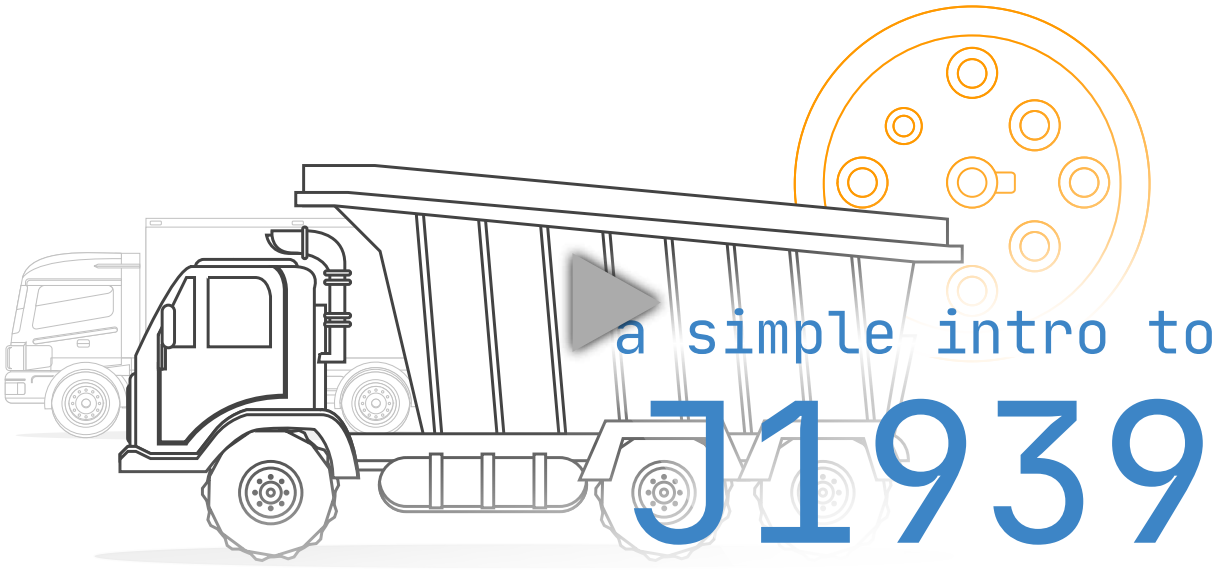
J1939 Explained - A Simple Intro [2023]



Need a simple, practical intro to SAE J1939?

In this guide we introduce the J1939 protocol basics incl. PGNs and SPNs.

Note: This is a **practical intro** so you will also learn how to decode J1939 data via DBC files, how J1939 logging works, key use cases and practical tips.

Learn below why this has become the **#1 introduction to J1939**.

You can also watch our J1939 intro above - or get the PDF

In this article

Author: Martin Falch in (updated March 2022)

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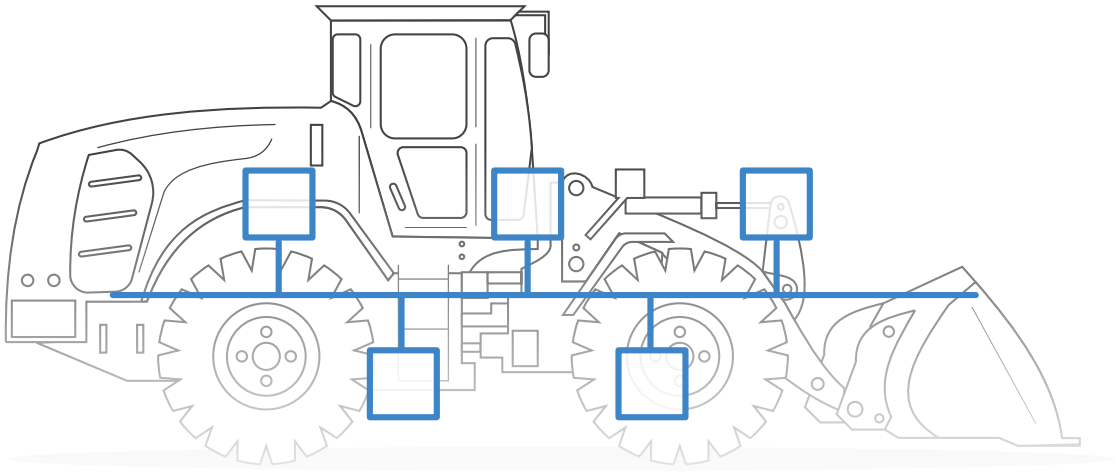


What is J1939?

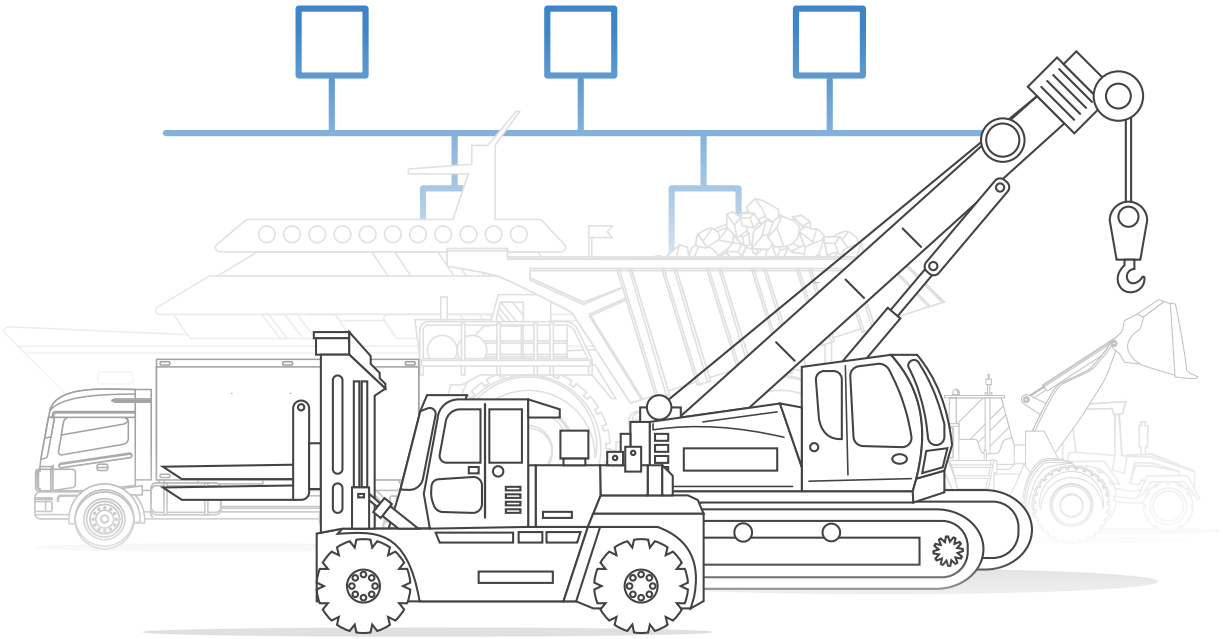
In short, SAE J1939 is a set of standards that define how ECUs communicate via the CAN bus in heavy-duty vehicles.

As explained in our CAN bus intro, most vehicles today use the Controller Area Network (CAN) for ECU communication. However, CAN bus only provides a "basis" for communication (like a telephone) - not a "language" for conversation.

In most heavy-duty vehicles, this language is the SAE J1939 standard defined by the Society of Automotive Engineers (SAE).

In more technical terms, J1939 provides a higher layer protocol (HLP) based on CAN as the "physical layer".

What does that mean, though?



One standard across heavy-duty vehicles

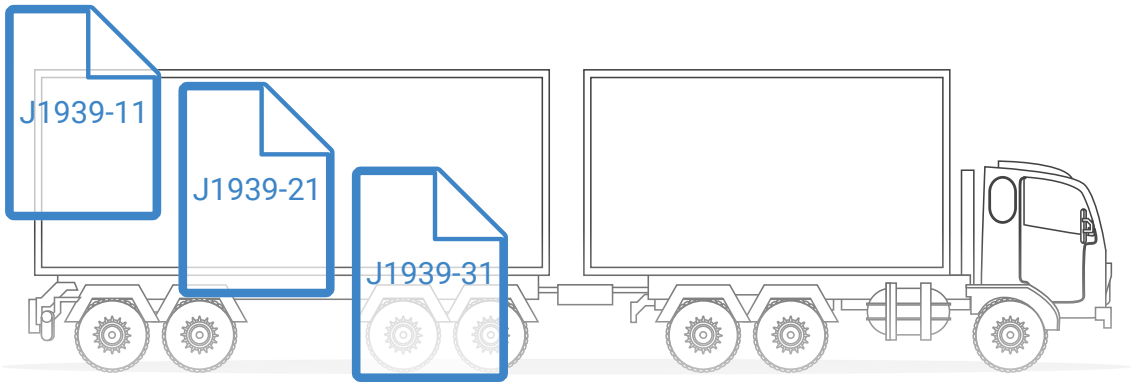
In simple terms, J1939 offers a **standardized** method for communication across ECUs, or in other words:

J1939 provides a common language across manufacturers.

In contrast, e.g. cars use proprietary OEM specific protocols.

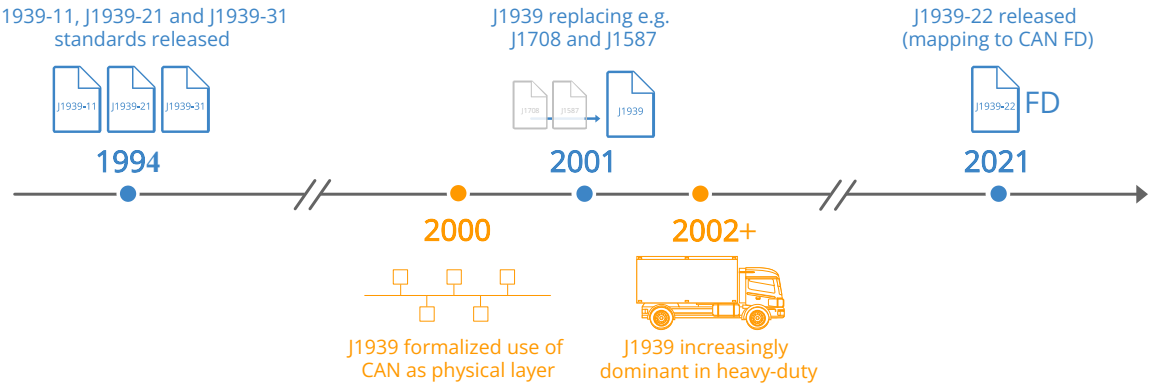
J1939 application examples +

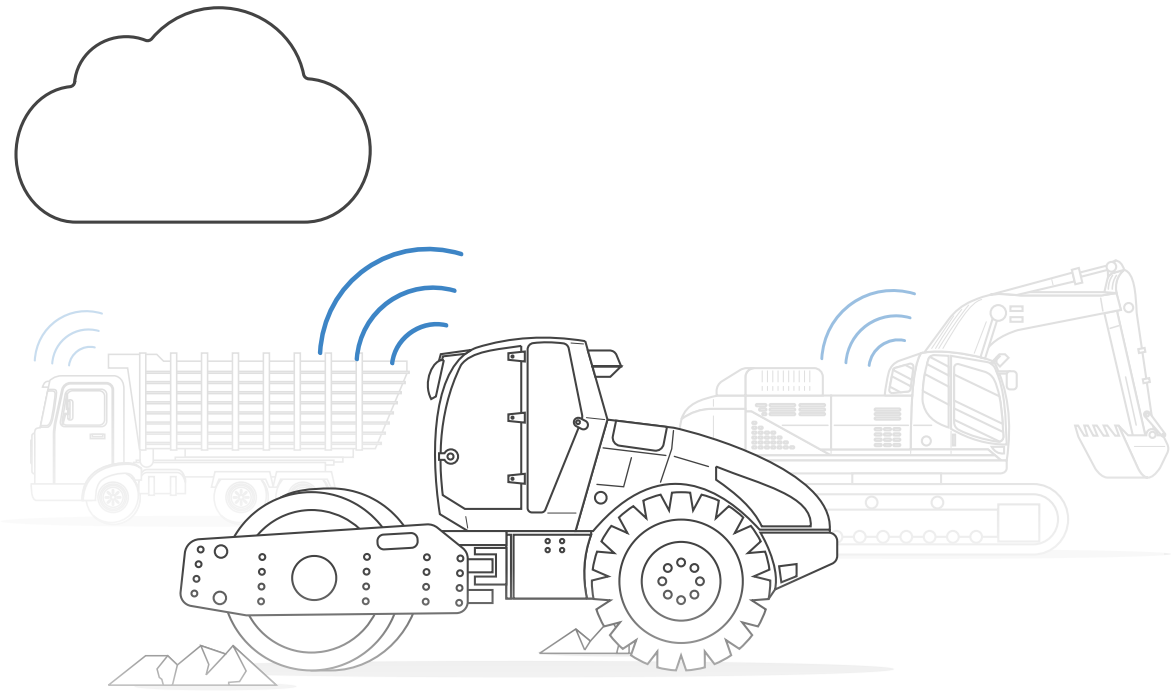
The standardization is a key enabler to data logging use cases across heavy-duty vehicles - more on this further below.



J1939 history

- 1994: First docs were released (J1939-11, J1939-21, J1939-31)
- 2000: The initial top level document was published
- 2000: CAN formally included as part of J1939 standard
- 2001: J1939 starts replacing former standards SAE J1708/J1587





J1939 future

With the rise of heavy-duty telematics, J1939 will increasingly play a role in the market for connected vehicles. In turn, this will increase the need for secure J1939 IoT loggers.

In parallel, OEMs will increasingly shift from Classical CAN to CAN FD as part of the transition to J1939 with flexible data-rate. In turn, this will increase the need for J1939 FD data loggers.

"The market for in-vehicle connectivity - the hardware and services bringing all kinds of new functionality to drivers and fleet owners - is expected to reach EUR 120 billion by 2020."

- Boston Consulting Group, Connected Vehicles and the Road to Revenue

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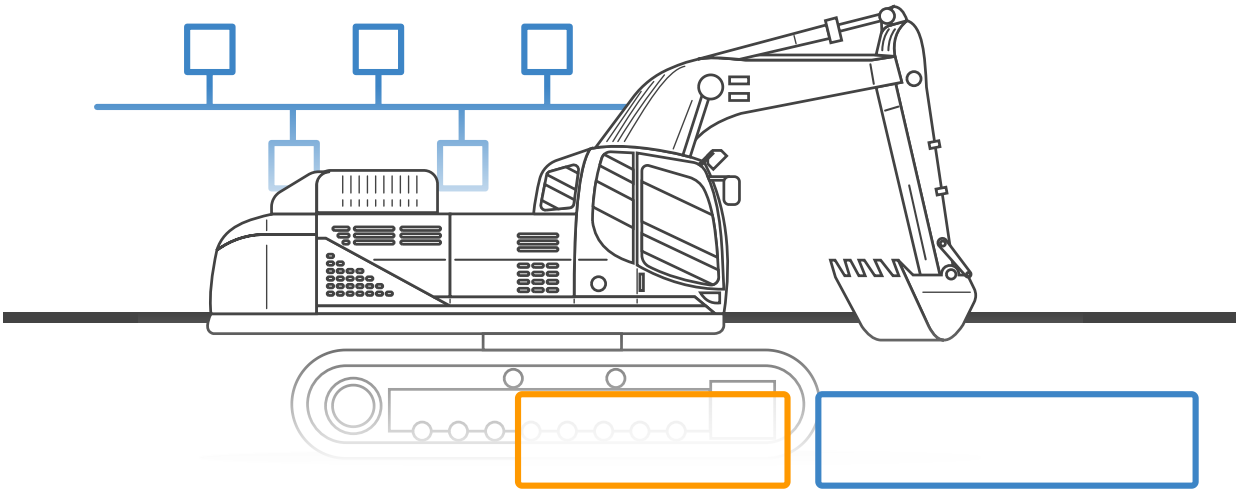
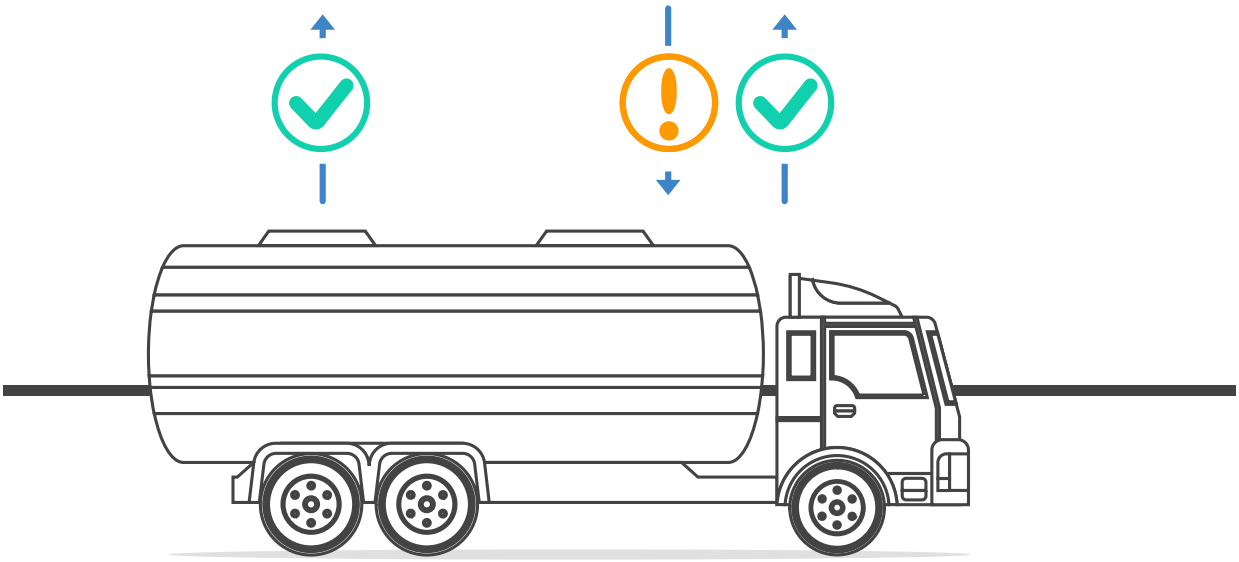
4 key characteristics of J1939

The J1939 protocol has a set of defining characteristics outlined below:



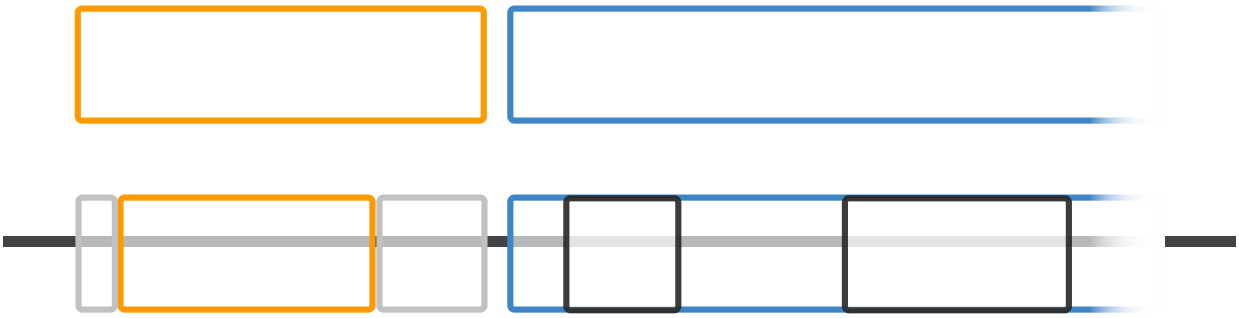
250K baud rate &
29-bit extended ID

The J1939 baud rate is typically 250K (though recently with support for 500K) - and the identifier is extended 29-bit (CAN 2.0B)



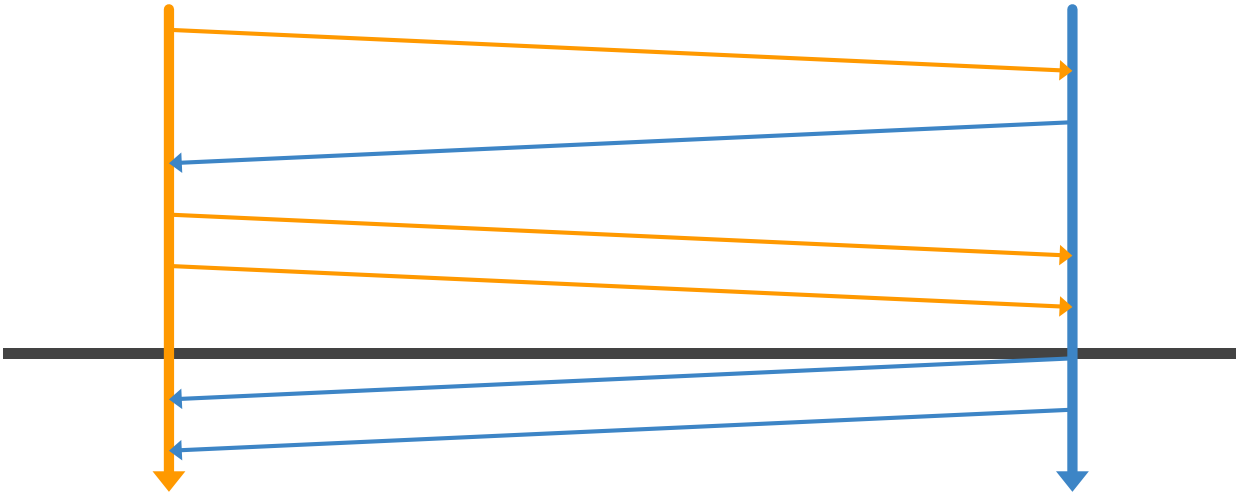
Broadcast + on-request data

Most J1939 messages are broadcast on the CAN-bus, though some data is only available by requesting the data via the CAN bus



PGN identifiers & SPN parameters

J1939 messages are identified by 18-bit Parameter Group Numbers (PGN), while J1939 signals are called Suspect Parameter Numbers (SPN)



Multibyte variables & Multi-packets

Multibyte variables are sent least significant byte first (Intel byte order). PGNs with up to 1785 bytes are supported via J1939 transport protocol

Additional J1939 characteristics +

Technical: J1939 'higher layer protocol' explained +

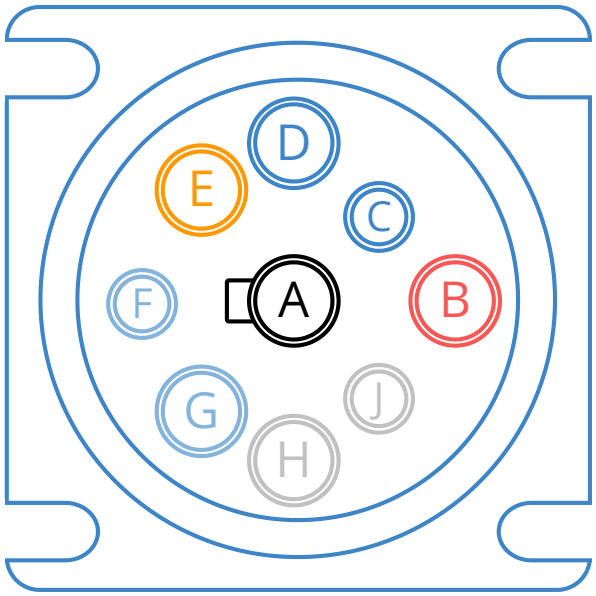
The J1939 connector (9-pin)

The J1939-13 standard specifies the 'off-board diagnostic connector' - also known as the J1939 connector or 9-pin deutsch connector. This is a standardized method for interfacing with the J1939 network of most heavy duty vehicles - see the illustration for the J1939 connector pinout.

Black type 1 vs green type 2 +

Multiple J1939 networks +

Other heavy duty connectors +



A	Ground
B	Battery power
C	CAN 1 H
D	CAN 1 L
E	CAN shield
F	J1708 (+) / CAN 2 H
G	J1708 (-) / CAN 2 L
H	OEM specific
J	OEM specific

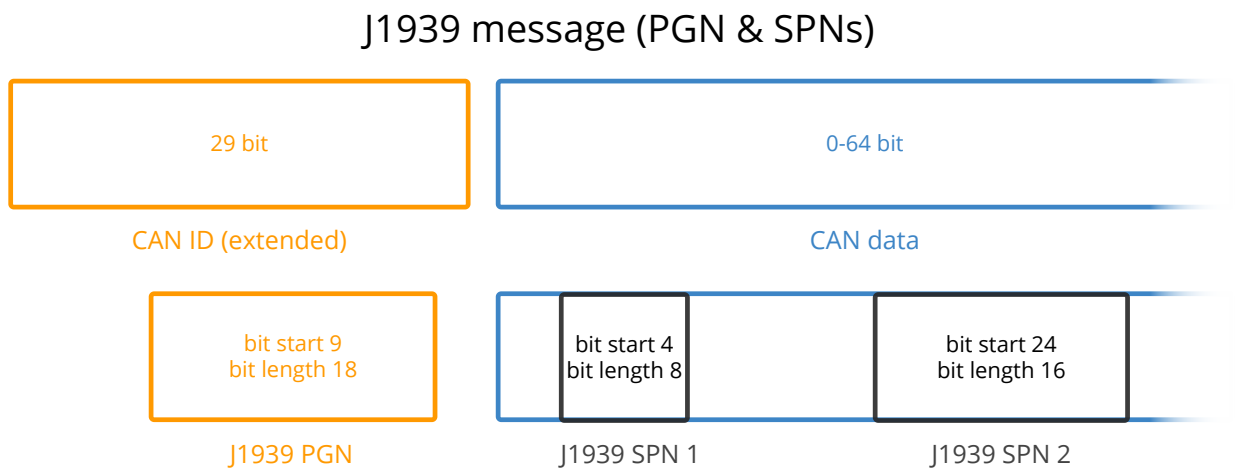
Type 1 (black): CAN 1 = 250K
Type 2 (green): CAN 1 = 500K

The J1939 PGN and SPN

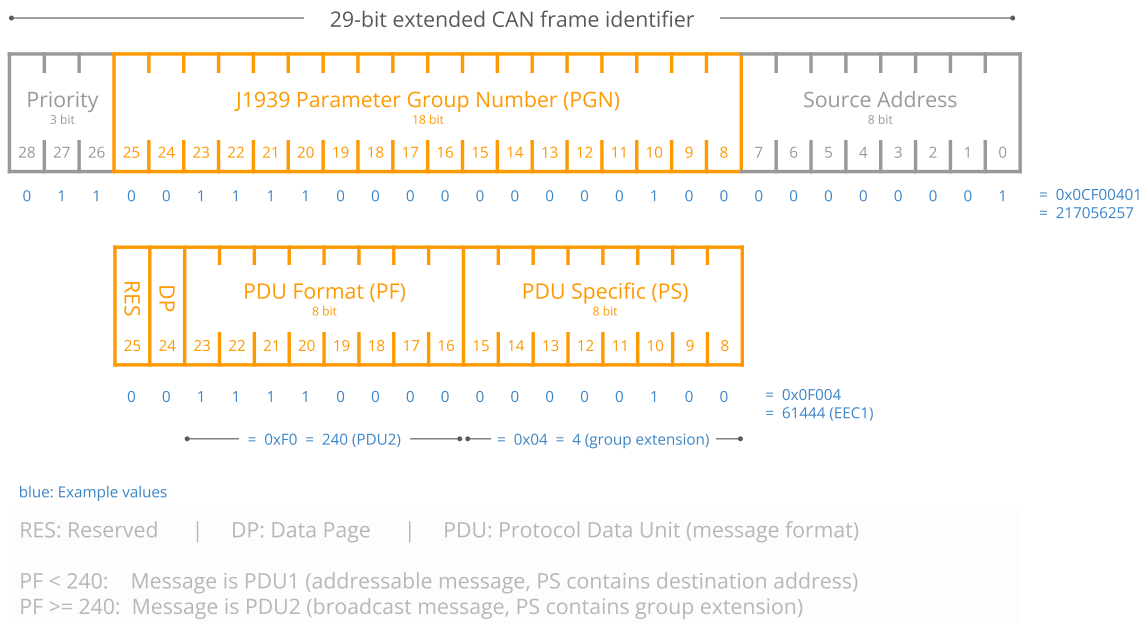
In the following section we explain the J1939 PGNs and SPNs.

Parameter Group Number (PGN)

The **J1939 PGN** comprises an 18-bit subset of the 29-bit extended CAN ID. In simple terms, the PGN serves as a unique frame identifier within the J1939 standard. For example, you can look this up in the J1939-71 standard documentation, which lists PGNs/SPNs.



Example: J1939 PGN 61444 (EEC1) +



Detailed breakdown of the J1939 PGN

Let's look at the CAN ID to PGN transition in detail.

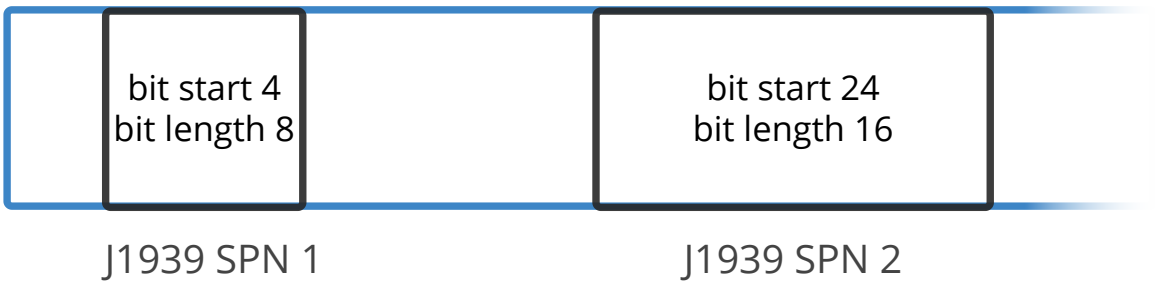
Specifically, the 29 bit CAN ID comprises the Priority (3 bits), the J1939 PGN (18 bits) and the Source Address (8 bits). In turn, the PGN can be split into the Reserved Bit (1 bit), Data Page (1 bit), PDU format (8 bit) and PDU Specific (8 bit).

The detailed PGN illustration also includes example values for each field in binary, decimal and hexadecimal form.

To learn more about the transition from 29 bit CAN ID to 18 bit J1939 PGN, see also our online CAN ID to J1939 PGN converter. The converter also includes a full J1939 PGN list for PGNs included in our J1939 DBC file.

Suspect Parameter Number (SPN)

The **J1939 SPN** serves as the identifier for the CAN signals (parameters) contained in the databytes. SPNs are grouped by PGNs and can be described in terms of their bit start position, bit length, scale, offset and unit - information required to extract and scale the SPN data to physical values.



Example: Extracting J1939 SPN 190 (Engine Speed) +

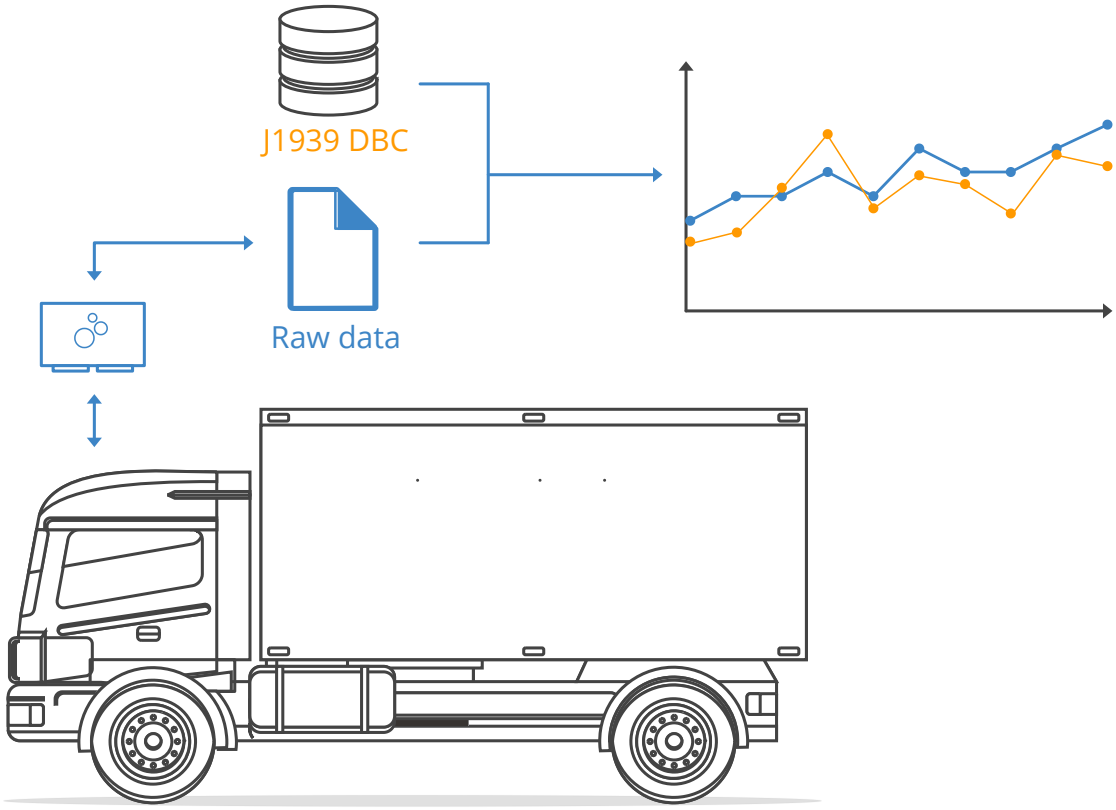
In practice, you will not PDF-lookup decoding rules for J1939 data - instead, this info can be stored in a CAN database file (DBC).

Example: J1939 DBC file

A J1939 DBC file can be used to decode data across most heavy-duty vehicles. For example, raw J1939 data can be recorded with a CAN bus data logger and analyzed in a CAN software tool that supports DBC conversion (e.g. asammdf).

This will typically result in a conversion of 40-60% of the vehicle data - with the rest being OEM specific proprietary data that requires reverse engineering.

j1939 dbc intro



J1939 truck sample data: Raw & physical values

Below we illustrate what real J1939 data looks like. The 'raw' J1939 data was recorded from a heavy duty truck using a CANedge2, while the 'physical values' reflect the output after decoding the raw data via the free asammdf software and the J1939 DBC.

Sample: Raw J1939 truck data (CSV) +

Sample: Decoded physical values J1939 truck data (CSV) +

About the CANedge J1939 logger

The CANedge lets you easily record J1939 data to an 8-32 GB SD card. Simply connect it to e.g. a truck to start logging - and decode the data via free software/APIs and our J1939 DBC.

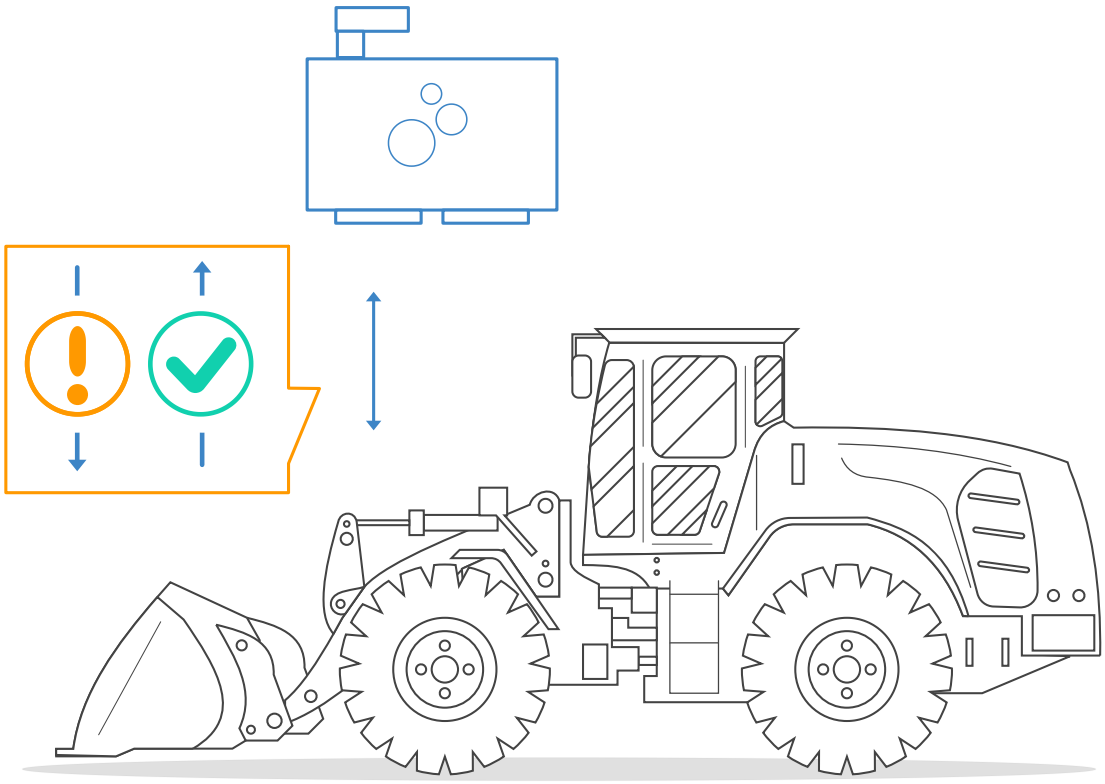
j1939 logger intro

J1939 request messages

Most J1939 messages are broadcast via the CAN bus, but some are only sent "on-request" (e.g. when polled by a J1939 data logger).

On-request data often includes J1939 diagnostic trouble codes (DTCs), making it important in J1939 diagnostics - see also our J1939-73 DBC file. Below we briefly outline

how it works:

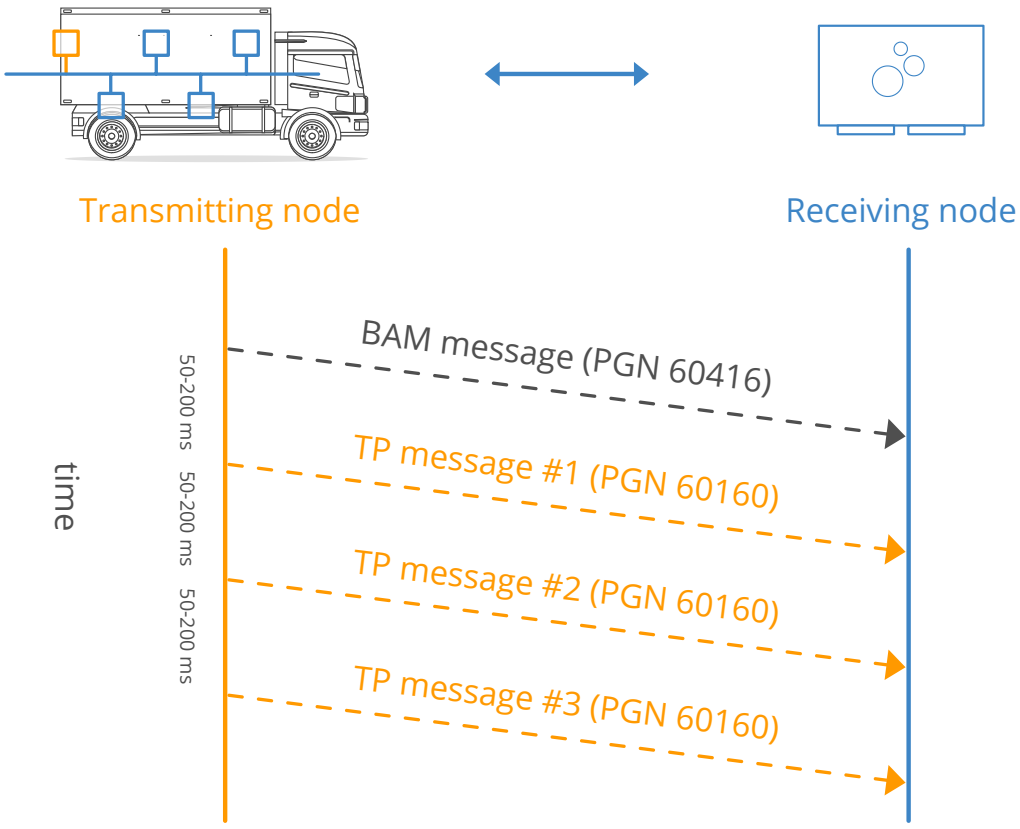


Sending J1939 request messages +

J1939 transport protocol (TP)

The previous PGN and SPN examples are based on J1939 messages with 8 data bytes. While these are most common, J1939 multi-frame messages also exist with >8 data bytes - sent via the J1939 transport protocol.

Below we outline how the J1939 transport protocol works, a practical J1939 TP data example and how to decode multi-frame J1939 messages via DBC files:



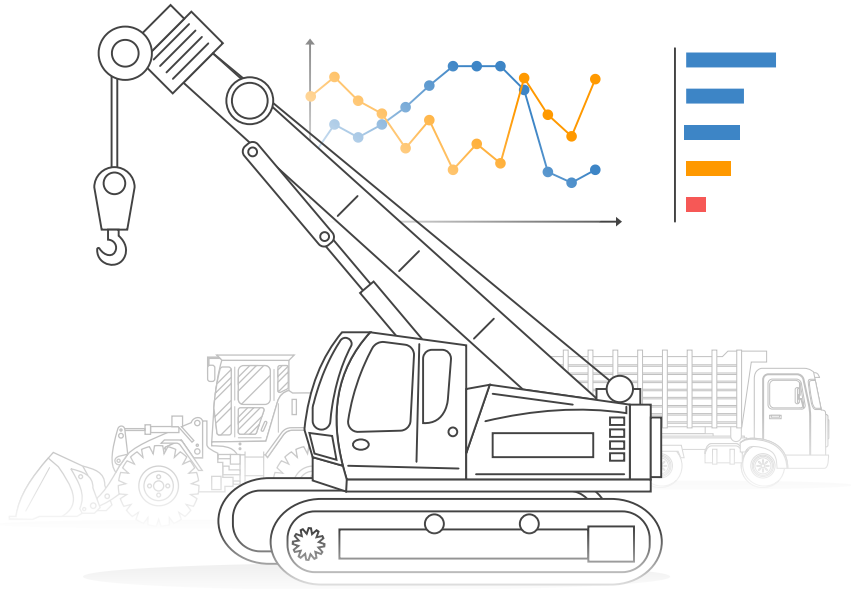
How does the J1939 transport protocol work? +

A practical J1939 transport protocol example +

How to decode a J1939 transport protocol message +

Logging J1939 data - example use cases

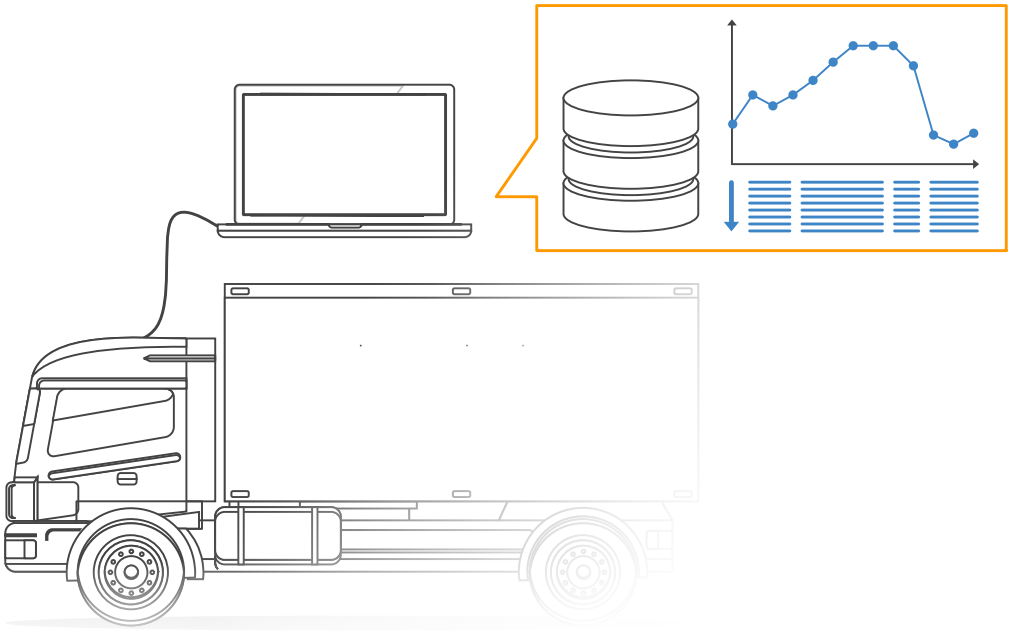
There are several common use cases for recording J1939 data:



Heavy duty fleet telematics

J1939 data from trucks, buses, tractors etc. can be used in fleet management to reduce costs or improve safety

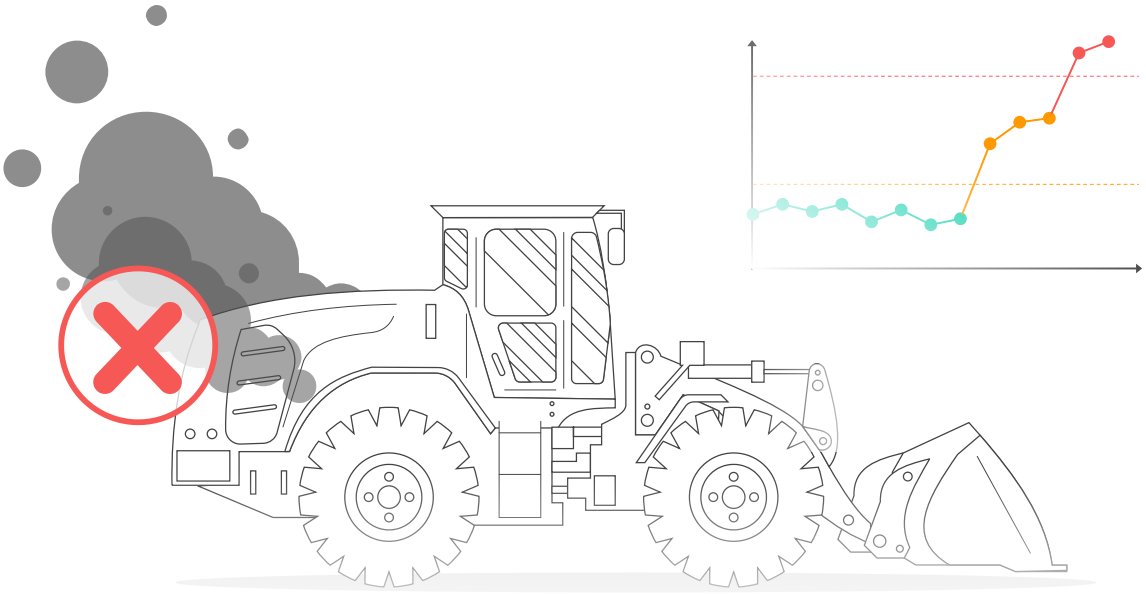
j1939 telematics →



Live stream diagnostics

By streaming decoded J1939 data to a PC, technicians can perform real-time J1939 diagnostics on vehicles

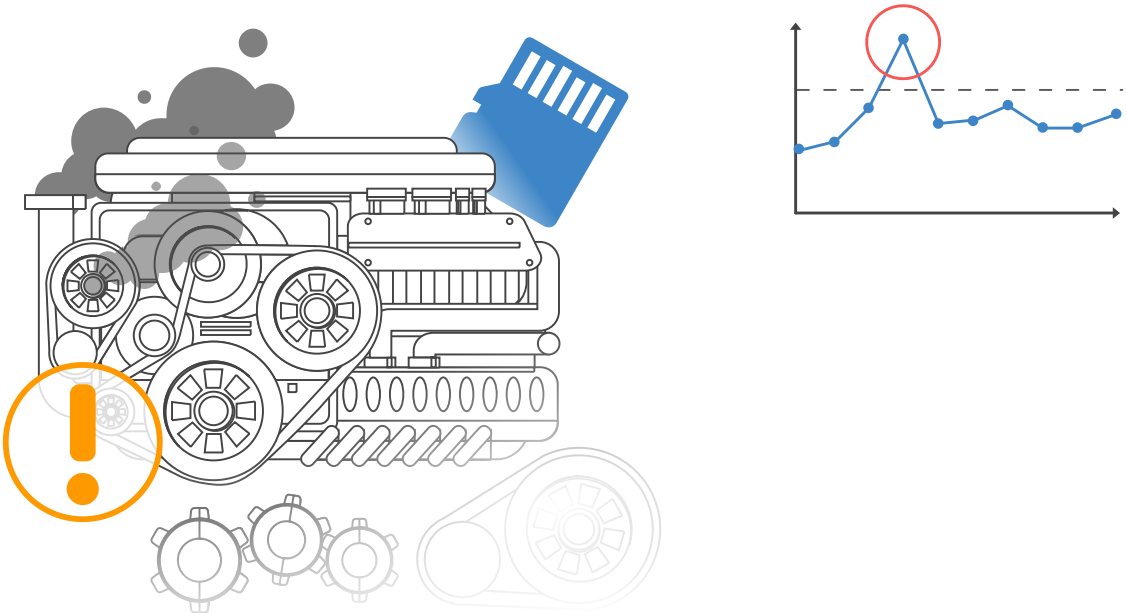
j1939 streaming →



Predictive maintenance

Vehicles can be monitored via WiFi CAN loggers in the cloud to predict breakdowns based on the J1939 data

predictive maintenance →



Heavy-duty vehicle blackbox

A CAN logger can serve as a 'blackbox' for heavy-duty vehicles, providing data for e.g. disputes or J1939 diagnostics

can bus blackbox →

Do you have a J1939 data logging use case? Reach out for free sparring!

contact us →

6 practical tips for J1939 data logging

Many of our end users work with J1939 logging in the field - and below we share 6 practical logging tips:

- J1939 logger vs J1939 streaming interface +
- Direct adapter cable vs contactless reading +
- WiFi vs. cellular (3G/4G) data upload +
- Software selection & J1939 DBC file +
- Consider the need for request PGNs +
- Filter, compress and encrypt the data +

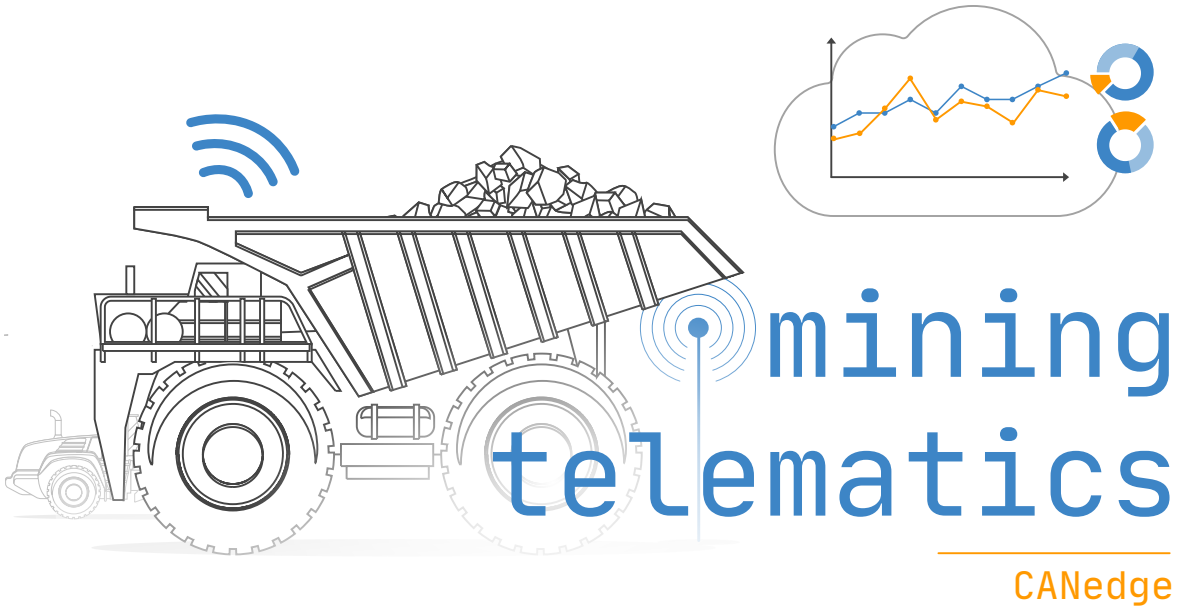
For more intros, see our guides section - or download the **'Ultimate Guide'** PDF.

Need to log/stream J1939 data?

Get your CAN logger today!

Recommended for you

J1939 VEHICLE TELEMATICS



MINING TELEMATICS & DASHBOARDS

CANEDGE2 - PRO CAN IoT LOGGER

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