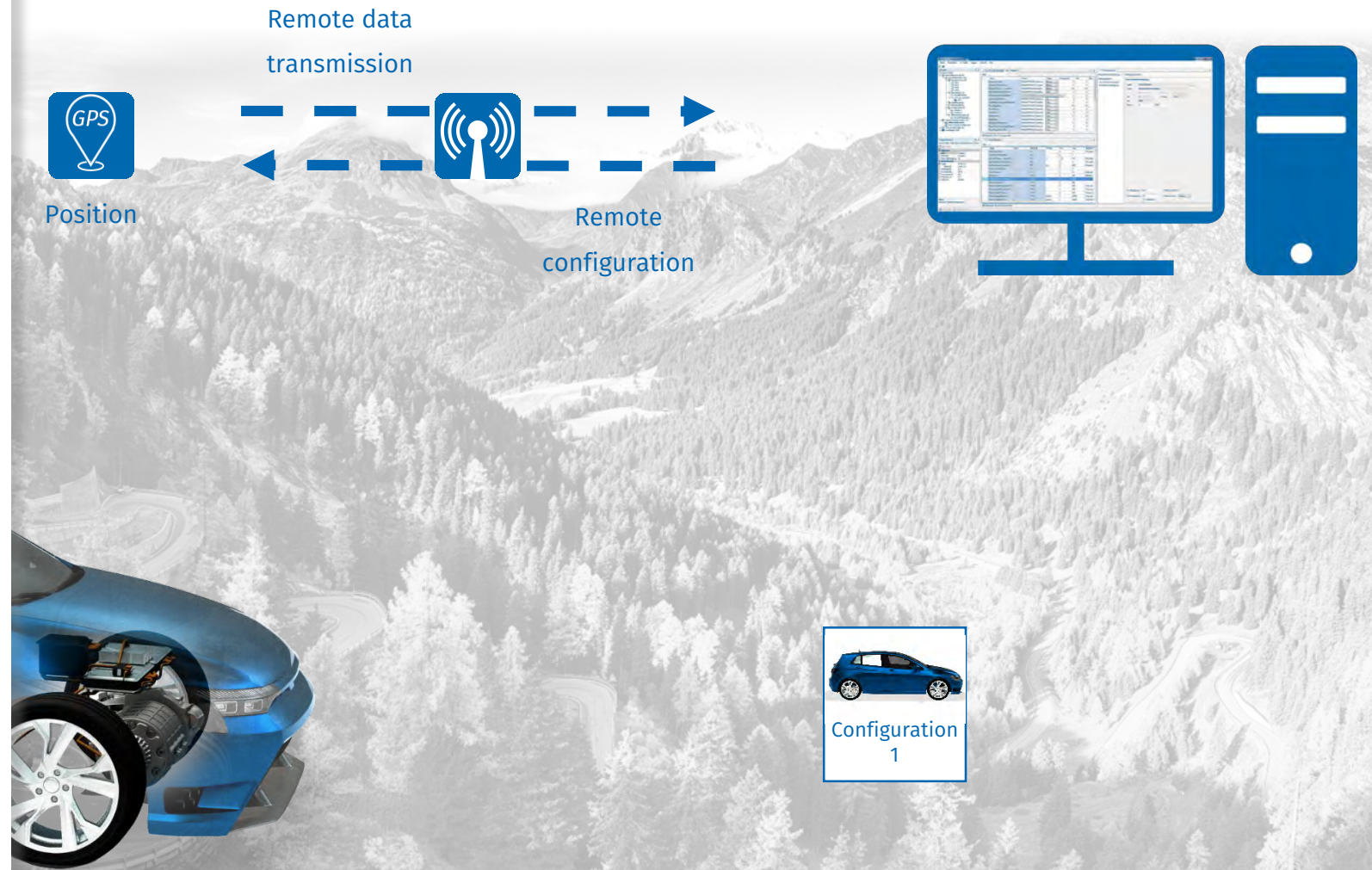
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  - Fast analysis of the data
  - Modification of the logger configuration

- ▶ **ECU data acquisition**
- ▶ **Additional current measurement**
  - Verification ECU data
- ▶ **Position data**
  - Current fluctuations occur at full load (uphill driving)
- ▶ **Transmission of measurement data while driving**
  - Fast analysis of the data
  - Modification of the logger configuration
- ▶ **Simple data management**
  - Time factor

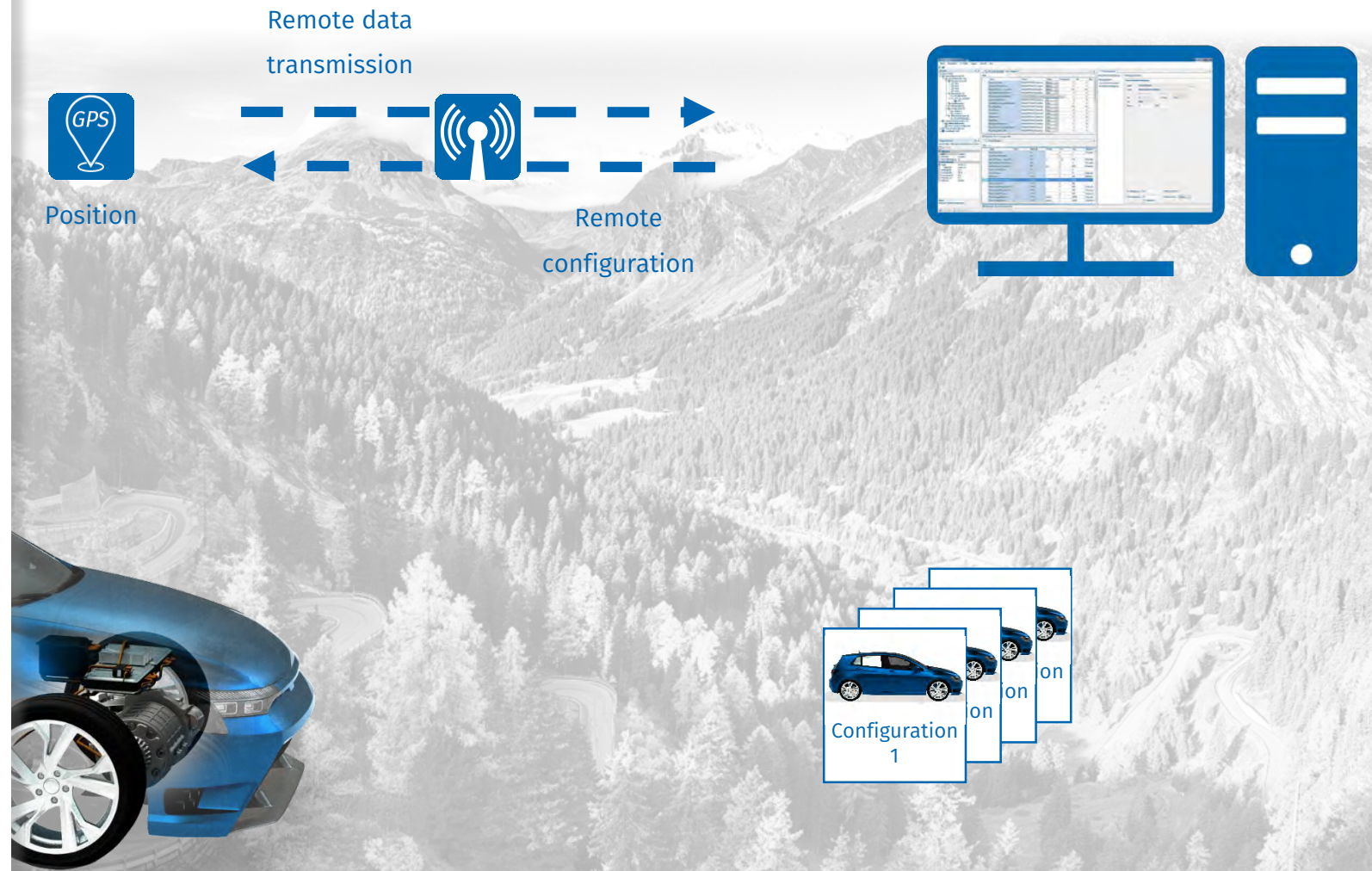




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- ▶ **Additional current measurement**
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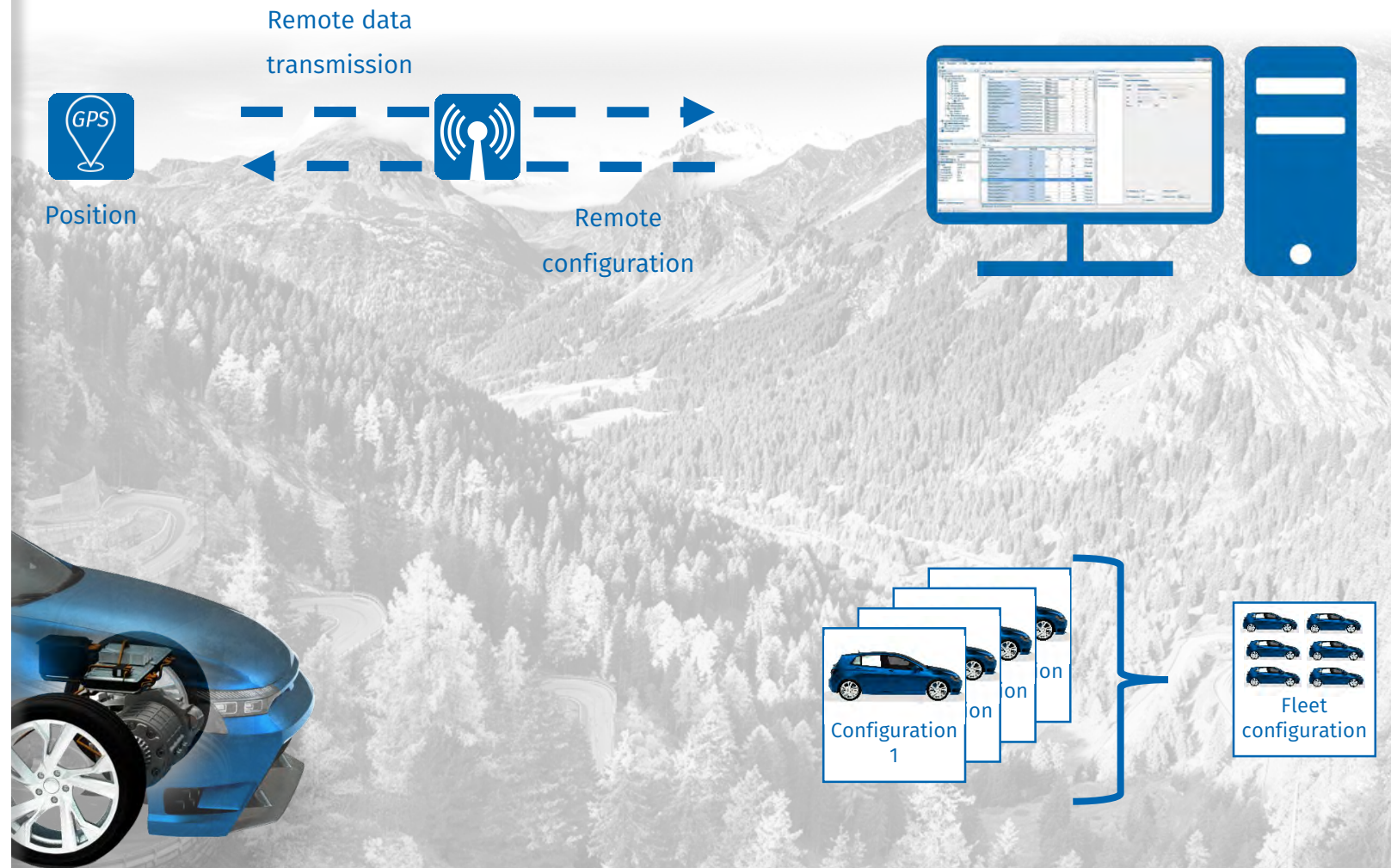


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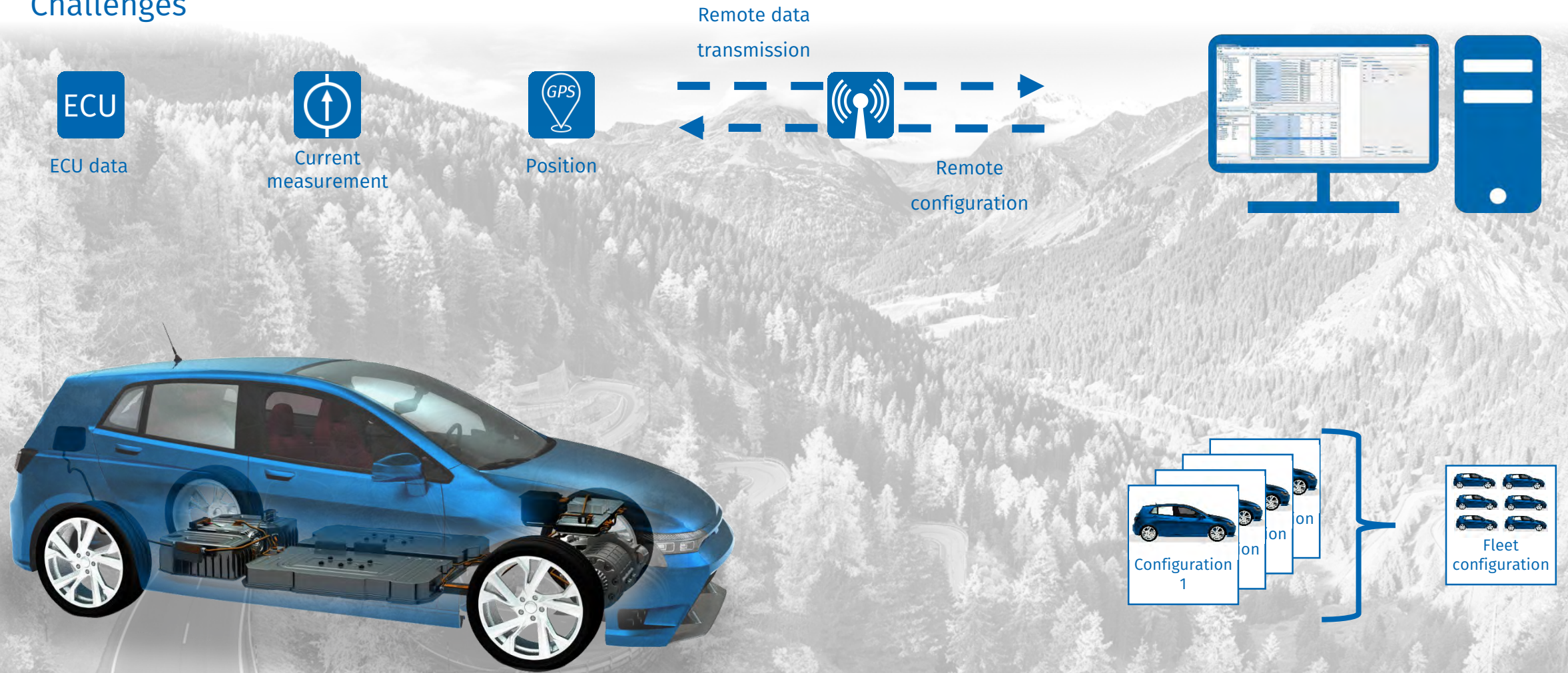
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  - Current fluctuations occur at full load (uphill driving)
- ▶ Transmission of measurement data while driving
  - Fast analysis of the data
  - Modification of the logger configuration
- ▶ Simple data management
  - Time factor
- ▶ Fleet management / measurement configuration in one project





# A trip to the Alps

## Challenges





# A trip to the Alps

## Hardware setup

► ECU data acquisition



# A trip to the Alps

## Hardware setup

ECU

ECU data



Current  
measurement



UniCAN 3 ETH

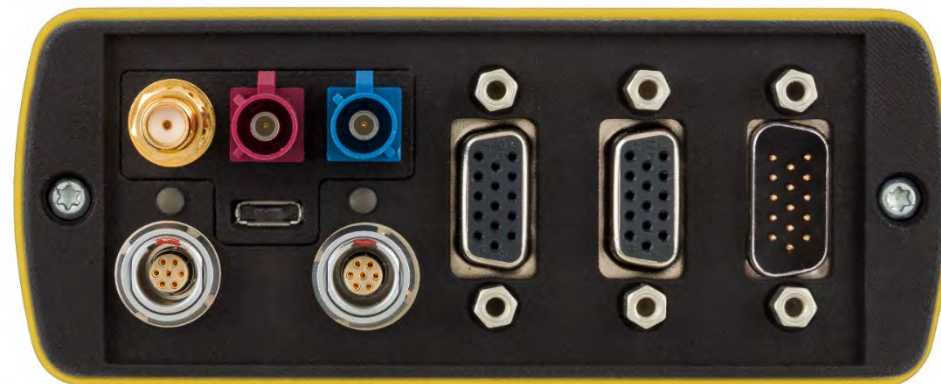
## Data logger UniCAN 3 ETH

UniCAN 3 ETH on  
[www.csm.de](http://www.csm.de)



### Data logger for mobile applications with Ethernet interface

- ▶ Ethernet interface
- ▶ 9 CAN interfaces
- ▶ Support AUTOSAR PDU
- ▶ Numerous options (CANsend, CAN stimulation, Wake-on-CAN) for application-specific configuration
- ▶ Recording on CF card (up to 64 GB)



UniCAN 3 ETH backside



# A trip to the Alps

## Hardware setup

► ECU data acquisition



# A trip to the Alps

## Hardware setup



## Protocols

### Ethernet interface

- ▶ Recording of Ethernet frames (UDP or TCP)
- ▶ Support of XCP-on-Ethernet

### CAN interfaces

- ▶ CCP, XCP-on-CAN, CCP Block Read, OBD2 / EOBD, J1939
- ▶ CAN FD
- ▶ Impact free operation ensured (read-only mode)



# A trip to the Alps

## Hardware setup

► Current measurement





# A trip to the Alps

## Hardware setup



## Integration of measurement data from measurement modules



Frequencies

CNT4 evo MiniModule



Analog signals

AD4 MiniModule



Analog signals  
(HV safe)

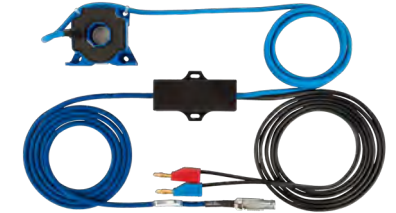
HV ADMM2 LI+

CAN



UniCAN 3 ETH backside

Current



LEM sensor package

Analog signals



ECAT AD4 IG100

EtherCAT®



XCP-Gateway

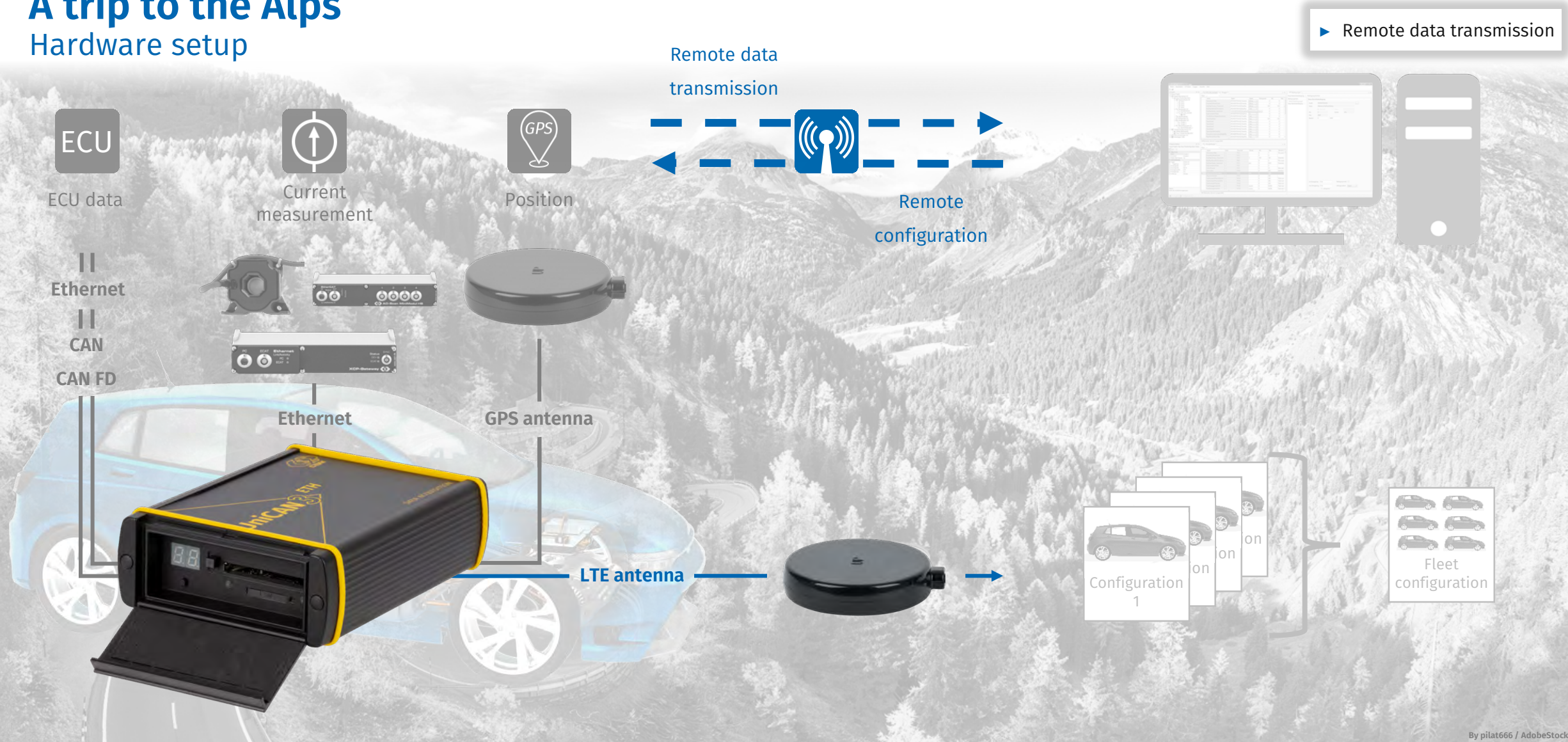
XCP-on-  
Ethernet





# A trip to the Alps

## Hardware setup

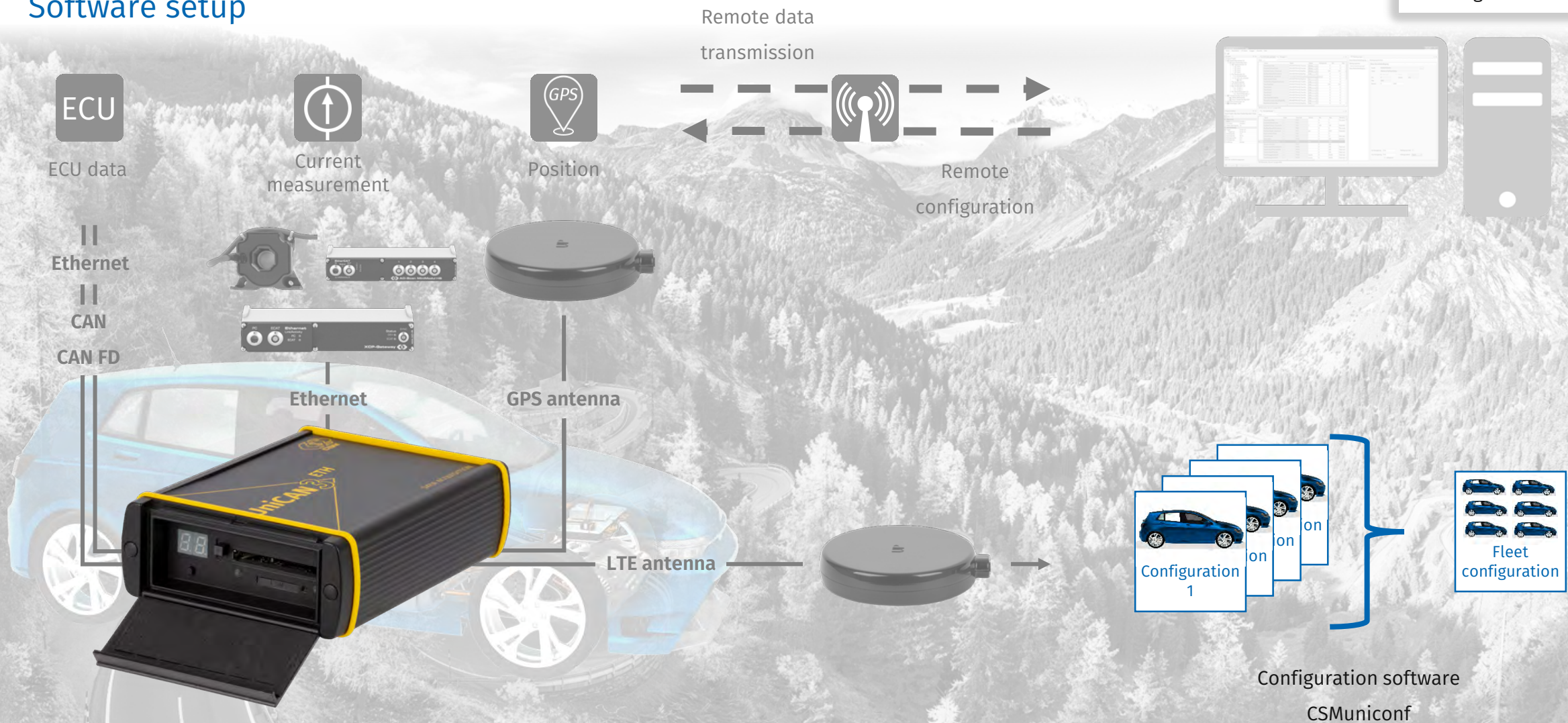




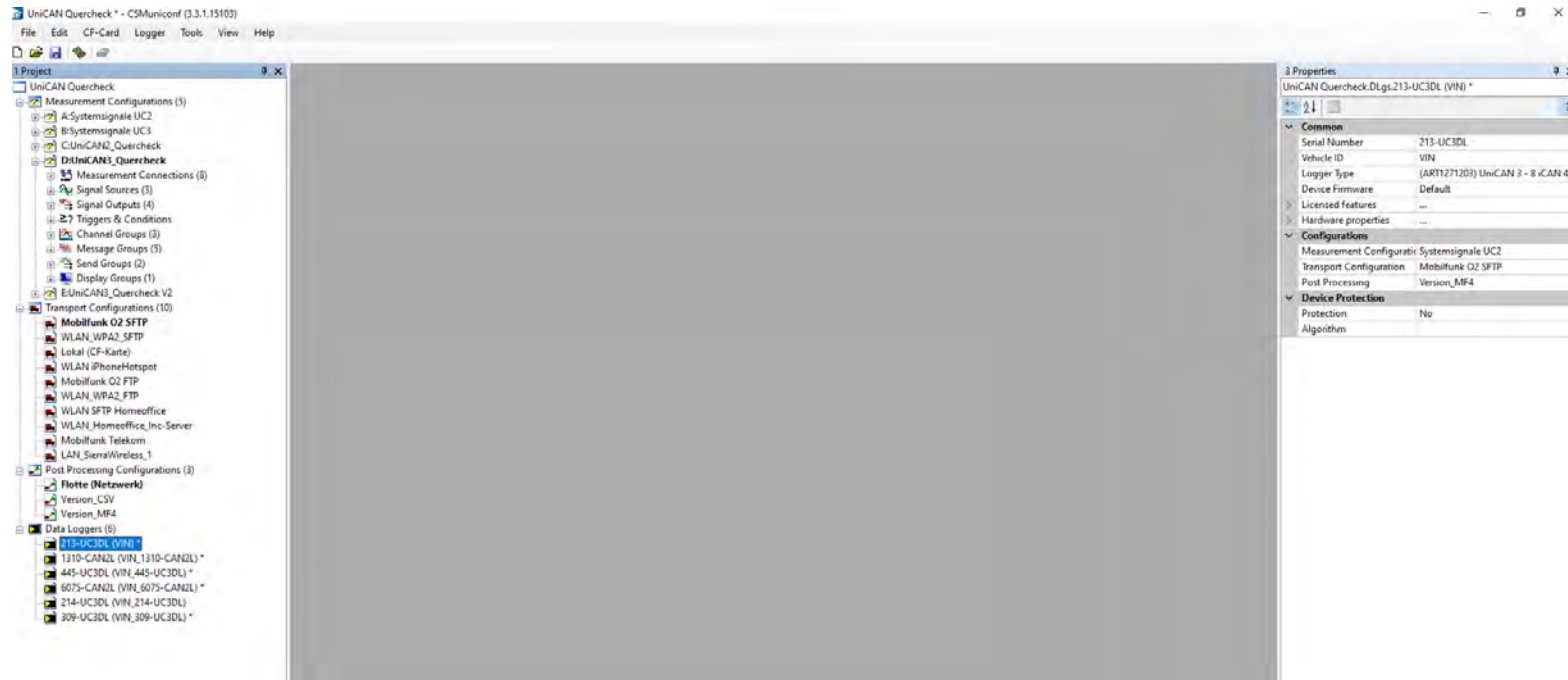
# A trip to the Alps

## Software setup

## ► Configuration

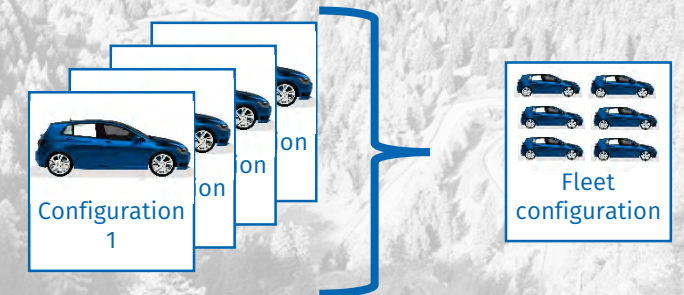






CSMuniconf on  
[www.csm.de](http://www.csm.de)

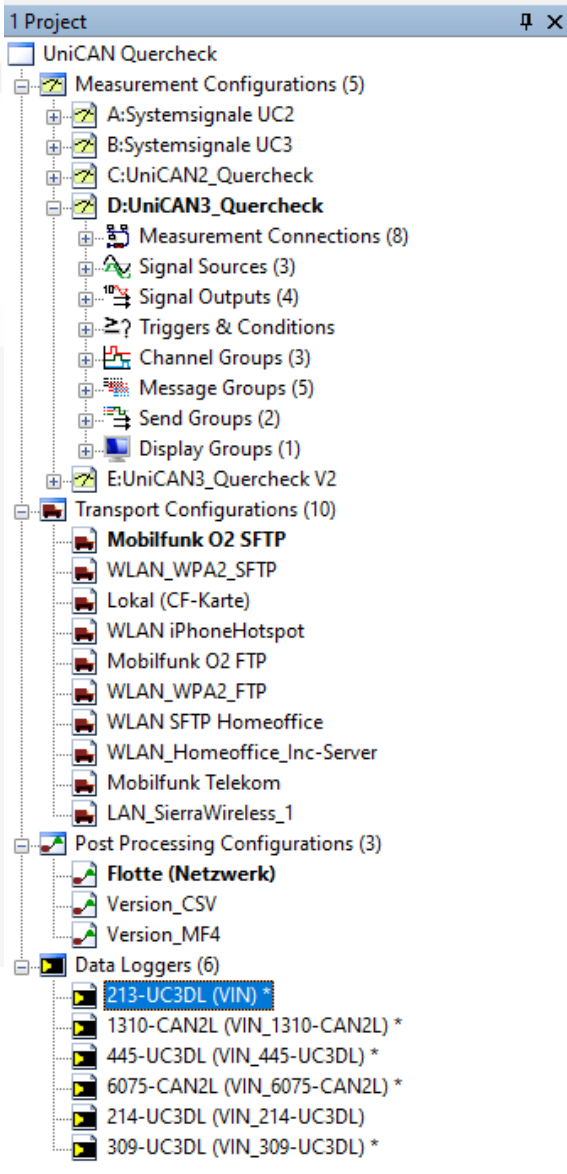
► Configuration



Configuration software  
CSMuniconf



CSM

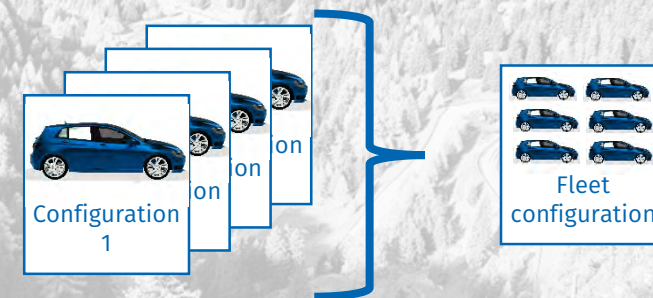


software for UniCAN data logger

## Fleet management

- Management and configuration of all loggers in one project file

► Configuration



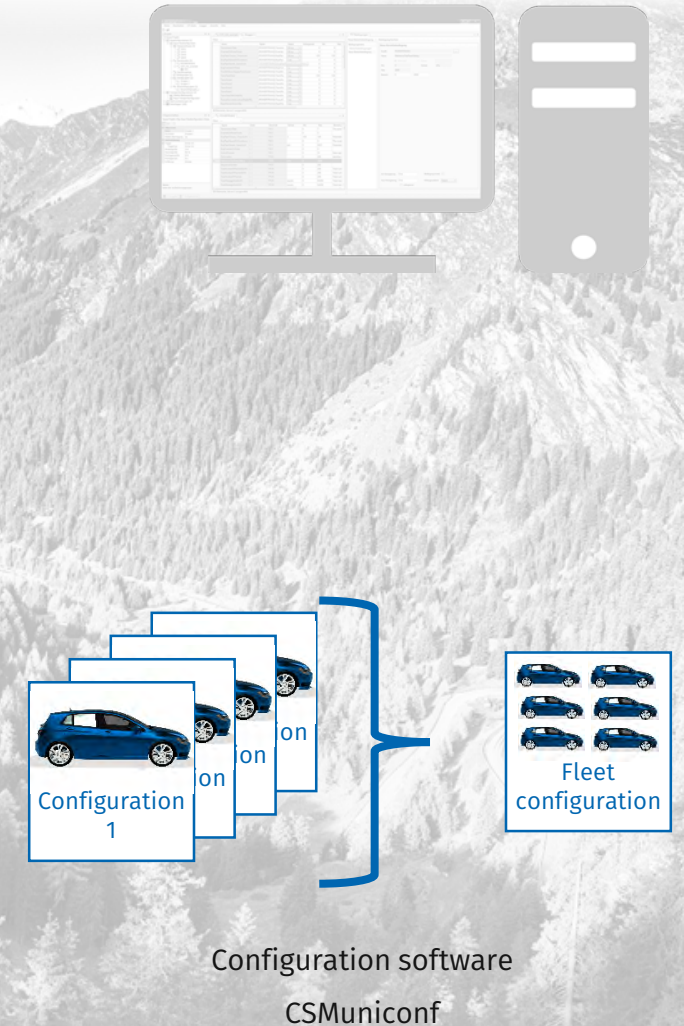
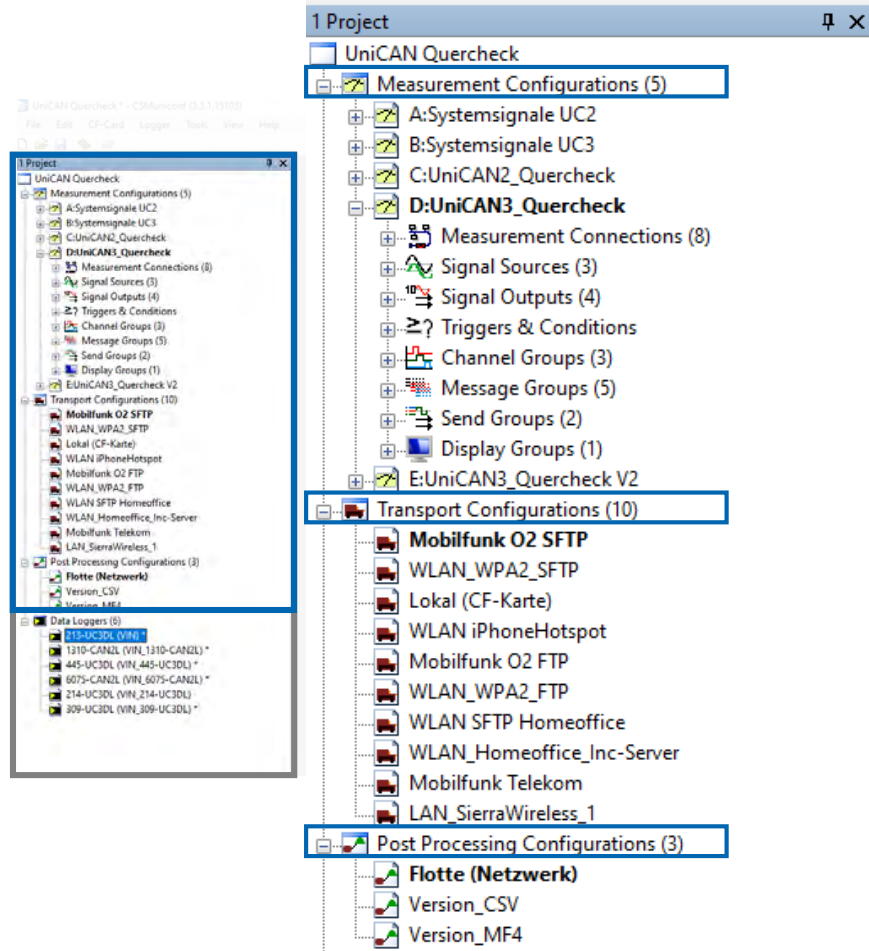
Configuration software  
CSMuniconf





## Fleet management

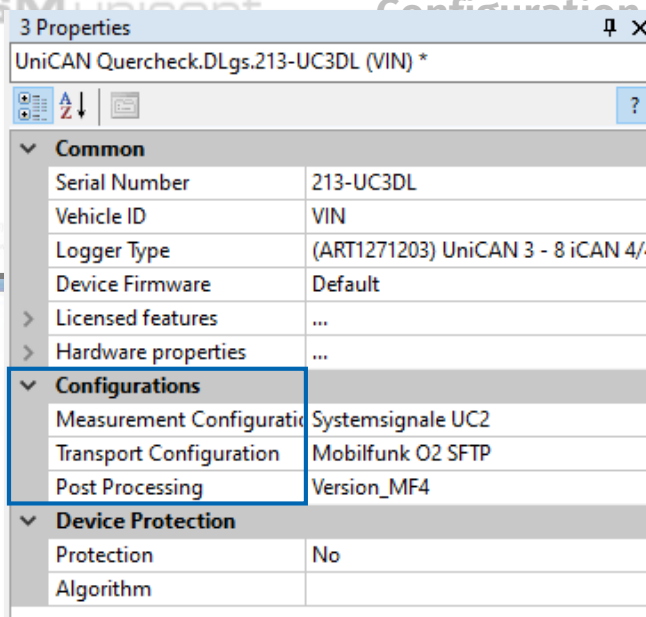
- Management and configuration of all loggers in one project file
- General default settings of configuration types
  - Measurement configuration (channels, channel groups, etc.)
  - Data transmission (WLAN, LTE, etc.)
  - Post Processing (Automatic conversion to file formats)





CSMuniconf

Configuration software for UniCAN data logger



## Fleet management

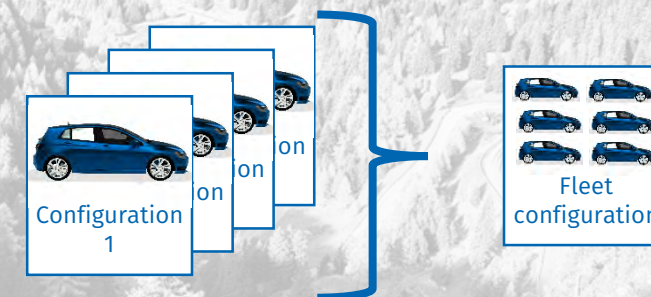
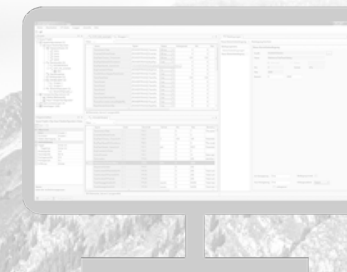
► Management and configuration of all loggers in one project file

► General default settings of configuration types

- Measurement configuration (channels, channel groups, etc.)
- Data transmission (WLAN, LTE, etc.)
- Post Processing (Automatic conversion to file formats)

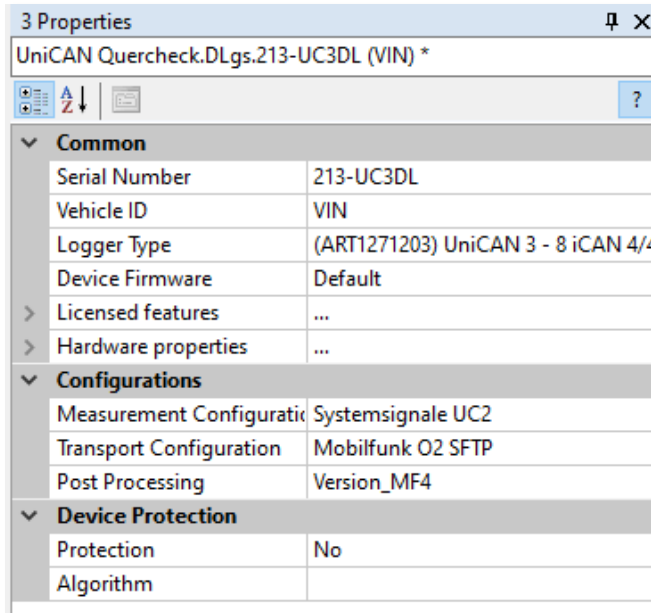
► Easy assignment of configurations to the respective logger via list selection

► Configuration



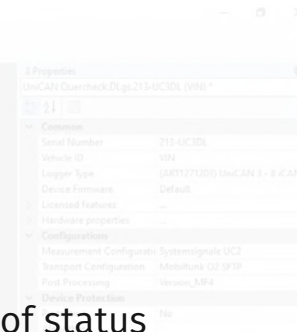
Configuration software  
CSMuniconf



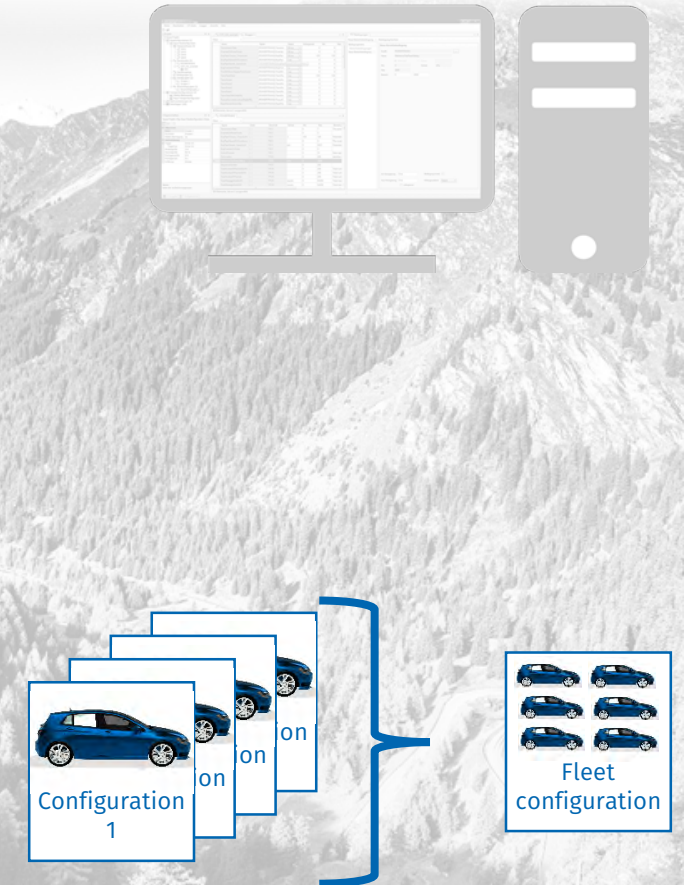


## Remote (Re-) Configuration

- Configuration update
- Firmware update
- Option update
- Target server update
- Additional transmission of status information such as
  - Memory card fill level
  - GPS signal strength
  - Bus loads
  - Etc...



### ► Configuration

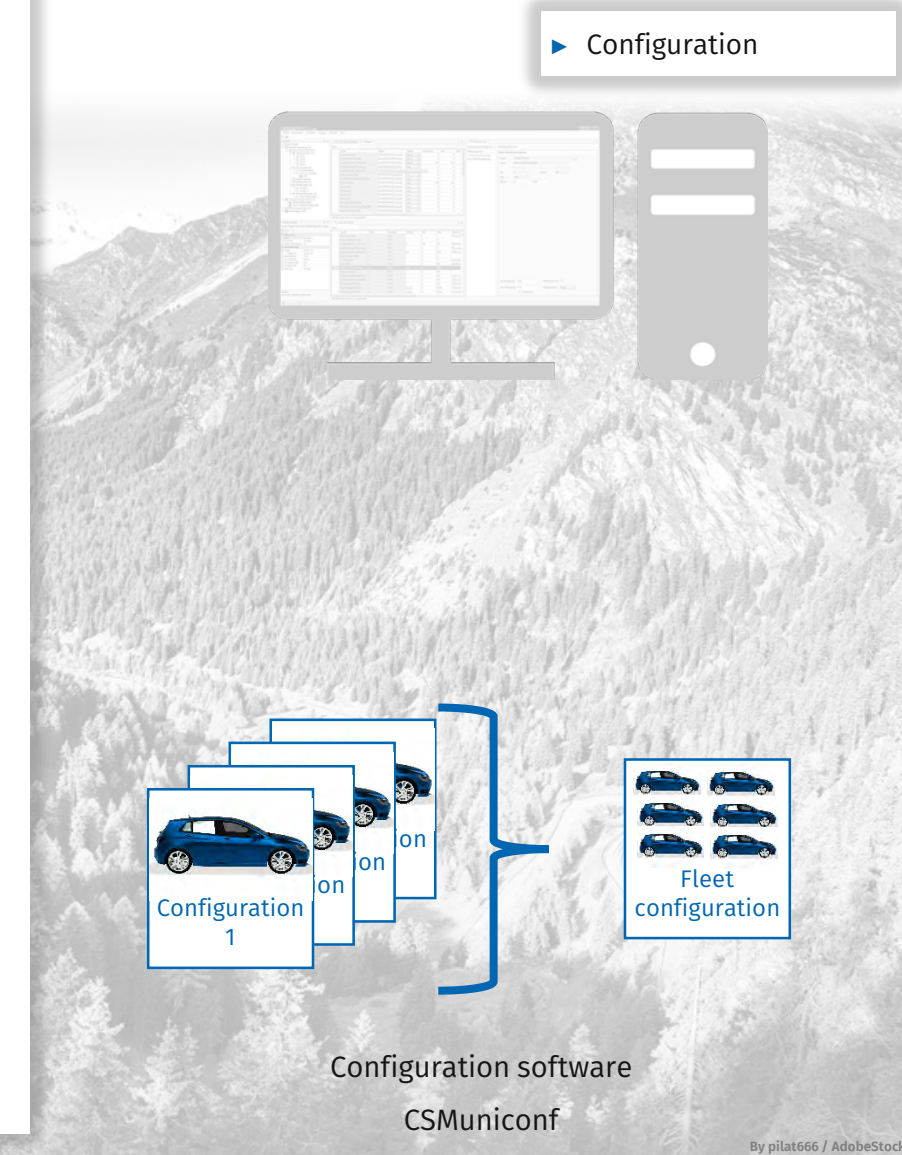


Configuration software  
CSMuniconf

### Trigger

- ▶ Automatic recording of defined events
- ▶ Short snapshot recording with pre-trigger and high resolution
  - Current peaks at full load
  - Geofencing: data recording only in the target area

### Efficient data recording to save storage space







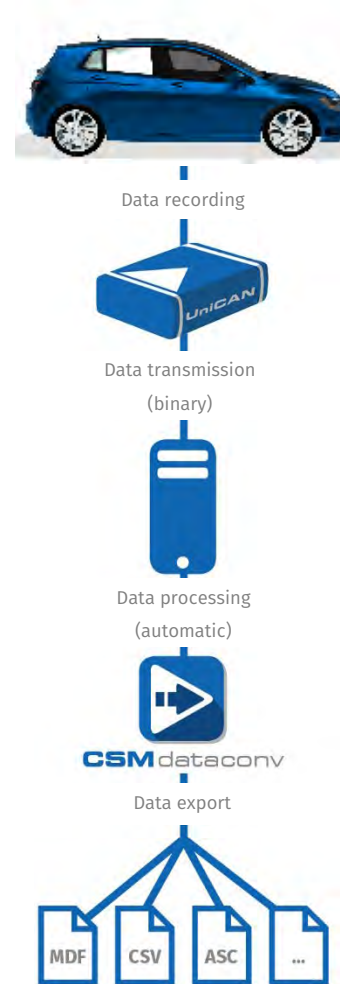
CSM dataconv

Data processing software

## Server-based data processing

- ▶ Automatic further processing and conversion of recorded measurement data
- ▶ Conversion into desired data format
  - MDF
  - CSV
  - ASC
  - ...
- ▶ Automatic sorting and data segmentering (e.g. one file per day, per hour, per test run...)

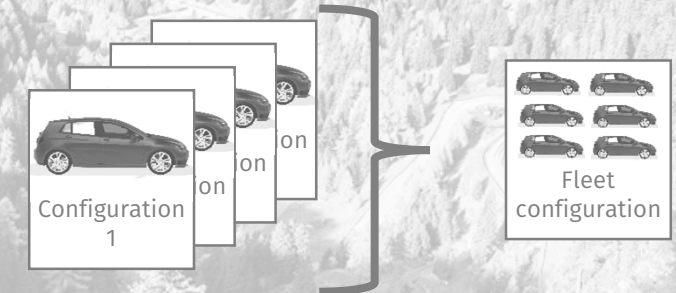
CSMdataconv on  
[www.csm.de](http://www.csm.de)



▶ Fleet management



Data processing software  
CSMdataconv

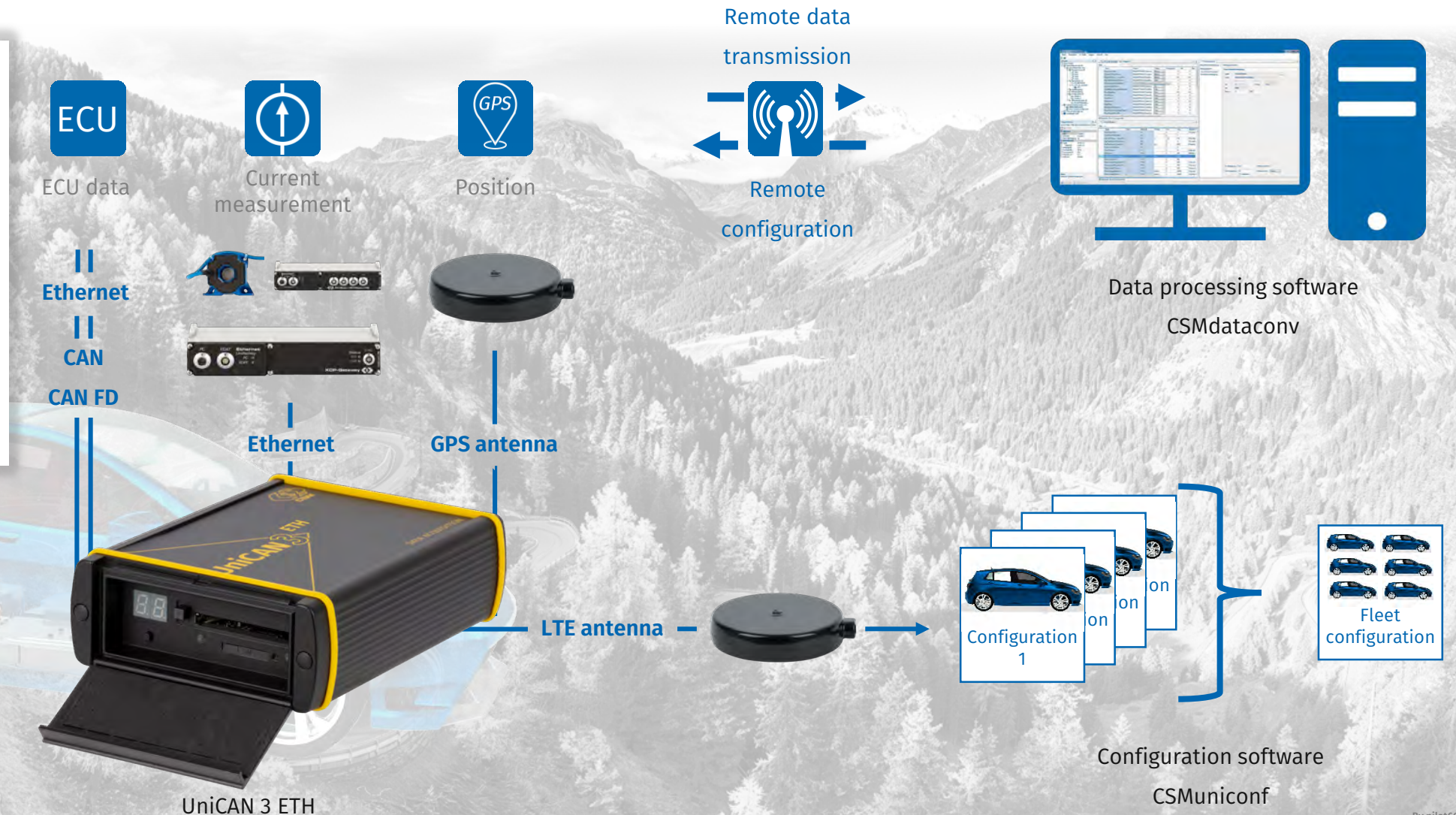


Configuration software  
CSMuniconf

# A trip to the Alps

## Overview

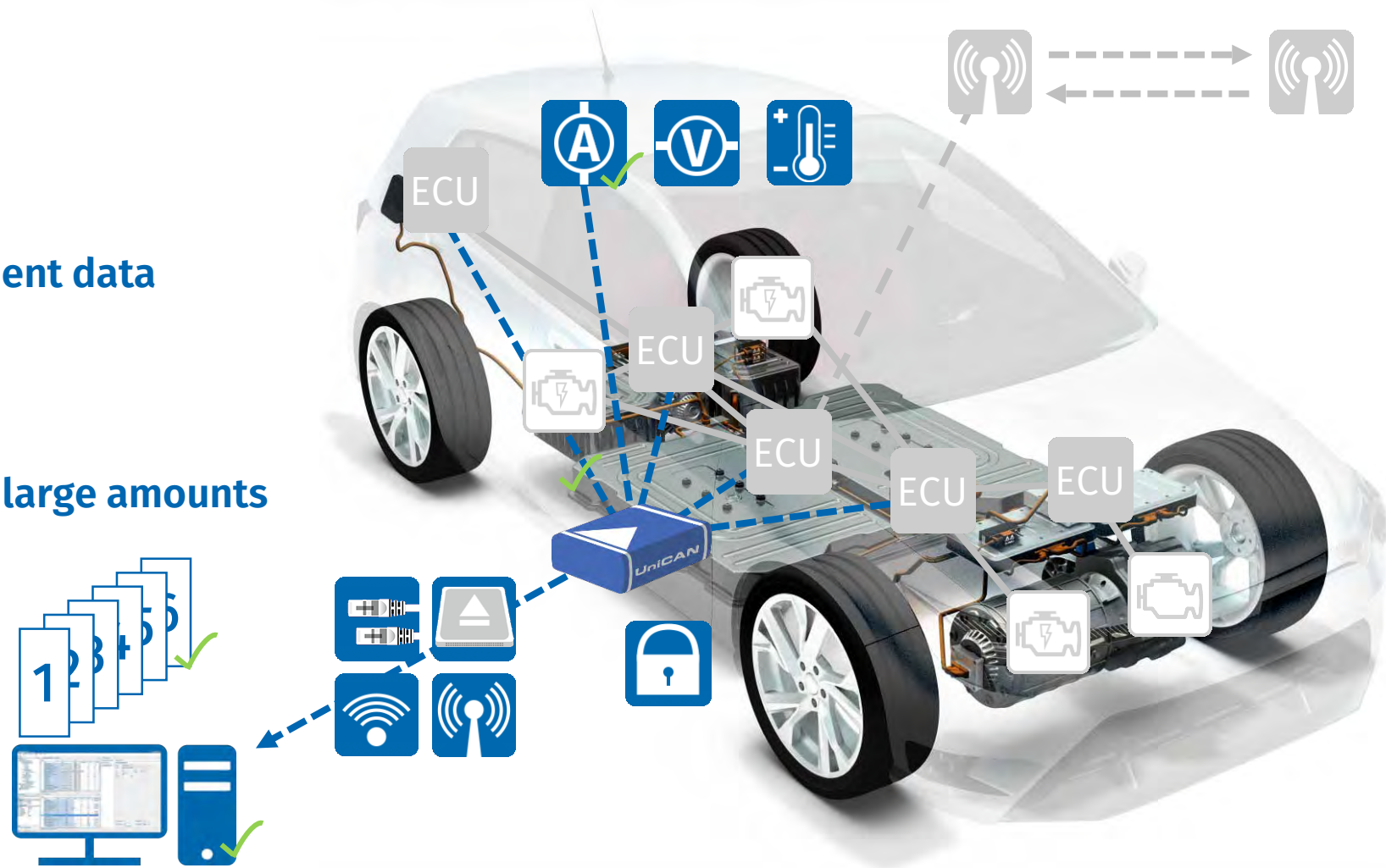
- ▶ ECU data acquisition
- ▶ Current measurement
- ▶ Position data
- ▶ Remote data transmission
- ▶ Simple data management
- ▶ Fleet management / measurement configuration in one project





# Data logger requirements

- ▶ Autonomous operation
- ✓ ▶ **Efficient data acquisition**
- ▶ Secure storage
- ✓ ▶ **Integration of analog measurement data**
- ▶ Flexible data transmission
- ✓ ▶ **Trigger configuration**
- ✓ ▶ **Acquisition and management of large amounts of data**



# City tour



## Scenario 2

Driving characteristics of the end customer during urban driving

### General conditions

- ▶ Vehicle fleet: 40 cars
- ▶ Duration: 9 months

### Challenges

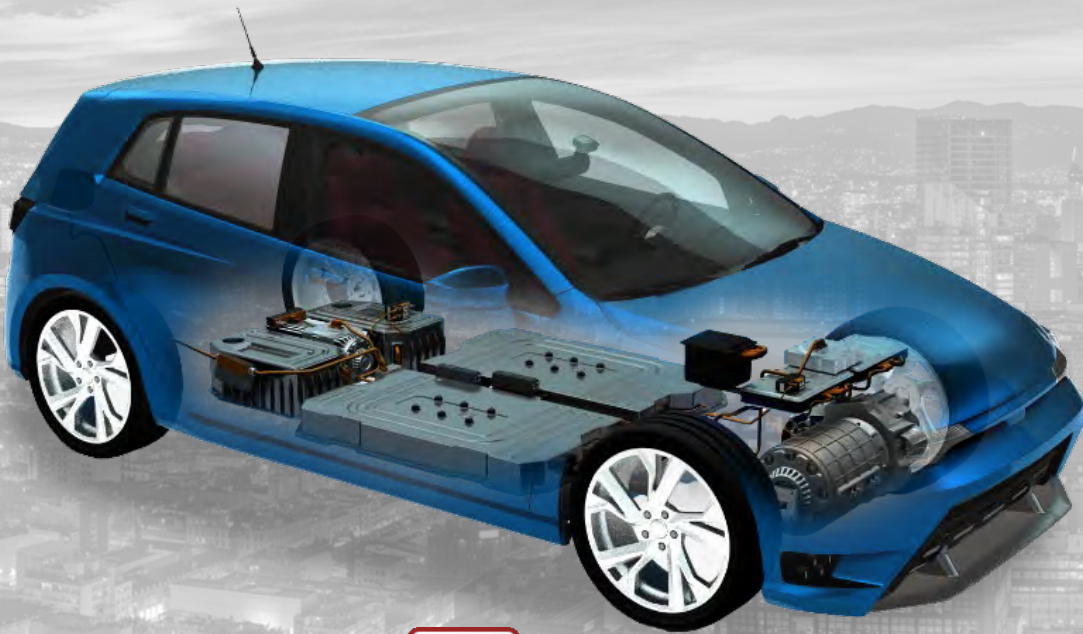
- ▶ High temperatures
- ▶ Drivers are end customers (not professional test drivers)



# City tour

## Challenges

- High ambient temperatures



Temperature

# City tour

## Challenges



Temperature



Installation space

- ▶ High ambient temperatures
- ▶ **Hidden installation in the vehicle**
  - No distraction of the driver
  - No self-heating  
(passive cooling)

By Andrea Izzotti / AdobeStock



# City tour

## Challenges

ECU

ECU data



Temperature



Installation space

- ▶ High ambient temperatures
- ▶ Hidden installation in the vehicle
  - No distraction of the driver
  - No self-heating  
(passive cooling)
- ▶ **ECU data acquisition**

By Andrea Izzotti / AdobeStock

# City tour

## Challenges



ECU data



Position



Temperature



Installation space

- ▶ High ambient temperatures
- ▶ Hidden installation in the vehicle
  - No distraction of the driver
  - No self-heating  
(passive cooling)
- ▶ ECU data acquisition
- ▶ **Position data**

By Andrea Izzotti / AdobeStock



# City tour Challenges



ECU data



Position

Remote data  
transmission



Remote  
configuration



Temperature



Installation space

- ▶ High ambient temperatures
- ▶ Hidden installation in the vehicle
  - No distraction of the driver
  - No self-heating (passive cooling)
- ▶ ECU data acquisition
- ▶ Position data
- ▶ Remote access

By Andrea Izzotti / AdobeStock

- ▶ High ambient temperatures
- ▶ Hidden installation in the vehicle
  - No distraction of the driver
  - No self-heating (passive cooling)
- ▶ ECU data acquisition
- ▶ Position data
- ▶ Remote access
- ▶ **Secure storage and transmission of data**





# City tour

## Challenges



ECU data



Position

Remote data  
transmission



Remote  
configuration



Recording

Encryption



Temperature



Installation space

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# City tour

## Hardware setup

► Ambient temperatures





# City tour

## Hardware setup

ECU

ECU data



UniCAN 3



Temperature



Installation space

## Data logger UniCAN 3

### Data logger for mobile applications

- ▶ 12 CAN interfaces
- ▶ Operating temperature range: -40 °C to +80 °C
- ▶ Dimensions (W × H × D): 109 × 45 × 158 mm
- ▶ Support of AUTOSAR PDU
- ▶ Numerous options for application-specific configuration
- ▶ Recording on CF card (up to 64 GB)

UniCAN 3 on  
[www.csm.de](http://www.csm.de)



UniCAN 3 backside

# City tour

## Hardware setup





# City tour

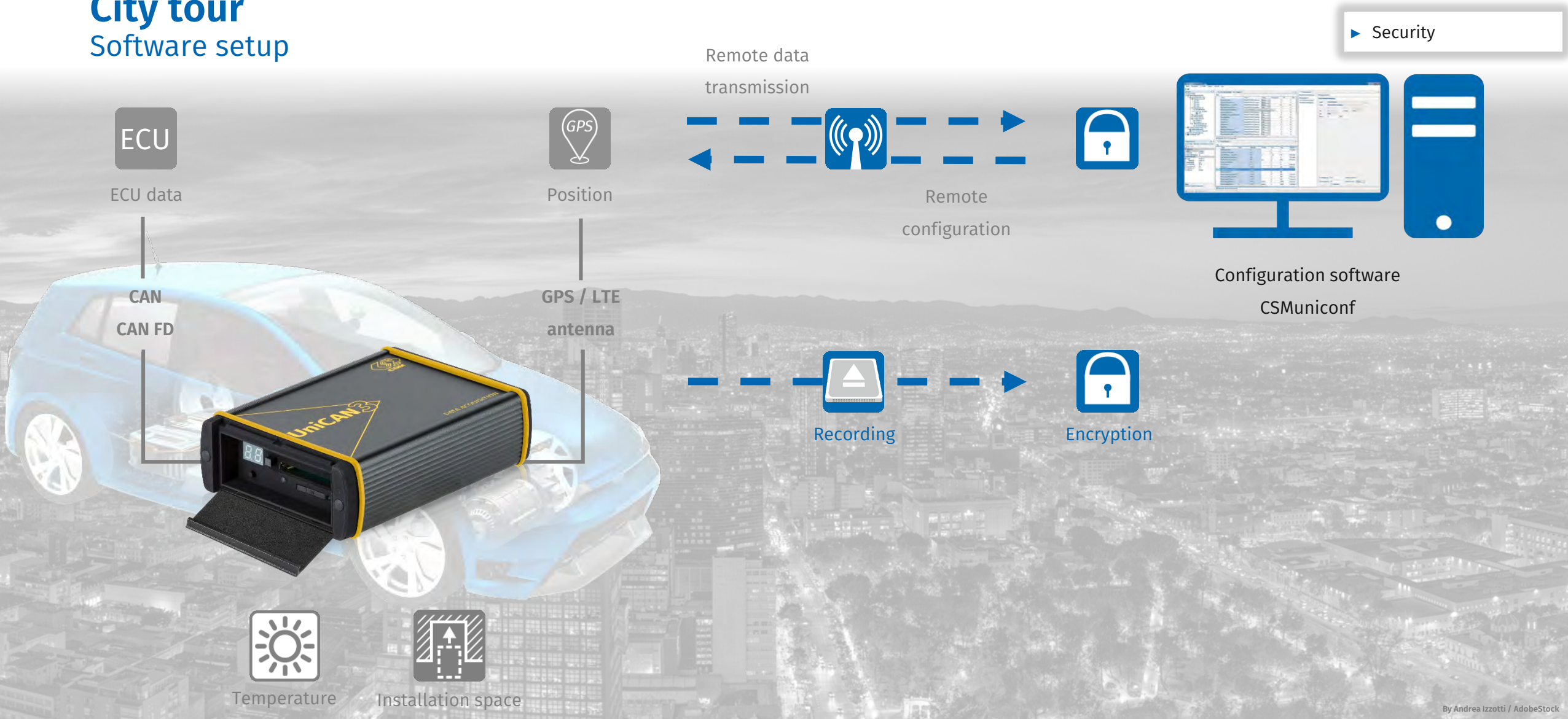
## Hardware setup



# City tour

## Software setup

► Security

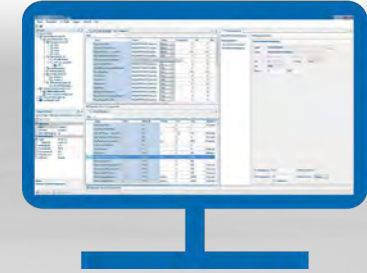




## Security

- ▶ No configuration files (dbc, a2l) are stored directly on CF card!
  - Instead: Binary configuration file
- ▶ Measurement data also stored in a binary file format on CF card
- ▶ Data transfer to SFTP server

▶ Security



Configuration software  
CSMunionconf



Encryption

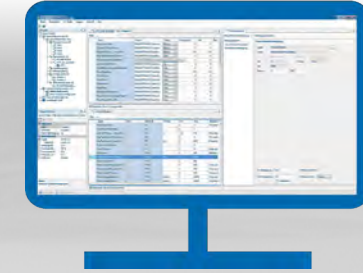


## Security

- ▶ No configuration files stored directly on the device
  - Binary configuration file
- ▶ Measurement data also stored in a binary file
- ▶ Data transfer to SFTP server
- ▶ Additional encryption (Device Protection)
  - Algorithm with 3 levels
  - Password protected

3 Properties	
UniCAN Quercheck.DLgs.213-UC3DL (VIN) *	
?	
▼ Common	
Serial Number	213-UC3DL
Vehicle ID	VIN
Logger Type	(ART1271203) UniCAN 3 - 8 iCAN 4/4
Device Firmware	Default
> Licensed features	...
> Hardware properties	...
▼ Configurations	
Measurement Configuration	Systemsignale UC2
Transport Configuration	Mobilfunk O2 SFTP
Post Processing	Version_MF4
▼ Device Protection	
Protection	Yes
Algorithm	AES256
Password	••••••••

▶ Security



Configuration software  
CSMuniconf



Encryption



# City tour

## Overview

- ▶ High ambient temperatures
- ▶ Hidden installation in the vehicle
- ▶ ECU data acquisition
- ▶ Position data
- ▶ Remote access
- ▶ Secure storage and transmission of data

ECU

ECU data

CAN  
CAN FD



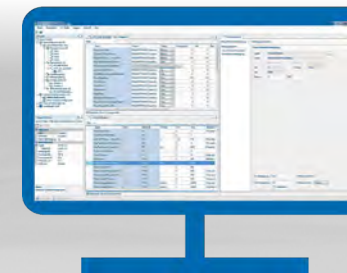
Position

GPS / LTE  
antenna

Remote data  
transmission



Remote  
configuration



Configuration software  
CSMuniconf



Recording



Encryption



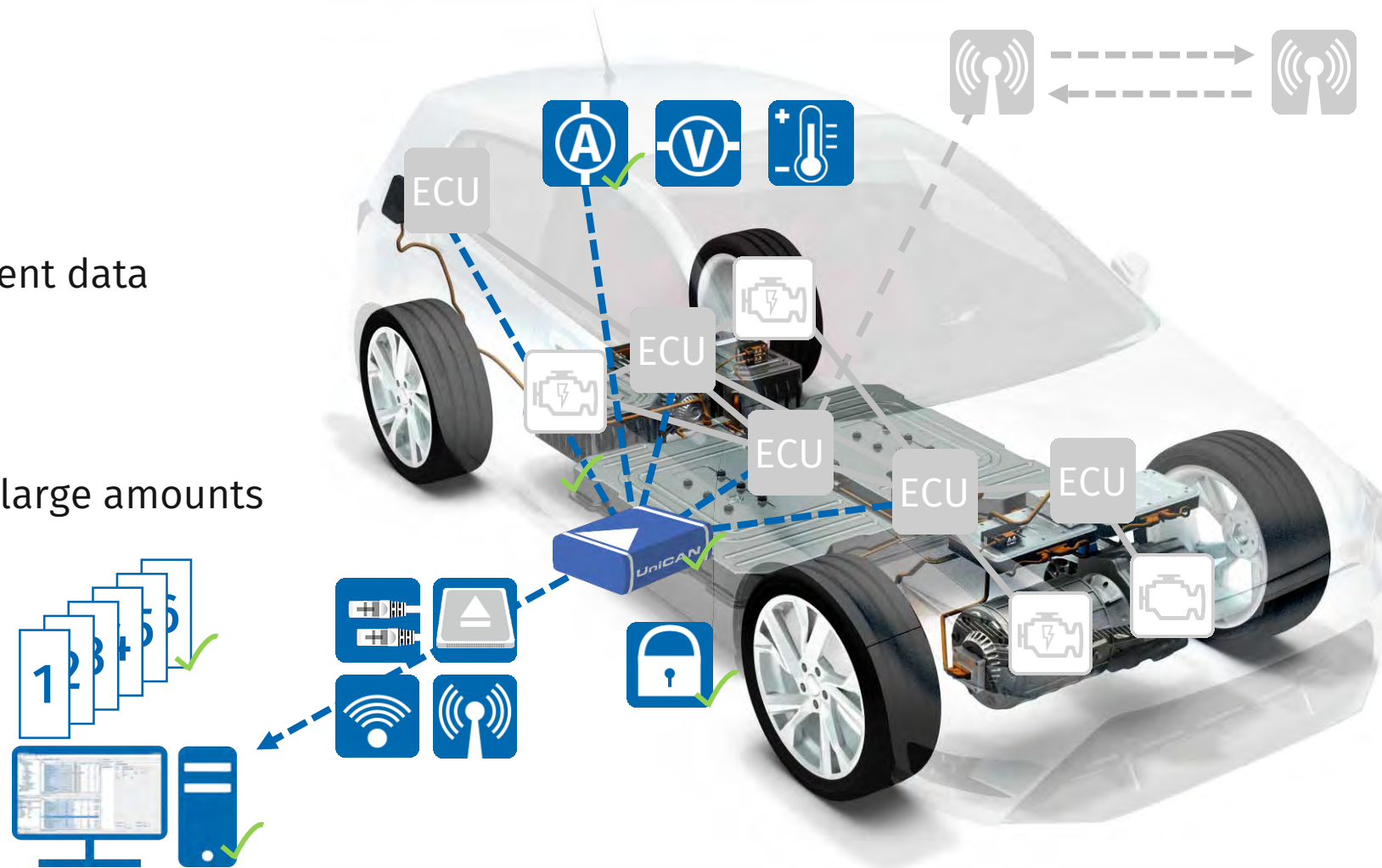
Temperature



Installation space

# Data logger requirements

- ✓ ▶ **Autonomous operation**
- ✓ ▶ Efficient data acquisition
- ✓ ▶ **Secure storage**
- ✓ ▶ Integration of analog measurement data
  - ▶ Flexible data transmission
- ✓ ▶ Trigger configuration
- ✓ ▶ Acquisition and management of large amounts of data





# Winter is coming

## Scenario 3

Behavior of the engine control unit in extremely cold conditions

### General conditions

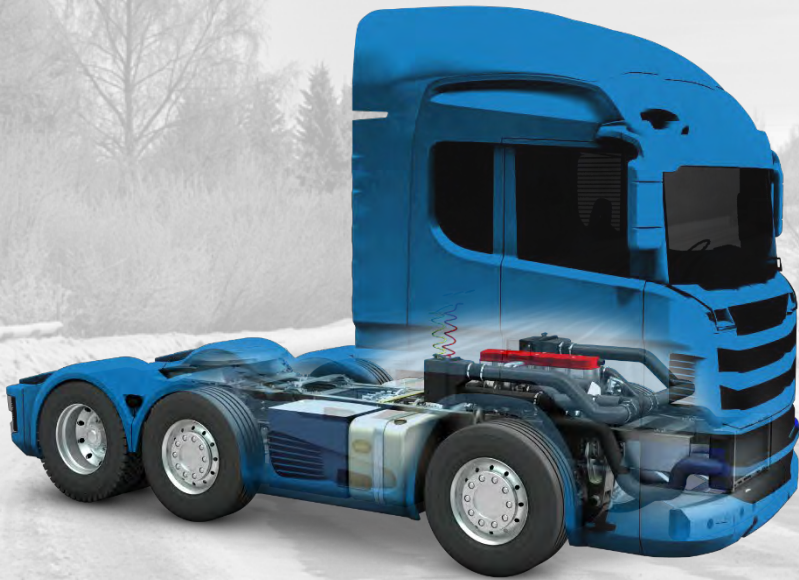
- ▶ Vehicle fleet: 10 trucks
- ▶ Duration: 6 weeks

### Challenges

- ▶ Extremely low temperatures (down to -40 °C)
- ▶ Poor mobile network coverage

# Winter is coming

## Challenges



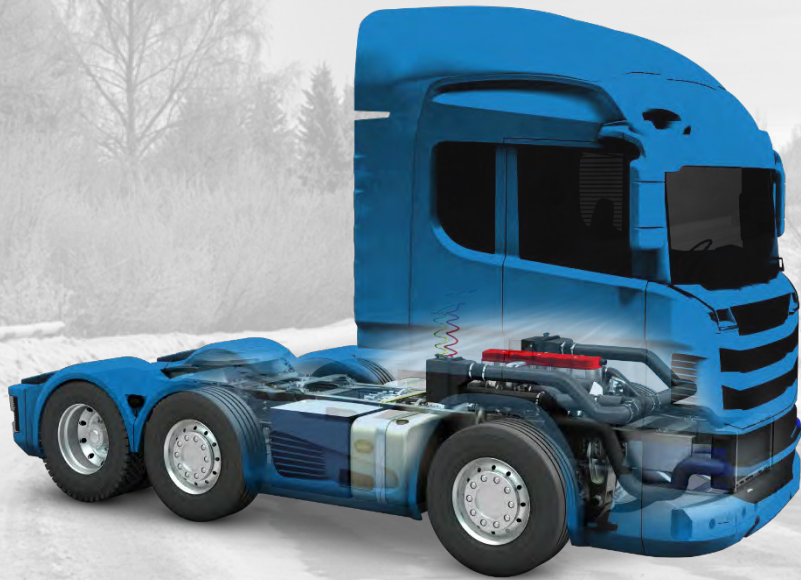
Temperature

- Extremely low ambient temperatures



# Winter is coming

## Challenges



Temperature



Power consumption

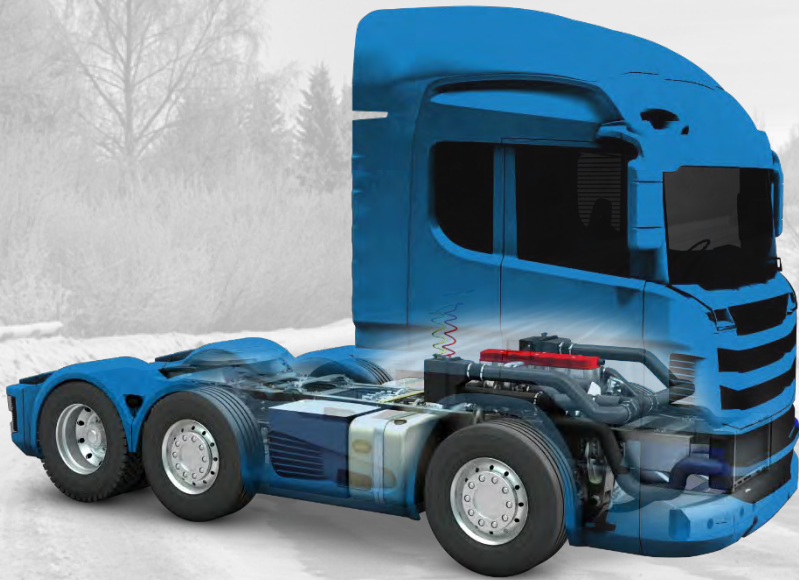
- ▶ Extremely low ambient temperatures
- ▶ **Low power consumption**
  - Low load on vehicle battery

# Winter is coming

## Challenges

ECU

ECU data



Temperature



Power consumption

- ▶ Extremely low ambient temperatures
- ▶ Low power consumption
  - Low load on vehicle battery
- ▶ **ECU data acquisition**



# Winter is coming

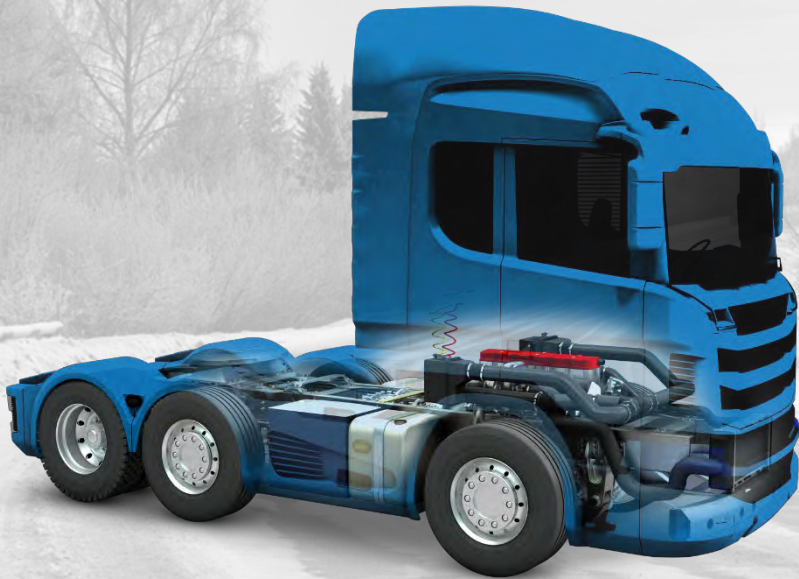
## Challenges



ECU data



Temperatures



Temperature



Power consumption

- ▶ Extremely low ambient temperatures
- ▶ Low power consumption
  - Low load on vehicle battery
- ▶ ECU data acquisition
- ▶ **Parallel recording of temperature measurement data**

# Winter is coming

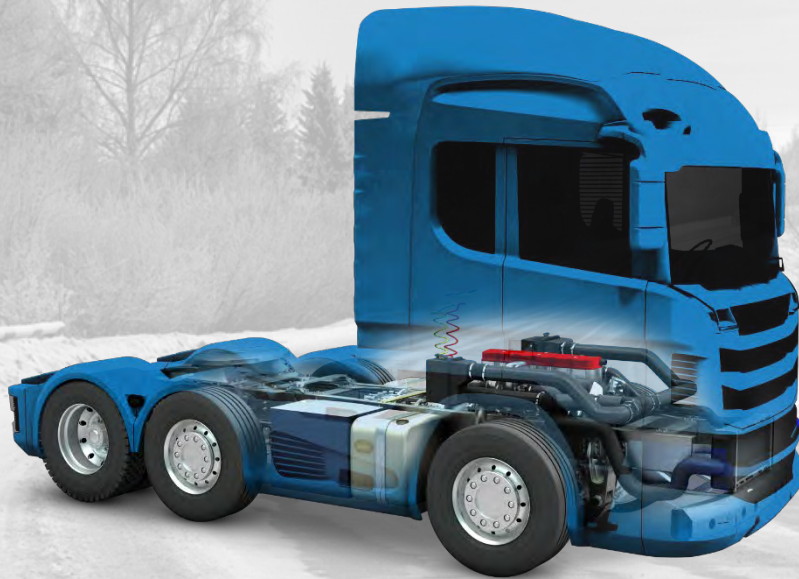
## Challenges



ECU data



Temperatures



Fast startup



Recording



Temperature



Power consumption

- ▶ Extremely low ambient temperatures
- ▶ Low power consumption
  - Low load on vehicle battery
- ▶ ECU data acquisition
- ▶ Parallel recording of temperature measurement data
- ▶ **Delay-free recording of the start behavior**



# Winter is coming

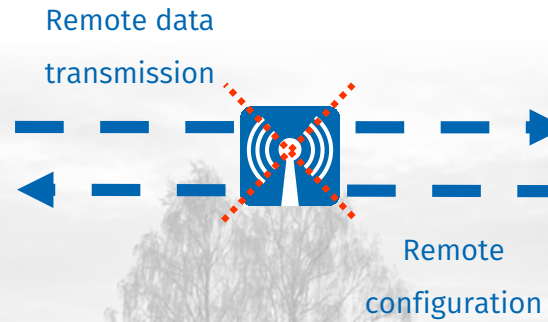
## Challenges



ECU data



Temperatures



Fast startup



Recording

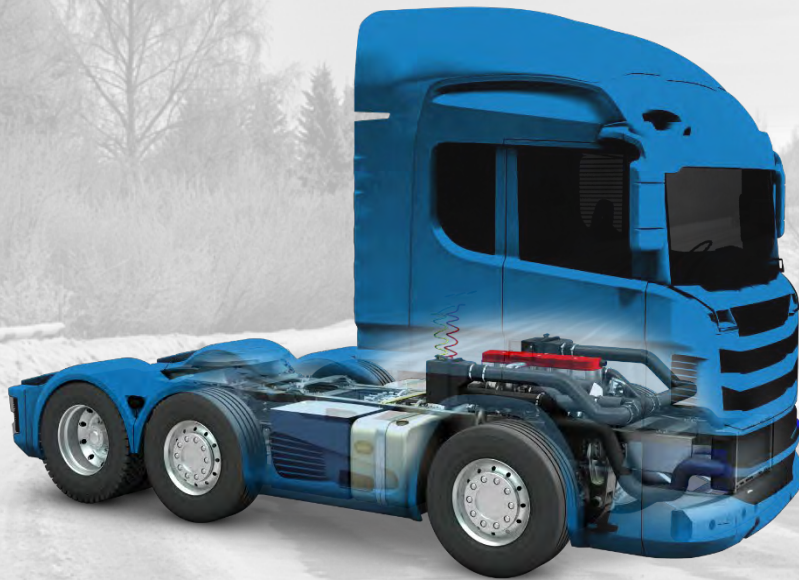


Temperature



Power consumption

- ▶ Extremely low ambient temperatures
- ▶ Low power consumption
  - Low load on vehicle battery
- ▶ ECU data acquisition
- ▶ Parallel recording of temperature measurement data
- ▶ Delay-free recording of the start behavior
- ▶ **Option for radio dead zones**



# Winter is coming

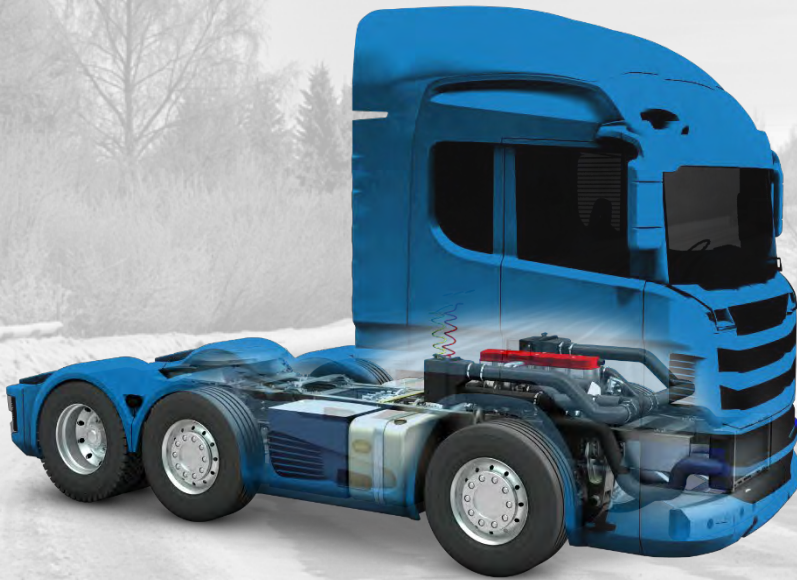
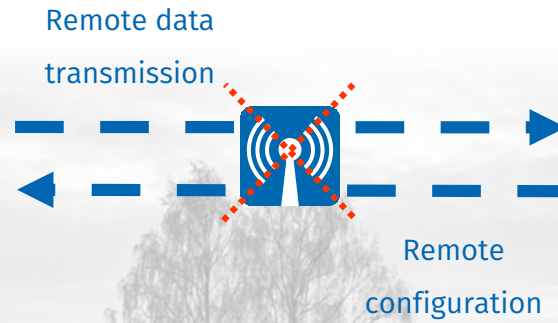
## Challenges



ECU data



Temperatures



Fast startup



Recording



Temperature



Power consumption



# Winter is coming

## Hardware setup



► Ambient temperatures



By yanikap / AdobeStock

# Winter is coming

## Hardware setup



## Datea logger UniCAN 3 ETH

### Data logger for mobile applications with Ethernet interface

- ▶ Operating temperature range: -40 °C to +80 °C
- ▶ Power consumption
  - Normal operation: 3.6 W
  - Full load: 7.3 W

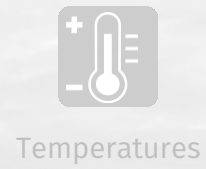
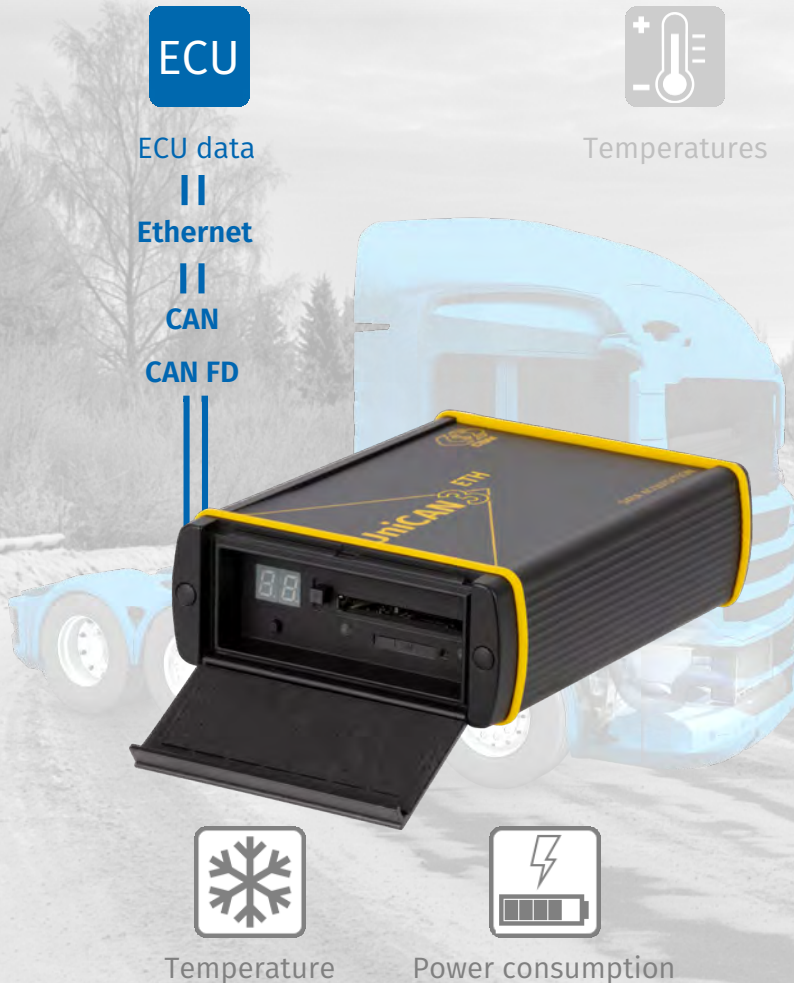


UniCAN 3 ETH



# Winter is coming

## Hardware setup



► ECU data acquisition



# Winter is coming

## Hardware setup



► Temperature measurement





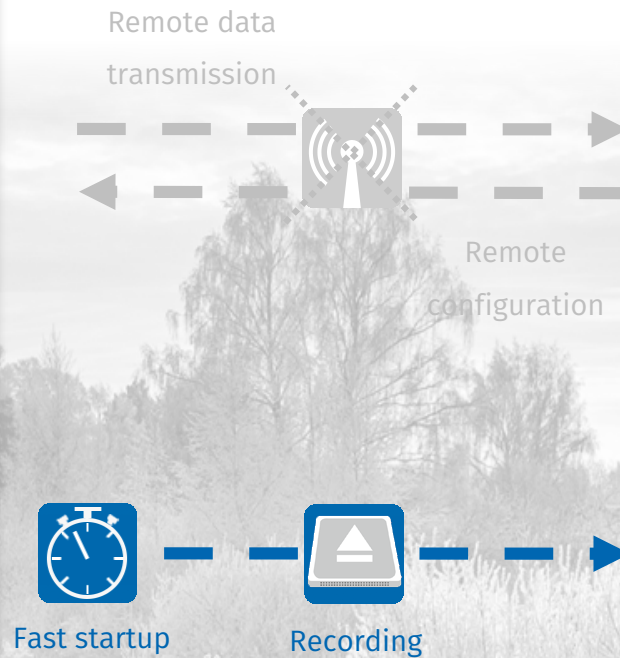
# Winter is coming

## Software setup



## Delay-free recording

- ▶ FPGA architecture
  - no operating system necessary
  - cold start <1 second
  - low power consumption <1 mA, in sleep mode
- ▶ Wake-on-CAN
  - Automatic start due to bus activity
  - No Message Lost

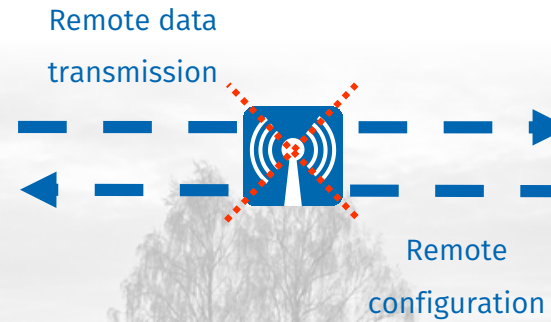


▶ Delay-free recording



## Handling of Radio Dead Zones

- ▶ Additional setting of fixed transmission time
- ▶ Data transmission only from selected measurement channels (minimizes data volume)
- ▶ Logging of same channels with different sampling rates to transmit channels with reduced data volume

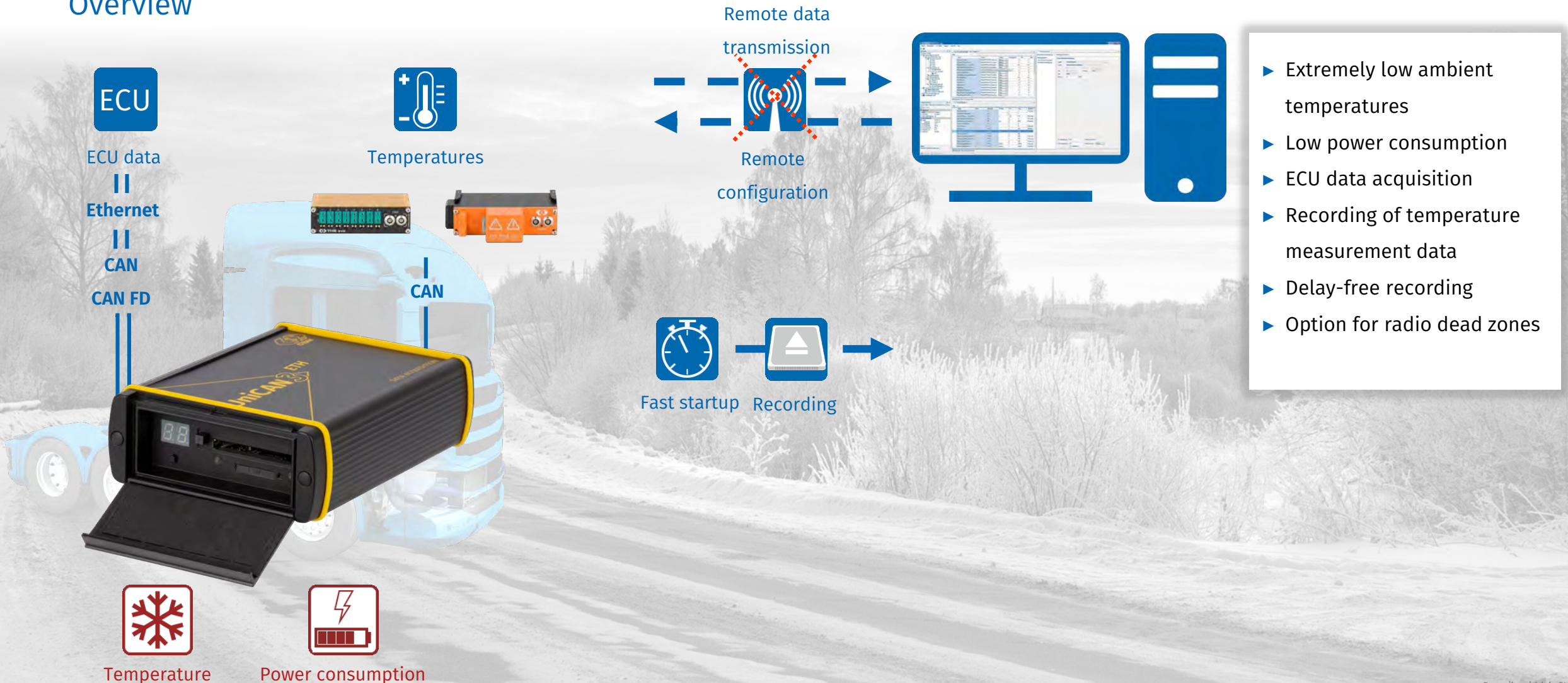


▶ Flexible transmission



# Winter is coming

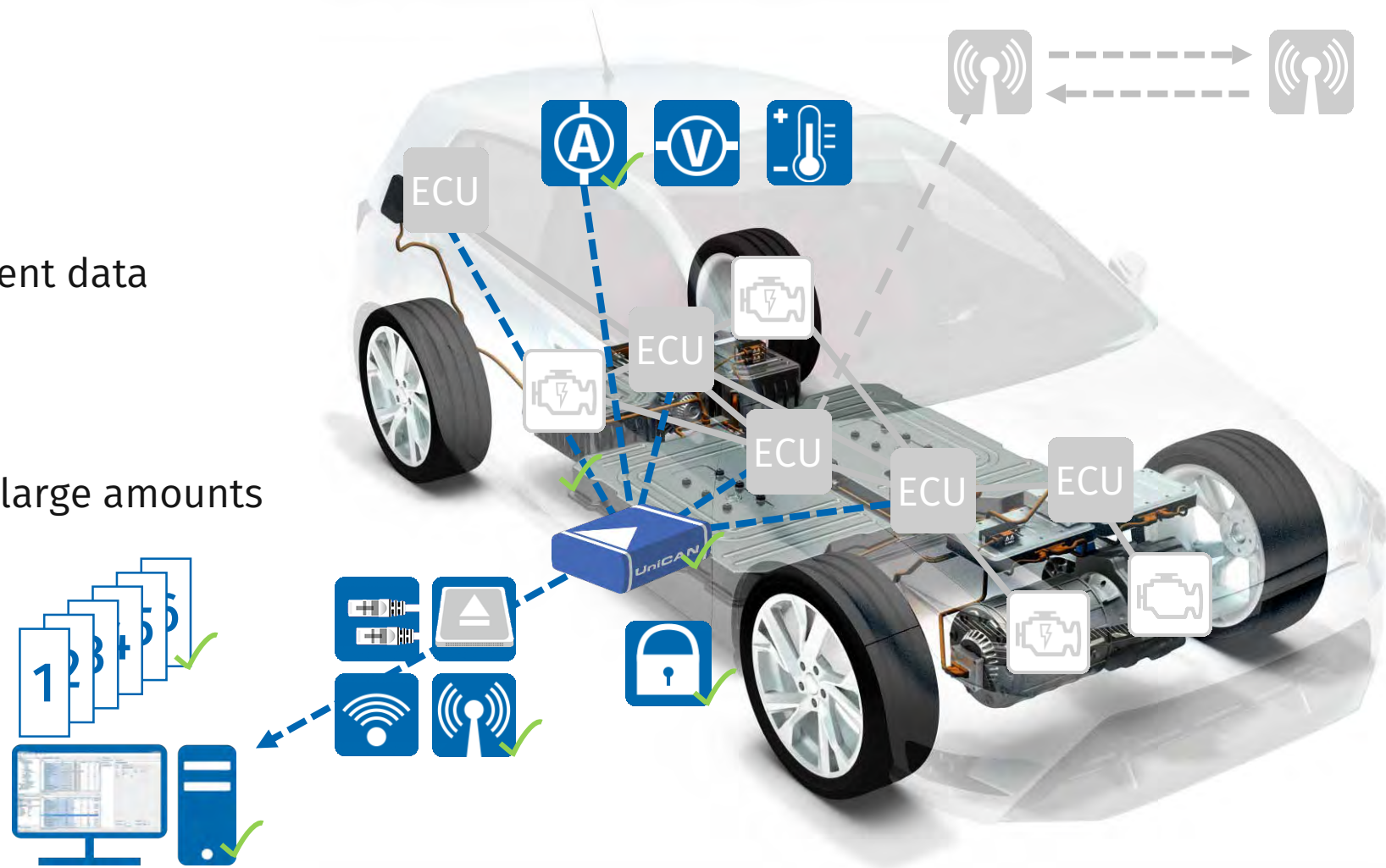
## Overview





# Data logger requirements

- ✓ ▶ Autonomous operation
- ✓ ▶ Efficient data acquisition
- ✓ ▶ Secure storage
- ✓ ▶ Integration of analog measurement data
- ✓ ▶ **Flexible data transmission**
- ✓ ▶ Trigger configuration
- ✓ ▶ Acquisition and management of large amounts of data



# Vector and CSM data logger portfolio

## CSM UniCAN 3 data loggers



Acquisition of analog and digital measurement values, internal ECU parameters and vehicle bus communication.

Easy configuration

## Vector GL logger family



Vector Logger Suite (VLS)

vMDM Client

Logging of automotive network communication, internal ECU parameters (FlexRay, LIN, ...) and measured values. Comfortable diagnostic functions.

Flexible configuration

## Vector VP smart logger



Vector Logger Suite (VLS)

CANape log (eMobilityAnalyzer)

vMDM

Intelligent high performance logging solution for e-mobility and ADAS developments.  
In-depth real time calculations and analyses.



# Data logging of analog signals in worldwide fleet testing

Vector CSM E-Mobility  
Measurement System on  
[www.csm.de](http://www.csm.de)

VECTOR



CSM

E-Mobility Measurement System



Hardware and software packages with flexible customization options  
for many test environments and requirements



# 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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