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New Diagnostic Standard for the Vehicle of Tomorrow

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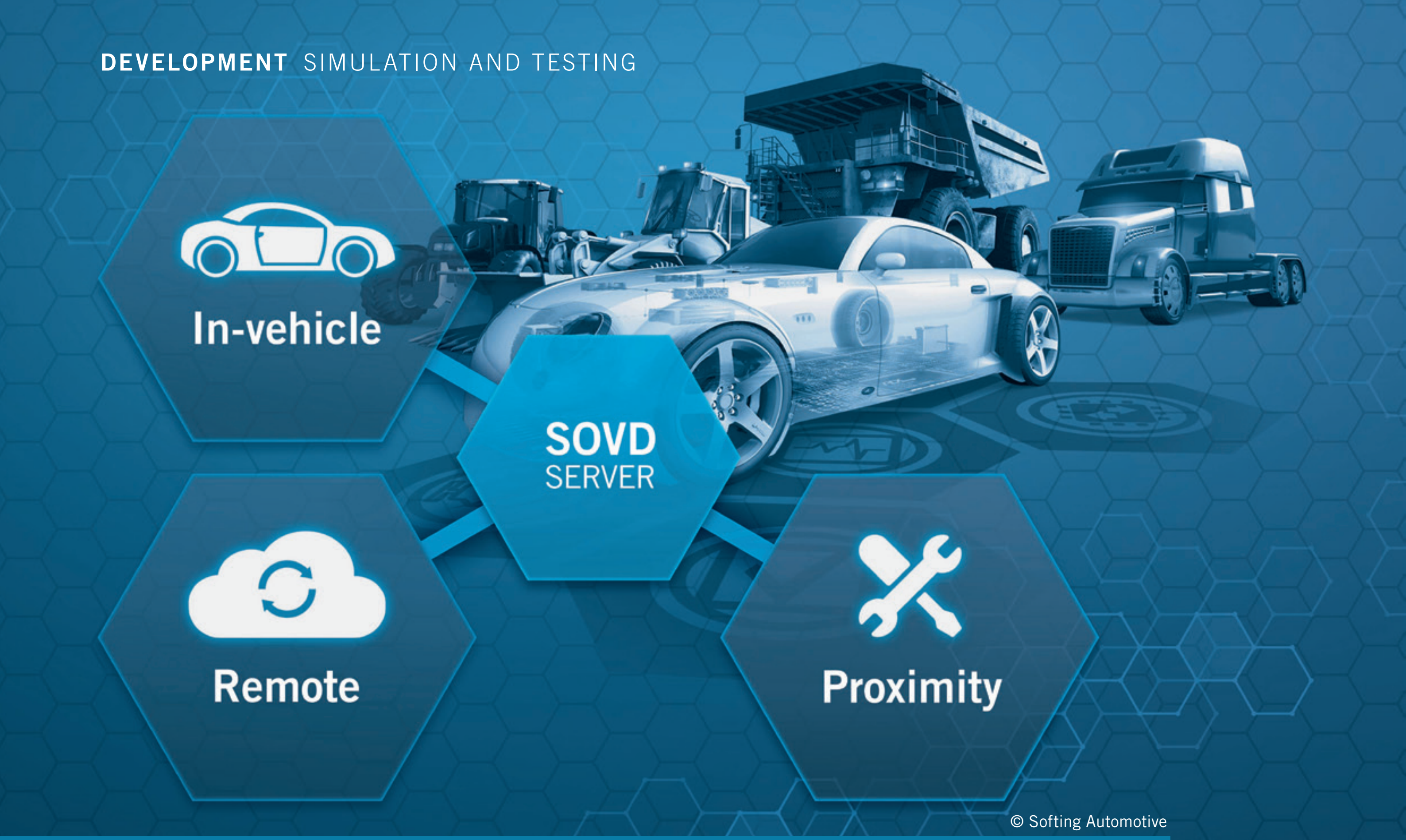

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SOVD – The Diagnostic Standard of Tomorrow

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The transformation of electronic vehicle architecture toward centralized high-performance computers also necessitates changes in diagnostic procedures. The Association for Standardization of Automation and Measuring Systems (ASAM) is currently preparing a standardization of the new diagnostic structure entitled Service Oriented Vehicle Diagnostics (SOVD). As Softing shows, today's diagnostic tools such as the so-called Smart Diagnostic Engine already offer the potential to meet future requirements.

It is no secret that two megatrends are driving the entire automotive industry: electric driving and autonomous driving. Both require completely new functionalities in the vehicle, which in many cases also influence diagnostics. One example is the newly added battery management, which must be used to check both the charging process and the cell status. Another example is the brake, which in an electric vehicle consists of the mechanical brake, recuperation via the electric motor and battery management. The overall status of the braking system thus results from three subsystems that must be diagnosed as one.

Looking at autonomous driving – regardless of the level reached –, the topic of "safety" plays a major role. The continuous monitoring of functions and subfunctions of the vehicle, as well as the interaction of different components in which these functions are implemented, is essential. All these examples have one thing in common: They describe the next evolutionary step in what is now called the self-diagnosis of Electronic Control Units (ECUs).

CHANGING DIAGNOSTICS

Today's situation has grown over the years: There is an ECU for every main function in the vehicle, every ECU monitors its environment (self-diagnosis), the ECUs are interconnected via bus systems – usually via a central gateway, which is also connected with the Onboard Diagnostics (OBD) jack. This is how a repair shop employee can connect an external tester in which appropriate algorithms read data from the ECUs and combine it to create meaningful repair instructions.

However, autonomous driving now requires significantly higher processing power in the vehicle than can be provided by today's ECUs. Consequently, at least two High-performance Computers (HPCs) are installed in the vehicle for redundancy reasons, **FIGURE 1**. These are usually multi-core systems with several operating systems and possibly dynamic load distribution and implement both centralized control and diagnostic functions. Furthermore, today's ECUs will continue to be used for local tasks for a long time to come.

At least two new diagnostic tasks will be implemented in the HPCs: on the one hand, a system diagnosis of the HPC which continuously monitors the function of the operating systems and of the distribution of tasks to the various processor cores, and, on the other, a diagnostic master that merges self-diagnosis at the function level as in the brake case described above. In addition, every HPC also performs today's self-diagnosis. In other words, it monitors the inputs and outputs as well as the significantly increased number of signals over the Ethernet connection to other HPCs, **FIGURE 2**.

STANDARDIZED HPC DIAGNOSIS

An HPC therefore represents its own diagnostics, function diagnostics and – since it enables connection to the Internet – also the interface for conventional ECUs. From the point of view of an external tester, this approach means a significant increase in the quality of information because much information is already pre-filtered, aggregated and evaluated before it is transmitted.

Such an interface for diagnostics is naturally not only of interest to OEMs, but also to numerous other parties: manufacturers of HPCs and ECUs for inside the vehicle, manufacturers of test tools used outside the vehicle, but potentially also fleet operators, testing organizations, insurance companies and legislators. The standardization of the interface thus stands to reason; this is currently taking place at the Association for Standardization of Automation and Measuring Systems e. V. (ASAM) under the name Service Oriented Vehicle Diagnostics (SOVD). The aim is to define an interface which allows diagnostics on a vehicle, for example in a repair shop, via remote access or also as a tester directly in the vehicle (Proximity, Remote, In-vehicle). As many existing mechanisms and standards as possible (for example TCP/IP) should be used to simplify standardization and subsequent implementations.

As the name suggests, access should follow the structural pattern of the service-oriented architecture. Today's diagnostic protocols operate almost exclusively in request-response mode. The tester usually queries individual data elements for each ECU and then evaluates them. The chunks of information are closely related and often available redundantly in different ECUs as well as temporarily uncorrelated. In service-oriented querying, a query enables the determination of precisely the information needed. This means the preprocessing is already taken care of by the data server, here the SOVD server in the HPC, **FIGURE 3**. Whether the data for this was queried from the individual ECUs or was already continuously aggregated in the HPC is irrelevant.

SOVD does not make today's diagnostics obsolete; rather, it fulfills all existing use cases, such as fault memory opera-

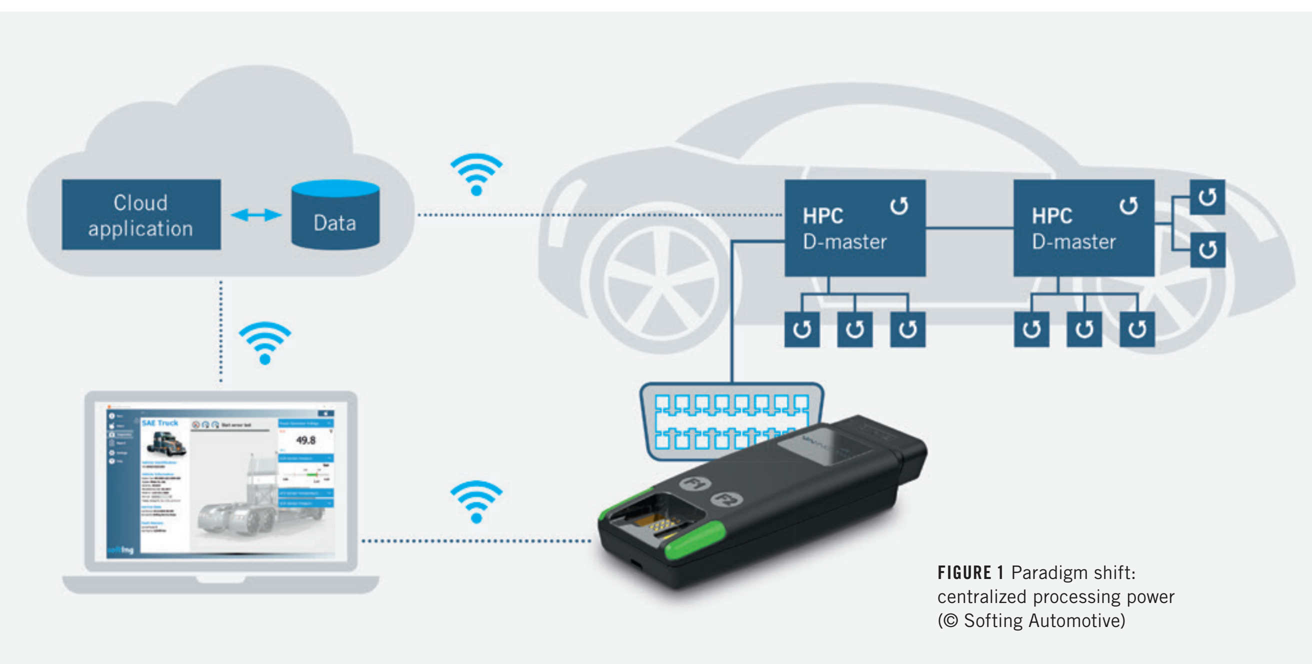

FIGURE 1 Paradigm shift: centralized processing power (© Softing Automotive)

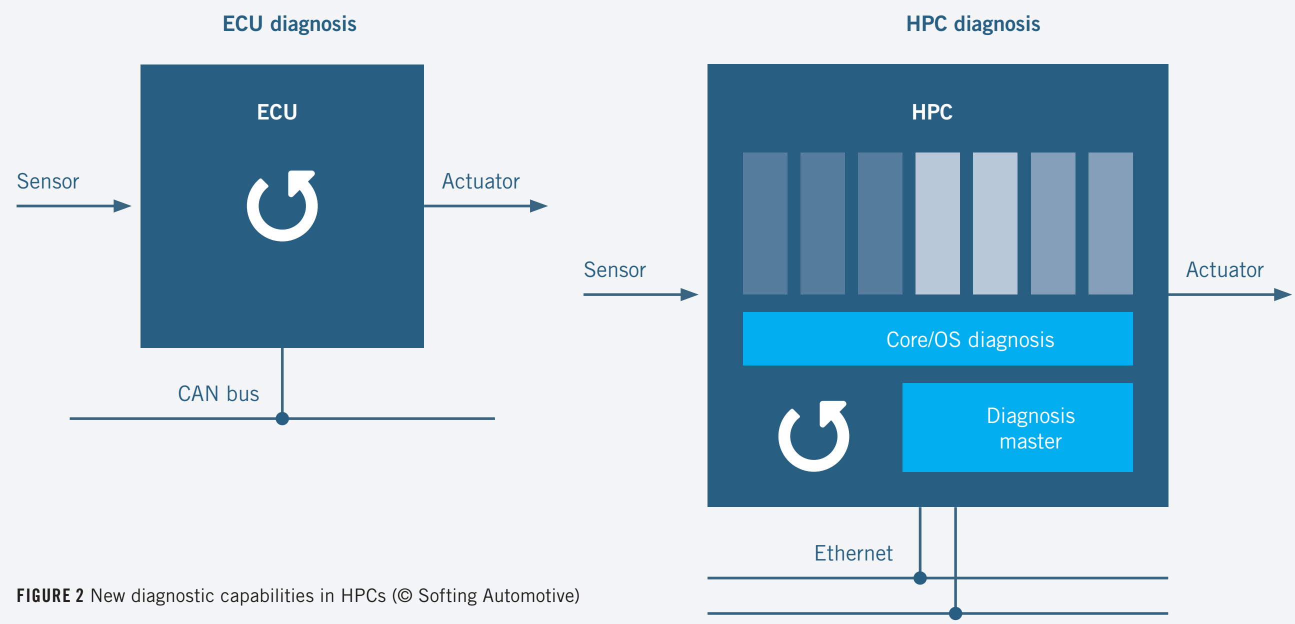

FIGURE 2 New diagnostic capabilities in HPCs (© Softing Automotive)

tions, ECU programming, variant coding, and adds new ones. With regard to data-oriented use cases, this includes, for example, the possibility of reading out current HPC-internal variables or large data containers. With reference to the process, it should be possible to directly analyze the vehicle status or log vehicle data in the HPC. Addressed vehicle-related use cases include, for example, the execution of processes directly in the vehicle and simultaneous access by multiple testers.

SMART DIAGNOSTIC ENGINE AS SOVD PROTOTYPE

The idea of a data server is nothing new in diagnostics; it has been established for many years now as a Modular Vehicle Communication Interface (MVCI) server with ODX data. However, the standardized object-oriented Application Programming Interface (API) is not suitable for remote use cases due to the large number of function calls required. The integrated Java-based environment for sequences, on the other hand, is too difficult to operate and is also not ideal from a security point of view; it has already been supplemented in a standardized manner by OTX.

Softing has therefore been using an extended solution for years; it is implemented as a platform-independent version and extends the MVCI server and the OTX runtime with a function-oriented interface, **FIGURE 4**. With it, the application engineers can always access precisely the functions they require at

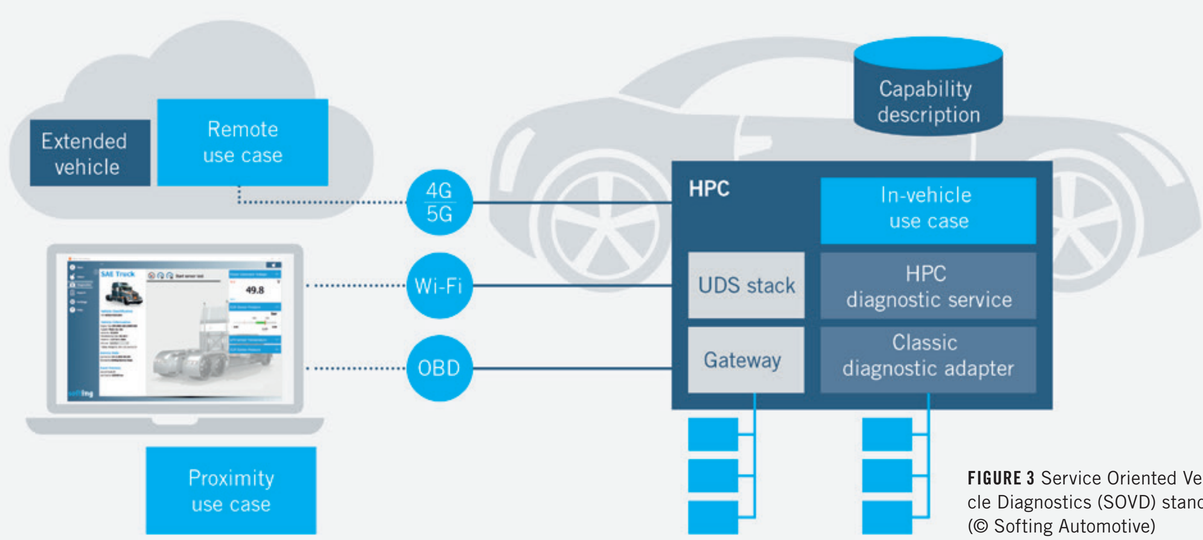

FIGURE 3 Service Oriented Vehicle Diagnostics (SOVD) standard (© Softing Automotive)

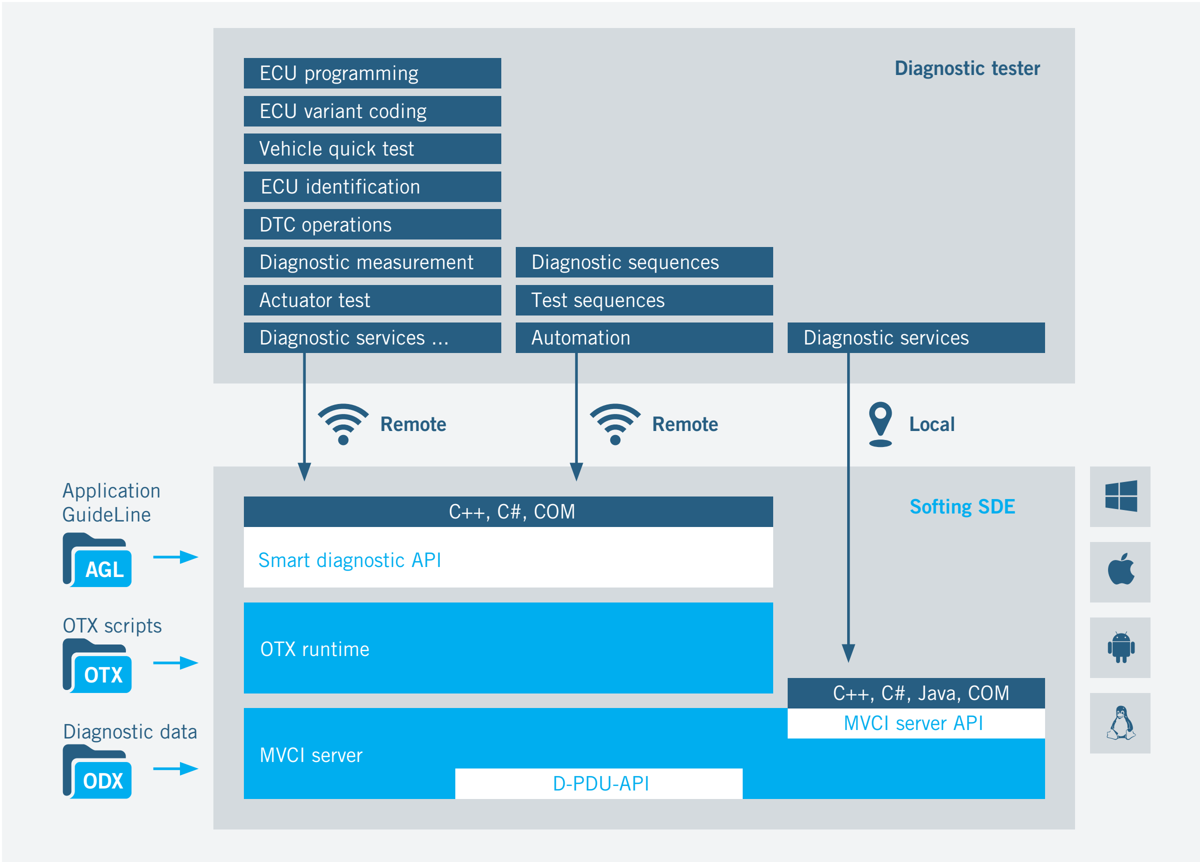

FIGURE 4 Smart Diagnostic Engine (SDE) from Softing (© Softing Automotive)

any one time, regardless of the diagnostic protocol, such as "FaultMemoryWholeVehicle" or "EcuProgramming." The implementation is manufacturer-specific or, depending on the function, even vehicle-variant-dependent and can therefore be controlled via a configuration file (Application GuideLine, AGL).

Today, the so-called Smart Diagnostic Engine (SDE) from Softing is already in use in all kinds of applications: in PC applications in engineering, manufacturing and repair shops, on smart devices, such as cell phones and tablets, but also in embedded applications such as data loggers and on Telematic Control Units (TCUs) in the vehicle. Comparing the use cases with those of the SOVD server, a complete match can be discovered. Both solutions address in-vehicle, near-vehicle and remote applications, offer a service-oriented API and also support today's (classic) diagnostics. A genuine service-oriented architecture is not given with Softing SDE because the current focus is on today's vehicles in which the communication status plays a major role (session selection, SecurityAccess). Therefore, with the completion of the standardization, a standardized API based on the REST paradigm and building on the current API will be offered alongside the current C++ API, **FIGURE 5**.

REMOTE DIAGNOSTICS WITH SOFTING SDE

The service-oriented approach is particularly well suited for remote diagnostics because it decouples the retrieval and preparation of information from the often unreliable transmission link: A request is made to the data server – regardless of whether it is implemented as an SOVD server or with Softing SDE in its current form – and the server obtains data from various sources and prepares it. The result can then be reported back. Delays, due perhaps to an interrupted connection, do not affect the validity of the information.

There are numerous use cases for the procedure: One example is remote engineering in development, where rare test objects are managed centrally and can be used and updated by different users all over the world [1]. A similar scenario is increasingly found in the repair shop, where a service technician can receive remote support from a technical center in complicated cases. This is particularly important when the repair shop has to come to the vehicle, for example in the case of construction machinery or agricultural equipment. This is where the combination of Vehicle Communication Interface (VCI) and a 4G/5G-capable TCU is an incredible help.

The integration of Softing SDE in the VCI is a great advantage, particularly in manufacturing, as the complete diagnostic solution can be plugged into the right place in the vehicle and diagnostic sequences can then be performed at all line positions independently of the Wi-Fi coverage. A Wi-Fi connection is then no longer required for ECU programming; test results from autonomous processes in the VCI are read out at a suitable point.

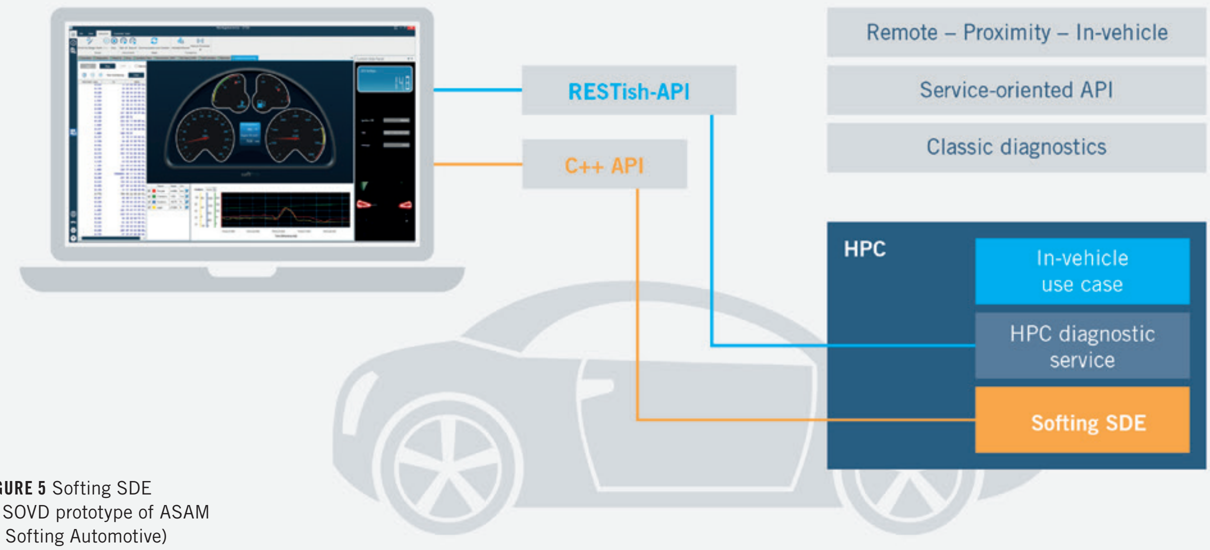

FIGURE 5 Softing SDE as SOVD prototype of ASAM (© Softing Automotive)

BEGINNING THE DIAGNOSTICS OF TOMORROW TODAY

Using a standard has advantages especially when there is considerable cooperation with other companies. Regardless of this, there is something to be said for starting with established implementations such as Softing SDE today:

- parallelism of legacy and new implementation
- functioning ODX data process
- continuity of the solution.

Even though, in the case of new vehicles, significantly more diagnostics can be implemented in the vehicle due to the introduction of HPCs, today's vehicles will still need to be maintained and repaired for decades. If both solutions use similar basic functionalities, the changeover is simpler and less error-prone. The introduction of functioning ODX data processes in particular required a great deal of effort – today, these processes are stable. Integrating Softing SDE only leads to a new localization in this case, with the data then available in encrypted form on the HPC in the vehicle, but the release procedures remain the same as they are today. Finally, the data processing chain is closed: In development, the SDE is integrated in the engineering tester on the PC, in manufacturing, it moves to the VCI, and, in the event of service, it is available in the HPC as part of the vehicle. Once the SOVD methodology is implemented in the company, the corresponding extension can be retrofitted. Diagnostics remains reliable in all cases because data and runtime behavior never change.

CONCLUSION

Autonomous and electric driving are leading to new electric/electronic architectures that also enable a new form of diagnostics through the integration of HPCs in the vehicle and connection to the Internet. This is currently being standardized by ASAM e. V. under the name SOVD. In the process, today's use cases are being complemented by new capabilities that include, in particular, remote diagnostics and specific diagnostics with and for the HPCs. Solutions that exist today, such as the Softing SDE, target the same use cases and have been proven in practice. They can be implemented immediately and later expanded into a standardized solution.

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