Data is the new oil

(Source: Softing Automotive)

Fleet managers expect error-free inspection, maintenance, and repair. For many businesses, an inspection and maintenance (I/M) process that meets the requirement "right at the first time" and serves the reduction of expensive downtime to a minimum is existential.

Be it a passenger car, a heavy-duty truck or a non-road mobile machine (figure 1), preventive maintenance (PM) is an important measure to reduce unexpected breakdowns. PM is a scheduled process, performed at regular service intervals. It includes but is not limited to inspection, cleaning, and lubrication, but also the exchange of fluids, filters, spark plugs, and drive/timing belts.

Predictive maintenance is similar to preventive maintenance and performed only when necessary. It consists of measures such as the exchange of a component that still functions but became conspicuous, because specific parameters indicate that a failure is about to occur, for example a bearing that started making noise.

Predictive maintenance is associated with condition monitoring and performed by the service technician only when needed – but how is the need discovered? It´s all about data - data is the new oil.

This term is credited to the British Mathematician Clive Humbry and leads to the question, what data and oil have to do with each other. The simple answer is that both have no value in their raw state.

- Crude oil or petroleum has no value unless it is extracted and refined, e.g. to gas or plastics or other chemical products.
- Data has no value unless it is acquired, stored, decomposed, analyzed, converted, and processed.

Figure 2 shows a simplified example of a data processing system.

Data processing

In the context of predictive maintenance, the vehicle is one of the most important data sources. Today´s vehicles and mobile machines are packed with E/E components. Figure 3 shows a representation of an E/E system and its most important components. Electronic control units (ECUs) such as the engine control module (ECM) and the transmission control module (TCM) are connected to each other by an in-vehicle network, typically CAN.

The gateway separates the in-vehicle network (and thus the in-vehicle data exchange) and the diagnostic link connector (DLC). ECUs process self-diagnostic functions, ▷

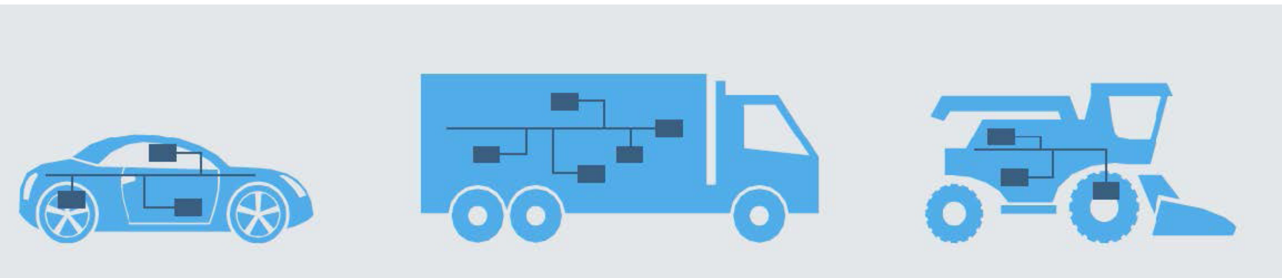

Figure 1: Road-vehicles and non-road mobile machines (Source: Softing Automotive)

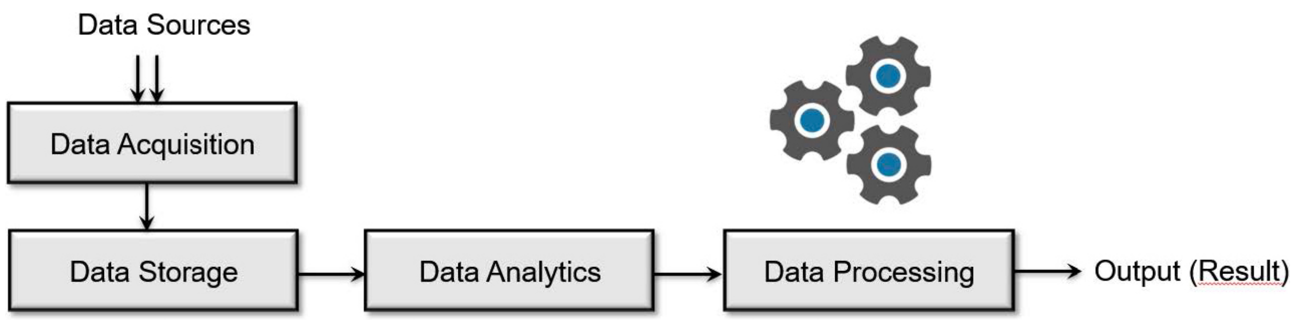

Figure 2: A simplified example of a data processing system (Source: Softing Automotive)

monitor their environment, and generate diagnostic data. Common examples of diagnostic data are diagnostic trouble codes (DTCs) and their associated freeze frames, and the DM1 message in a J1939 network.

For the purpose of I/M, road-vehicles are usually driven to a service workshop. Figure 4 shows the setup of a service workshop. A workshop tester (TST) is connected to the DLC of the E/E system. In this most common setup, a vehicle communication interface (VCI) is used for that purpose. The TST-to-VCI connection can be wired (USB) or wireless (Wi-Fi). The VCI-to-DLC connection is always wired and either CAN or Ethernet. K-Line and SAE J1850 are outdated.

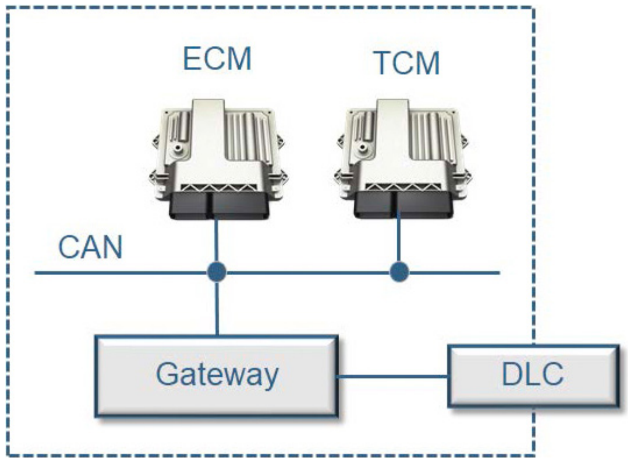

Figure 3: Representation of an E/E system (Source: Softing Automotive)

The workshop tester supports the service technician in the diagnostic process and the necessary I/M measures, for example by guided fault finding sequences. To acquire diagnostic data, the tester sends a diagnostic service request and receives the associated diagnostic services response from the vehicle's E/E system. Requests and responses are standardized as diagnostic protocols such as OBD, SAE J1939, and UDS (Unified Diagnostic Services) on CAN or IP/Ethernet (ISO 14229).

A very common request is known as "mode 1" requesting the current powertrain diagnostic data from the OBD (on-board diagnose) system of the vehicle. Another common service is the ISO 14229 (UDS) request "read data by Identifier" with a 2-byte data identifier (DID) for the acquisition of theoretically more than 65 000 different values.

Table 1 shows the OBD and UDS services for data acquisition.

Inspection and maintenance in the service workshop is carried out when the vehicle speed is zero. To process condition monitoring under real driving conditions, the vehicle must be equipped with a data-logging device that is connected to the in-vehicle system and becomes part of the E/E-system. Figure 5 shows such a device and figure 6 the upgraded drawing of the E/E-system.

Extended telematics control unit

The extended telematics control unit (xTCU) has two CAN channels. One can be connected to the DLC, the other one to the powertrain CAN. The xTCU reads raw CAN signals and supports diagnostic protocols to request diagnostic data at the same time. In addition, the product comes with internal sensors for the position (GNSS), the acceleration, and the rotation (gyroscope) of the vehicle.

Most of the CAN signals are original equipment manufacturer (OEM) specific and confidential. Some of the sent signals can be used for predictive maintenance measures, but it is up the OEM to enhance their in-vehicle ▷

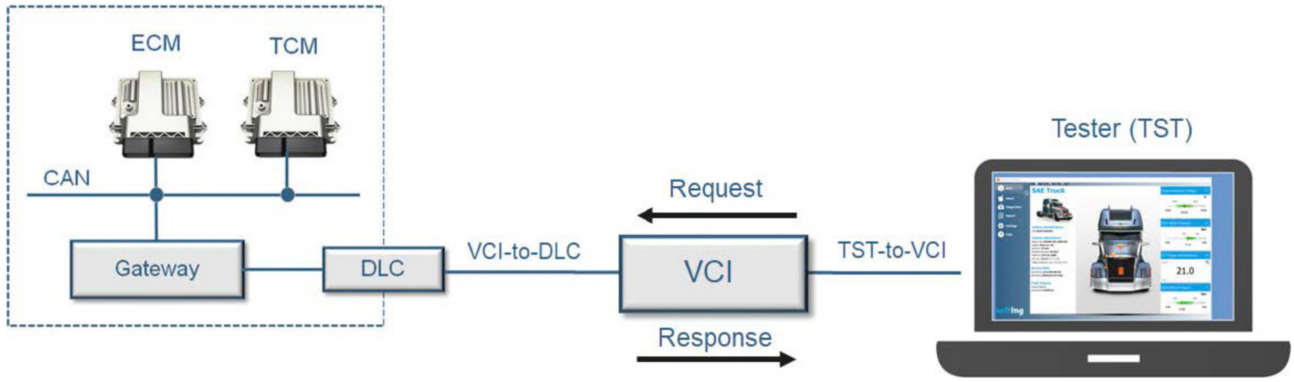

Figure 4: Setup of a service workshop (Source: Softing Automotive)

Table 01: OBD and UDS services for data acquisition and their service identifier (SID)

SID	Diagnostic data
01_h	Current powertrain diagnostic data
02_h	Powertrain freeze frame data
03_h	Emission-related DTCs
06_h	On-Board monitoring test results
07_h	Emission-related DTCs detected during current or last completed driving cycle
09_h	Vehicle information (VIT)
$0A_h$	Emission-Related DTCs with permanent status
19_h	DTC information
22_h	Data by identifier
24_h	Scaling data by identifier
$2A_h$	Data by periodic identifier

communication system with CAN signals that better support condition monitoring and predictive maintenance. The xTCU comes with an integrated 4G/LTE modem that connects the vehicle with a mobile network base station. CAN signals, diagnostic data, and inertia data are acquired under real driving conditions, enhanced with an e-SIM based identifier and sent periodically as MQTT packages to the data processing system in the cloud. The security of the communication link between CAN and cloud is patented.

Figure 5: The extended telematics control unit xTCU (Source: Globalmatix AG)

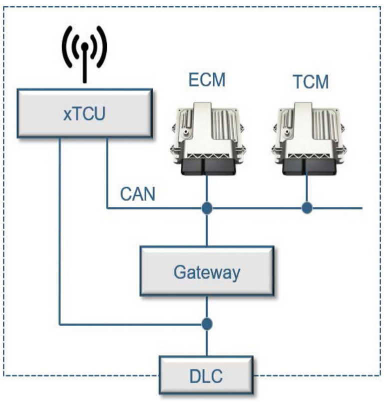

Figure 6: E/E system with xTCU (Source: Softing Automotive)

The quality of condition monitoring and predicted maintenance depends on the amount of data and its smart, targeted analysis. Installed in (multi-brand) vehicle fleets, the xTCU not only enables the OEM or the fleet manager to monitor the health status of their vehicles but to

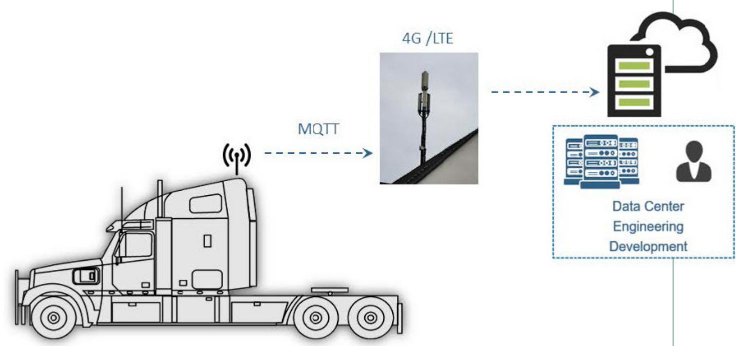

Figure 7: Cloud-based data acquisition system (Source: Softing Automotive)

extract information for predictive maintenance measures. The combination of real-time fleet data with diagnostic data collected in the workshops also enables the service organization to predict failures before they occur and thus increase the quality of the I/M process – right at the first time. ◀

Author

Peter Subke
Softing Automotive
info@softing.com
www.softing.com