Reducing power consumption in passenger cars through automated evaluation of CAN data from driving tests

Summary

Due to the increasing complexity of bus systems and the steadily growing number of electrical consumers in motor vehicles, powerful methods for analyzing the power balance are becoming more and more important.

For validation and analysis purposes, the responsible department of Volkswagen AG carries out real and simulated test drives in which all signals of the comfort CAN as well as operating currents are recorded. To evaluate the recordings, müller+krahmer GmbH developed a modular, server-based DIAdem application that automatically retrieves files from the measurement computers according to a predefined configuration and analyzes them. The application searches the data for configurable events, isolates the data ranges delimited by these events and displays them graphically. Characteristic values such as consumer and quiescent currents are determined from the data processed in this way.

Data access as a competitive factor

In the automotive industry in particular, increasing competitive pressure and stricter legal regulations require ever more extensive testing. At the same time, ever larger amounts of data are generated as systems become more complex and modern acquisition hardware becomes more powerful. Managing and efficiently using this data is therefore an ever-growing challenge. It has become vital to be able to access all archived data at any time and extract the currently required information from it without loss of time.

One application for which this is particularly true is the analysis of CAN data from driving tests. In these test drives – carried out both with vehicles on the road and simulated with so-called reference bodies in the workshop – the vehicles are subjected to typical operating situations. The recorded CAN measurement data is then analyzed above all with regard to the vehicle's energy balance, since the growing number of electrical consumers places an ever greater load on the on-board power supply. Carried out manually, this analysis is a laborious and time-consuming affair. Hundreds of signals have to be reviewed and searched for certain events – events that are not simply defined as a change in the value of one signal, but result from the combination of a number of state changes. At the same time, numerous driving tests run in parallel around the clock produce large amounts of data every day that have to be mastered. On the other hand, most evaluations are similar, since they relate to similar test objects and basically the same physical processes. This gave rise at Volkswagen in Wolfsburg to the idea of an application that allows typical evaluations to be preconfigured and, on the basis of these configurations, certain data ranges to be isolated from the measurement data at the push of a button and displayed graphically in various ways.

A prerequisite for realizing this idea was the availability of a tool able to process typical CAN logger formats, handle the large amounts of data resulting from the tests mentioned above and offer flexible options for task-specific adaptation. With the CAN log file converter available since DIAdem 11 and the extensive functionality of DIAdem itself, such a tool exists. The CAN log file converter filters the measured values out of the CAN messages contained in the log file, combines them into time-based measurement signals and converts this data into DIAdem's own TDM format. The only prerequisite is that the CAN databases describing the structure of the various CAN messages are provided. Once the measurement data has been converted, it can be evaluated with DIAdem's wide range of capabilities. And this is exactly where the State Monitor application comes in, which müller+krahmer GmbH developed on behalf of Volkswagen.

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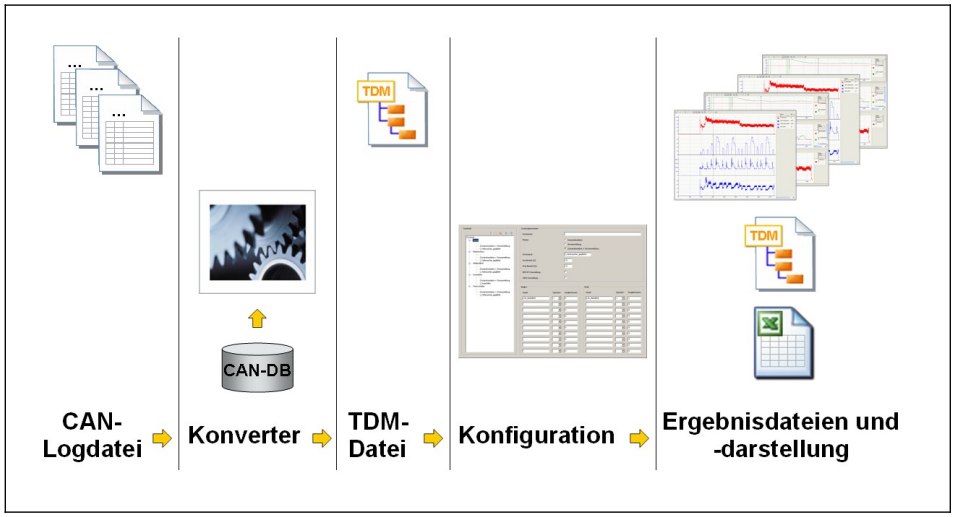


Figure 1: Interaction of the components in the State Monitor application

The DIAdem core application itself consists of two independent modules, one for creating configurations and one for evaluating them automatically. The two-part approach takes into account that configurations, once created, are rarely changed, whereas test evaluations are carried out more frequently, namely after the end of each test. Both sub-applications consist of scripts, user commands and user dialogs and use numerous standard functions of the software, such as the extensive library of mathematical functions and flexible report layouts.

A configuration can comprise a few hundred but also more than 10,000 parameters, the complexity depending on the application. The core elements of the configuration are user-defined states, i.e. data ranges delimited by events. Events are defined as a change in a quantity or signal. The change can be specified either as an absolute amount or in relation to a limit value. The application's user interface currently allows up to ten events each to be specified, linked by AND, to define the beginning and end of a state. To make it easier for the user to define the events, lists of signals typical of different vehicles are provided for selection based on existing measurement files.

For each state, parameters specify how the data is to be processed. Possible options are state isolation, current determination, quiescent current determination and trip statistics. In state isolation, the data sections specified by events are saved in separate files. Optionally, a graphical display of the respective sections can be selected. For current determination, the change in the total battery current after switching on the consumer is evaluated, while the quiescent current evaluation analyzes consumption after the ignition has been switched off. The trip statistics evaluate the switch-on time of individual consumers during the driving test. The configuration creation sub-application transfers the user's specifications regarding the processing options to configuration files. Configuration files can be entered completely from scratch or created by loading and modifying an existing parameter set.

Once the configuration file has been saved, a few steps are sufficient for evaluating a test. After starting the configuration evaluation sub-application, only the data set to be evaluated and the configuration to be applied to it have to be selected. Then, as if by magic, event files in DIAdem TDM format and graphical displays in the DIAdem modules View and Report are created within a very short time. For current-relevant events, RMS values of the current changes are calculated, and for the trip statistics, the periods of consumer activity are summed up. To allow the analysis results to be passed on to employees without access to DIAdem, the calculated individual values are stored in a structured way in Excel files.

Automation lightens the load

Although using the State Monitor as an interactive tool already saves considerable time when evaluating CAN data, the optimization potential in this field was far from exhausted, as numerous manual tasks still remained for the users. In a second step, a server-based application for fully automatic data analysis was therefore created.

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Its functionality already starts with data acquisition. The DIAdem DAC diagrams on the numerous measurement computers were supplemented by function elements and a corresponding framework application that allow data to be stored at configurable intervals, taking maintenance breaks into account, and interrupt measurement when an adjustable storage reserve is undercut. Controlling this application via operating system services ensures constant availability.

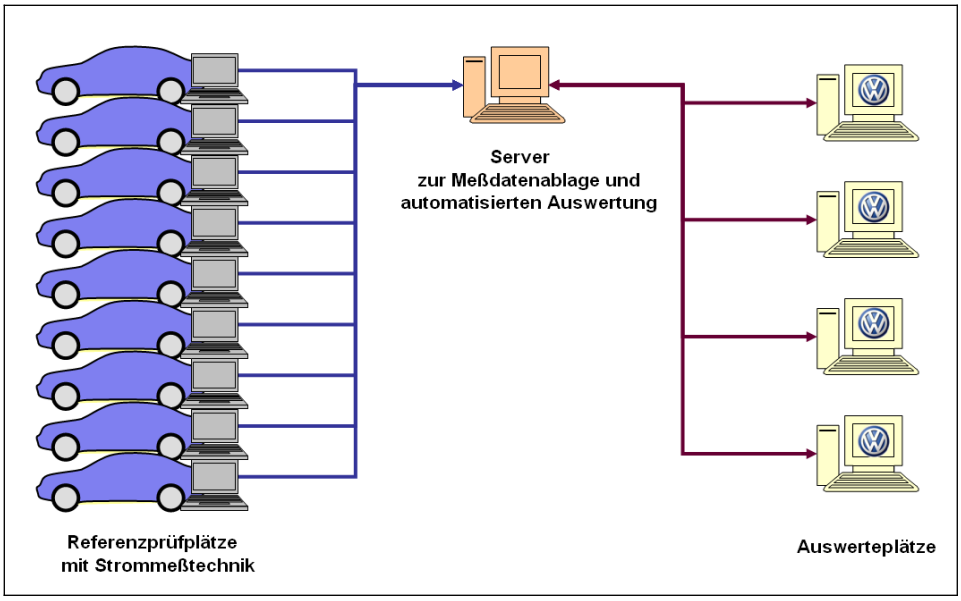


Figure 2: Server-based automatic data processing as the central component of the power consumption evaluation (Volkswagen AG)

As the counterpart to acquisition, a framework application for automatic data processing runs on the server. It transfers the data files of previously configured data stocks to the server, always keeping local copies with adjustable storage depth, and evaluates the transferred files using the functions described for interactive evaluation. In addition, measuring point identifiers are added to the data and offset correction is carried out. At the same time, the application monitors the activity of the measurement computers and informs the responsible employees by email in the event of an error. An administration tool that transfers the entries to a central configuration database is available for configuring the automatic data processing.

The result of the automatic data processing is preprocessed files on the server that users can analyze or process further. For data search, i.e. for the targeted search for measurement files based on any information stored in them, users have the DIAdem DataFinder Server Edition at their disposal. Thanks to corresponding DIAdem extensions, which were also implemented as part of the project, the evaluation functions can be applied directly to files found via a context menu.

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Summary

Thanks to the automatic data processing, the test engineer can concentrate fully on evaluating the results and deriving the required statements from them, above all on the energy balance. The application cannot – at least at present – take this part of the work off his hands. However, by reducing the time required for recurring and formal tasks, the engineer has more time for this, his core task.

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