CAN data logger case studies

Figure 1: A Ducati Diavel, the focus of Mr. Cobb's reverse engineering efforts (Source: CSS Electronics)

CSS Electronics offers complete CAN data logging solutions. Here are three data logging case studies from more than 40 provided on the company's website.

CSS Electronics (Danmark) develops CAN data loggers and sensor-to-CAN modules. The two-channel CANedge CAN/LIN data loggers (Figure 2) are used by automotive OEMs (original equipment manufacturers) in CAN (FD), CANopen, J1939, OBD2, NMEA 2000, and LIN applications. CANedge1 records data to an industrial SD card, while the CANedge2 also enables automatic log file upload via Wifi/4G to the end user's server. The recent CANmod sensor-to-CAN modules include the CANmod.gps and CANmod.temp. The first is a GPS-to-CAN module with a 3D IMU (inertial measurement unit). The second is a four-channel thermocouple-to-CAN sensor module. An input module with eight analog channels is under development. In addition, CSS offers three widely-used DBC files (data base CAN), including J1939 DBC, NMEA 2000 DBC, and OBD2 DBC. The files make it possible to decode CAN data to human-readable form.

The company's software tools are free and open source. Tools for the CANedge include the MF4 converters for turning MF4 log files into other formats (CSV, ASC, TRC, etc.). Another example is the Asammdf GUI (graphical user interface) for general-purpose analysis, DBC decoding, and plotting. Data from the CANedge can also be processed via the free Python API (application programming interface) and integrated with telematics dashboards (e.g. Grafana) for visualization. The MF4 data can be also processed in 3rd party tools such as the Matlab Vehicle Network Toolbox.

CAN data logger use cases span heavy duty, automotive, agriculture, electric vehicles, and marine industries. Applications include trucks, buses, cars, tanks, drones, submarines, and more. Offline logging, USB streaming, Wifi, and cellular telematics are the possible data acquisition options.

CAN dashboards and telematics for military UGV

Havelsan (Turkey) offers end-to-end technology solutions within defense, simulation, IT, homeland security, and cybersecurity. The company needed to record and collect data from unmanned ground vehicles (UGV). Normal data acquisition systems were too heavy (and expensive) for UGVs. Adding external sensors was not feasible. Hence a compact CAN data logger was required to collect all the data for analysis.

Figure 2: CANedge is a series of two-channel CAN/LIN data loggers (Source: CSS Electronics)

Realized solution: The CANedge2 Wifi CAN logger was deployed to measure the general vehicle health as well as to benchmark different scenarios based on data changes. Havelsan installed the logger on the UGV, where it collected data during field operation to the SD card. When the UGV returned to the workplace, the data logger came into the range of a stationary Wifi router and automatically offloaded the log files to Havelsan's server. For some tests, Havelsan deployed the logger with a 4G cellular network router on the vehicle. Grafana/Influx dashboards software tools were used for visualizing of CAN data in the browser. If abnormal data patterns were detected, the relevant MF4 log files (found via CANcloud) could be analyzed in detail. This was possible via the Asammdf GUI (graphical user interface) using the appropriate DBC file.

Figure 3: Havelsan's CAN-based unmanned ground vehicle (Source: CSS Electronics)

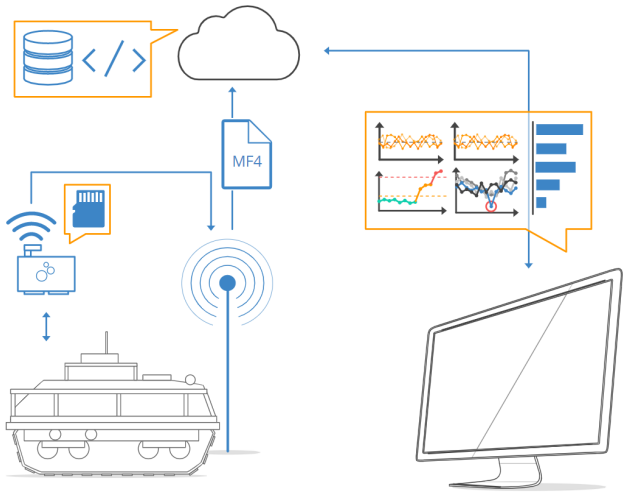

Figure 4: CANedge2 automatically uploads MF4 log files when the UGV gets within the Wifi range (Source: CSS Electronics)

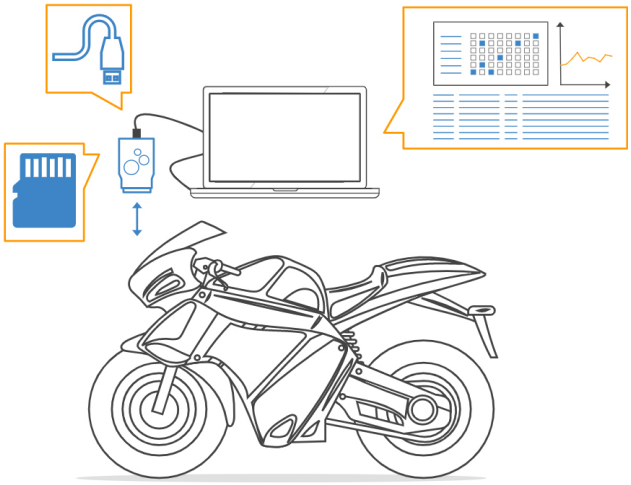

Figure 6: CL2000 enables real-time streaming of CAN data from/to SavvyCAN software tool (Source: CSS Electronics)

Benefits and choosing reasons: Sezer Kiral, Systems Engineer at Havelsan, explained: “The device helps us increase test/evaluation capability and enables us to take immediate action in response to technical parameters of the vehicle. The CANedge2 is an autonomous way to collect, transfer, and analyze data. Set it up - and watch the data from your office." Regarding the CANedge choice, he answered: “We were using Vector tools in the previous main battle tank project. During our search for an alternative and easy solution we found the CANedge. If we have any questions, the technical support is so fast and helpful.”

Reverse engineering a motorcycle's CAN

Thomas Cobb (a private person) used the CL2000 logger for CAN reverse engineering. Thus, he has been one of the first testers of the CSS’ recent CLX000-SavvyCAN integration. The challenge for Mr. Cobb was to tune his Ducati Diavel 2015 motorcycle. To do so he needed to log CAN data, decode the messages, and make changes based on real data.

Realized solution: Mr. Cobb reported: “Over all it was a steep learning curve when I started with Wireshark, but seeing the real-time data was great for identifying the relevant messages. SavvyCAN was my preferred software tool (also before it was supported by CSS Electronics), even if there was originally no support for a live data connection. I would log data and play it back in SavvyCAN, and the graphs and flow of data made it possible to slowly identify and interpret the changing bytes and bits. Now we have a CLX000-SavvyCAN integration that works great! Further, support has been great and any questions get answered very quickly.”

Benefits and choosing reasons: The mentioned tools have allowed Mr. Cobb to learn more about CAN data and to appreciate the work that goes into the reverse engineering process. Further, he has managed to decode most of the important messages of interest. “The CL2000 is compact, feature rich, and highly configurable. I chose the CL2000 as it had good reviews, the price was reasonable, it offered plug-and-play features, it required minimal configuration, and came with a real-time clock (RTC). Now, I often look at the CANedge ...”, added Mr. Cobb.

J1939 analysis for ship telematics

Vives is the largest university of applied sciences in West Flanders, Belgium. It has campuses in five student cities: Bruges, Ostend, Kortrijk, Roeselare, and Torhout. The university participated in a European funded project ISHY (implementation of ship hybridization) that wants to achieve 50 % of CO_2 reduction on medium ships. The project researches the possibility to use fuel cells, battery

Figure 5: Vives recorded data from the GEOxyz maritime vessel (Source: CSS Electronics)

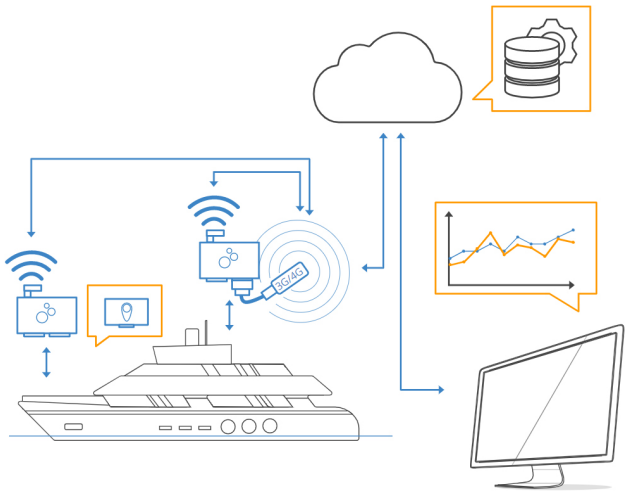

Figure 7: Two CANedge2 units upload MF4 log files from their SD cards via 4G to an AWS S3 server when connectivity is available (Source: CSS Electronics)

supply, and hydrogen in ships in place of heavy fuels. It was required to know how much power the combustion engines deliver in order to improve the power supply possibilities.

Realized solution: To calculate the size of the alternative power supplies exactly the project members needed to know how much power the combustion engines deliver at any time. On the in-vessel J1939 network the messages EngSpeed (engine speed) and ActualEngPercentTorque (actual torque in %) had to be monitored and logged. With those two parameters it was possible to make a power profile of the combustion engine. The boat has two engines (port and starboard) so one CANedge2 device was used for logging of parameters on those two networks. Further, the researchers wanted to know why the engine uses the amount of power it does. For this, a third network was set up and the data was logged by a second CANedge2 device. On this network a GPS (global positioning system) receiver, IMU (inertial measurement unit), wind speed sensor, wind direction sensor, wave sensor (and more) were implemented. The two CANedge2 units uploaded the MF4 log files from their SD cards via the 4G mobile network to an AWS S3 server. Finally, the data could be displayed on a monitor in the office using the Grafana dashboard software tool.

Benefits and choosing reasons: Arne Depuydt, Researcher ISHY and Lector of automotive technology itemized the benefits: "The benefits of this logger are the configuration simplicity and the 4G connectivity. In which the device also makes a difference is the data transportation to a third-party S3 server and not a server of the logger manufacturer. The reason is that AWS uses much better technologies than a manufacturer of logging devices can make."

He also explained: "Last year we tested ten CAN logger devices and the CANedge2 has delivered good and stable results. It does not have the largest number of configuration settings (e.g. on-board database decoding, pull data over the air with a button, gateway, I/Os, GPS, etc.), but in return it is powerful in that it lets us set up a new installation quickly. The documentation and service enable non-IT people to set everything up - and that is a big plus! We have worked with big companies that deliver their products to huge car companies, with similar products (but more expensive) - and they do not have such a good service and documentation." Interested parties are also welcome to contact Mr. Depuydt to get trainings on how to use the CANedge2 and set up dashboards. ◀

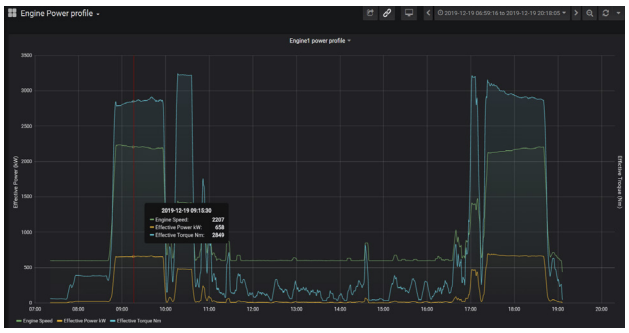

Figure 8: Vives deploy a Grafana telematics dashboard for visualization of their data (Source: CSS Electronics)

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CAN in Automation

The non-profit CiA organization promotes CAN and CAN FD, develops CAN FD recommendations and CANopen specifications, and supports other CAN-based higher-layer protocols such as J1939-based approaches.

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