Softing TDX ODX- and OTX-Based Diagnostic System Framework

ODX (Open Diagnostic data eXchange) and OTX (Open Test sequence eXchange) standards are very well established description formats for diagnostics in the automotive and related vehicle industries. Especially OTX, which was invented and developed on behalf of OEMs, is now increasingly used in diagnostic systems and applications.

The driver for the standardization of diagnostic description formats is most definitely the exponentially growing complexity of modern and technologically advanced vehicles. Modern automobiles, trucks and especially agricultural and civil engineering machines can have up to 100 or even more electronic control units (ECU) on board.

These have to be covered by the functionality of a diagnostic system used by the technician in the service workshop or in the field. The diagnostic systems also play an important role during the vehicle development and validation process as well as in the production and post-production life cycle stages.

Diagnostic Strategies for Modern Vehicles

In the days when there was only one or at most a few ECUs on board, ECU oriented diagnostics was adequate for troubleshooting. A technician focused mainly on the common diagnostic tasks, such as error memory read out, observation of measurements, (re)calibration, parametrization and software flashing.

Today, ECU oriented diagnostics is no longer enough for the efficient troubleshooting of complex vehicles. A modern diagnostic system has to offer not only ECU oriented diagnostics but further diagnostic strategies such as:

- function oriented diagnostics;
- guided diagnostics;
- function tests.

To date, failure or diagnostic trouble code (DTC) oriented diagnostics was well supported in most proprietary diagnostic solutions. Conversion to OTX-based solutions could offer one additional degree of freedom. Especially because with OTX it is easy to read out the environmental data of the stored DTCs and convert it to the localized human readable form by taking into account vehicle configuration specifics. In this particular case the diagnostic system determines the vehicle configuration automatically and reads out the stored data in parallel from all ECUs on board (as far this is permitted by the available communication bandwidth). Applying this method boosts the flexibility and efficiency of a diagnostic solution with minimum effort.

The primary aim of function oriented diagnostics is to troubleshoot vehicle functions that can be spread over several ECUs and vehicle domains. This is especially the case with advanced driving systems and comfort functions in automobiles, not to mention modern agricultural machines and excavation machinery with on-the-fly exchangeable tools.

In this case the diagnostic system "knows" which ECUs are involved in specific vehicle functions and runs diagnostic tasks on these ECUs either in a specific sequence or in parallel.

Hence, one of the main benefits of function oriented diagnostics is that the technician does not need to know which vehicle function is implemented in which ECU. He also does not need to have a deeper understanding of the functional dependencies across several ECUs, but can still perform vehicle troubleshooting efficiently.

Guided diagnostics, such as symptom-based troubleshooting, is very helpful, particularly in cases when a vehicle problem cannot be determined by entries in the error memory or cannot be matched to a specific DTC. In this case a technician can be guided step-by-step through the various diagnostic functions to pinpoint the problem. Again, the benefit is that the technician does not need to know the vehicle in detail. Furthermore, the diagnostic guidance can be perceived as a didactical method which can help the technician to gain deeper understanding of the vehicle. The technicians do not need to be specially trained for the specific vehicle anymore. Their basic understanding of the vehicle is sufficient; the details are provided by the diagnostic system.

Functional Requirements for a Modern Diagnostic System

Besides the different diagnostic strategies, a modern diagnostic system has to provide the following functionality:

- Handling of variants;
- Parametrization and ECU coding;
- ECU replacement – learned data readout and backup, data recovery and re-programming;
- Actuator and sensor tests;
- Parallel flashing of several ECUs.

The handling of variants is still one of the greatest challenges for the automotive industry. Currently, we have

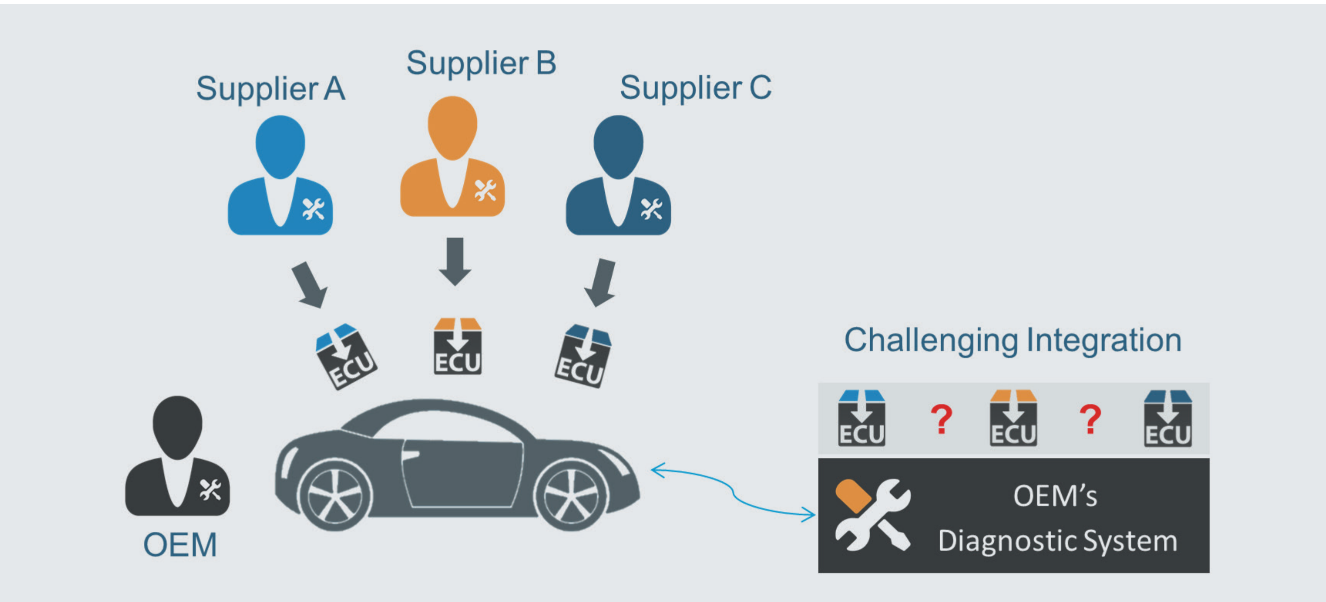

Figure 1: Multiple Sources Concept

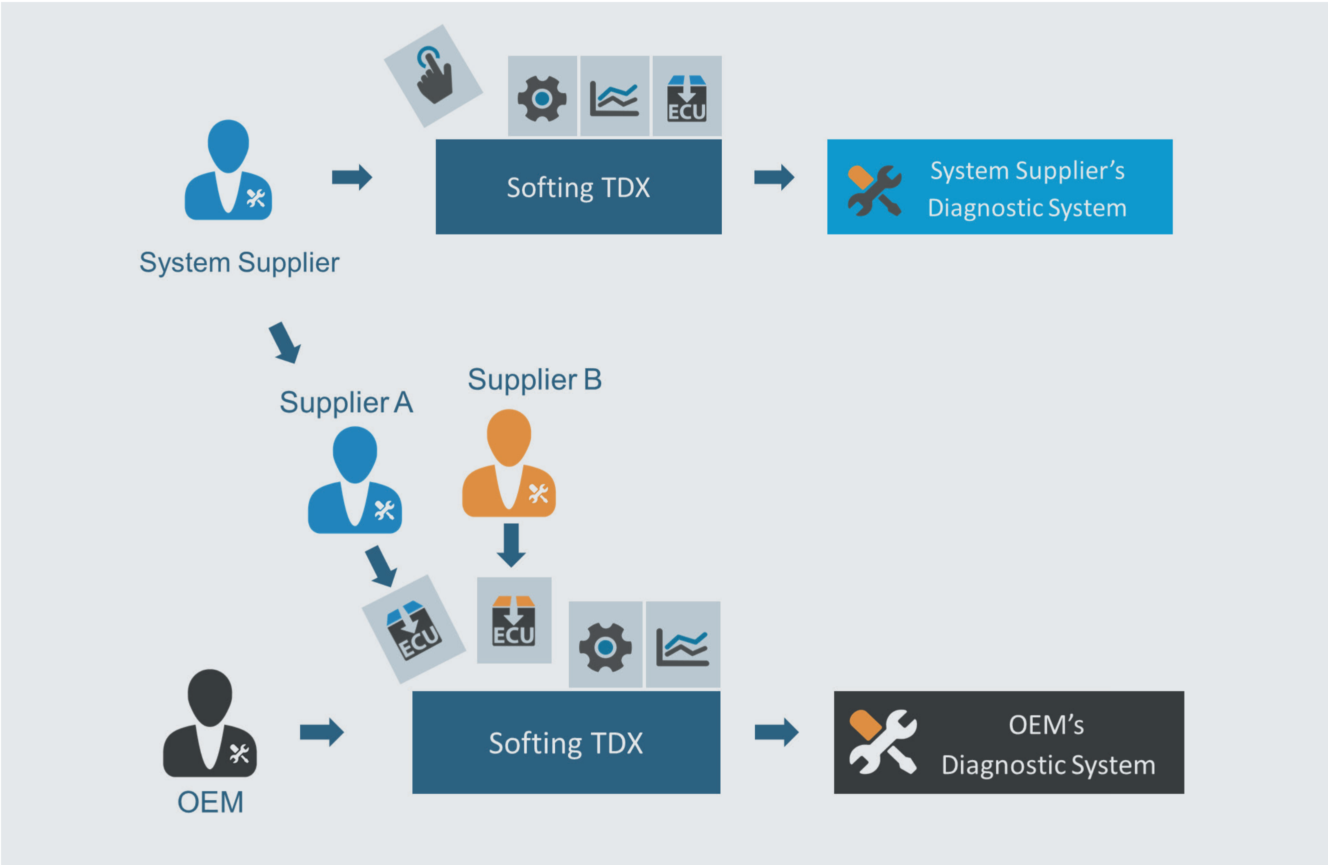

Figure 2 : Softing TDX – Modular Diagnostic System Concept

to deal with variants in vehicle options and coding, variants in ECU software, and variants caused by the introduction of second source concepts with many ECU suppliers.

All these variants have to be handled by the diagnostic system which has to determine the current variants and adopt them automatically. In the case of the software update, it has to be ensured that only compatible software is flashed into an ECU. Last but not least, in the quality assurance phase all these variants have to be approved with as little effort as possible and seamlessly integrated into the diagnostic system.

OTX, supported by the appropriate programming elements, certainly provides a solution for this challenging requirement.

Softing TDX – the Modular Solution for Current Diagnostic Requirements

Due to its modular architecture and scalability, Softing TDX (Tester for Diagnostic(X)) provides many advantages compared to classic proprietary diagnostic solutions. The solution is based on the OTX technology which stimulates the re-use of diagnostic sequences (OTX scripts) that have been designed and implemented for use in different phases of the vehicle's life cycle. Re-use generally saves time and costs. This is especially the case during vehicle validation in development as well as in the later phases.

OTX provides additional intelligence to the diagnostic systems. These can now execute diagnostic sequences which are dependent or independent of vehicle configuration automatically and in parallel. This boosts diagnostic system performance and reduces the downtime of a vehicle. Furthermore, OTX provides standardized solutions for localization aspects, such as textual translations and localization of the measurement units.

However, the main benefit of OTX is that it was designed by the automotive industry for long-term (re) use. The aim was to design a system that is and can remain independent, as far as possible, from extremely fast paced changes in basic IT technology (e.g. operating systems, programming tools and languages etc.).

The Softing TDX modular diagnostic solution is of large benefit to small OEMs in the aftermarket and retrofit area that cannot afford to develop complex diagnostic systems or have difficulty integrating their proprietary solutions into OEM diagnostic systems. By using the Softing TDX modular solution they can now focus on the content of the diagnostic system rather than on programming and integration. The maintenance of the diagnostic system is therefore simplified and the content can be developed and enhanced very quickly, especially in terms of time-to-market time. An application example from the retrofit field shows that the delivery time of a complete diagnostic solution can be shortened to only a few weeks.

OEMs can benefit from the modular and content-based concept as well (Figure 2), since they can simply include the diagnostic functions from a supplier in their complete diagnostic solution very quickly and without huge validation and testing effort.

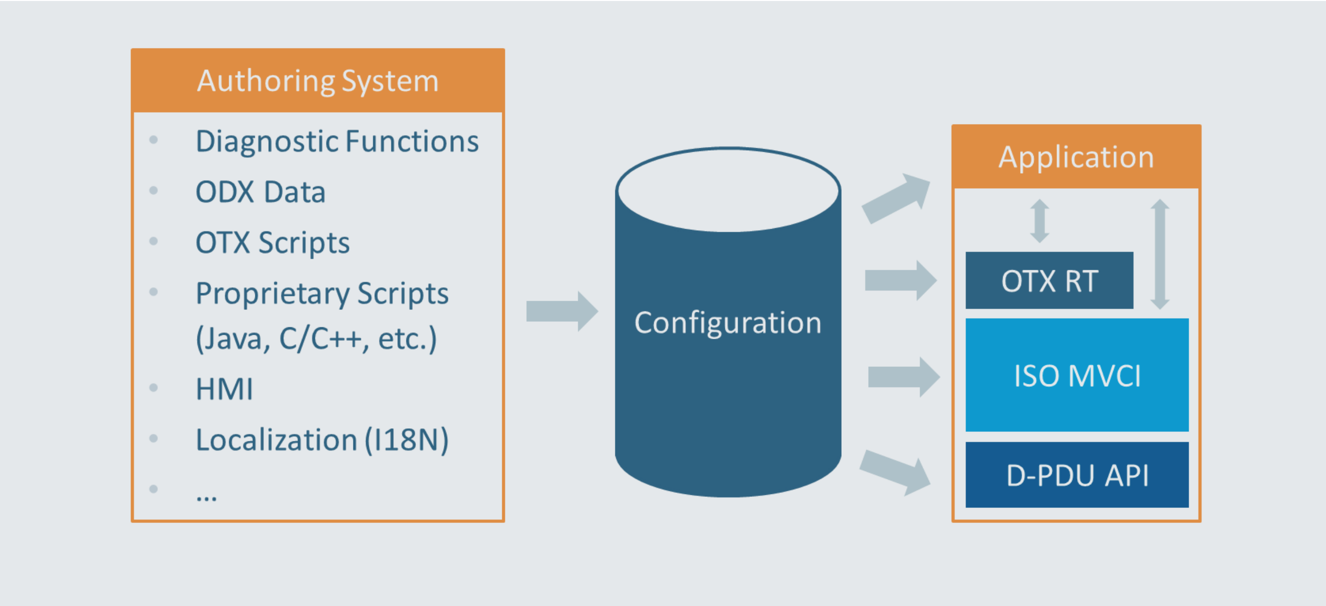

Figure 3: Overview Softing TDX

Software Architecture of Softing TDX

The Softing TDX modular software architecture is based on the ISO standards ISO13209 for OTX, ISO22901 for ODX and ISO22900 for the MCD-3D diagnostic base system, as well as other required system components. The figure below (Figure 3) shows the general overview of the modular diagnostic framework.

The configuration (diagnostic content) of the diagnostic system, in this case Softing TDX.workshop, is provided by the Softing TDX.studio authoring system.

A configuration contains the following:

- ODX data for symbolic communication description;
- OTX diagnostic scripts;
- Possibly proprietary programs e.g. Java Jobs;
- Graphical design of the HMI interface;
- Localization;
- Specific data and documents required by the user of the diagnostic system.

The later specific data and documentation is basically a collection of detailed component descriptions, mechanical drawings, and electrical circuit diagrams with details such as pin assignments and wiring color coding. Pictures with part placement details and possibly instructional videos can also be added to the configuration.

The configuration package is distributed to the workshops that use the Softing TDX.workshop diagnostic system over Internet or on removable media such as memory cards or CDs. The Softing TDX framework provides both application and content updates.

The diagnostic system Softing TDX.workshop (Figure 4) executes diagnostic sequences or single diagnostic services by using the OTX runtime (OTX RT) and diagnostic server (ISO MVCI). A vehicle is connected to the diagnostic server by a compatible vehicle communication interface (VCI) and through the standardized D-PDU application programming interface (API).

Furthermore, to ensure long-term stability and a standardized architecture, the main application accesses the core functions, such as diagnostics, HMI or I/O through the standardized OTX extensions. This concept ensures that even if the underlying base IT technology changes, the main system and content execution remain consistent, exchangeable and independent.

For third-party applications, if they are still required on such diagnostic systems, the software architecture provides standardized access to the OTX runtime and ISO MVCI diagnostic server over APIs.

The software architecture of the Softing TDX.workshop ensures the long term maintenance and independence of the IT base technology. Furthermore, the provided content can be executed on different diagnostic platforms (e.g. Android, iOS or Linux based).

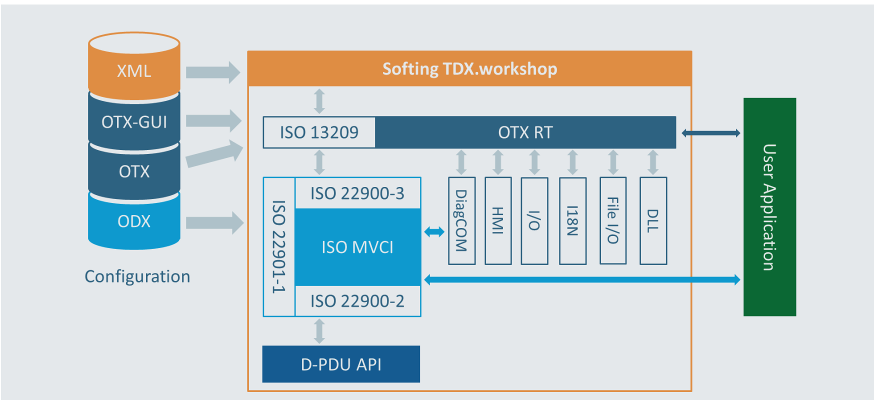

Figure 4: Software Architecture of the Softing TDX.workshop

Softing TDX.studio Toolbox

Softing TDX.studio toolbox contains several tools (Figure 5) required for the creation of ODX symbolic data, OTX diagnostic sequences and diagnostic system configuration.

For the creation, consistency checking and maintenance of ODX data, Softing's industry approved software DTS Venice is used. Softing's OTX Studio extended by the administration package, GUI Editor and OTX Wizard is used to create and test OTX scripts.

The GUI Editor (Figure 6) can be used for easy designing of the user interfaces. It provides configurable graphical components (Widgets), e.g. buttons, charts, checkboxes, gauges, indicators, labels, picture placeholders, tables etc. In the single GUI configuration, several screens can be used and switched interactively. The GUI form and placement of the widgets can be organized with containers and layout management components.

The OTX Wizard is specifically designed for re-using OTX sequences (Figure 7). It is an OTX code generator that helps the user to comfortably create diagnostic sequences without deeper programming knowledge. The user configures a script instead of programming it.

Factory supplied OTX modules can be configured as required and provide the necessary business logic for their execution. However, the main benefit is that modules can be extended by the user libraries and simply configured for use in the OTX sequences. The generated OTX code can be edited later in Expert mode and modified if required.

Softing TDX.workshop – the Individualized Diagnostic System Solution

The main idea behind the Softing TDX toolbox is that, at the end, the customer has an individualized diagnostic system solution. Hence, the supplier of a diagnostic solution based on Softing TDX framework has full control over the content, look and feel of the end solution.

The suppliers can change the graphical content, such as starting page, icons, and colors, and add a company logo to match the end customer's corporate identity (Figure 8). They also take over the distribution of the software and content. The software and content are also updated over their IT infrastructure (e.g. website)

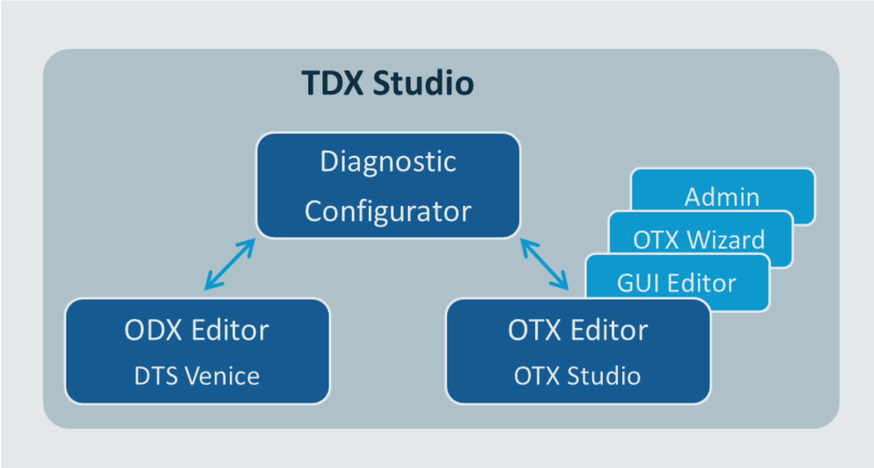

Figure 5: Softing TDX.studio Toolbox

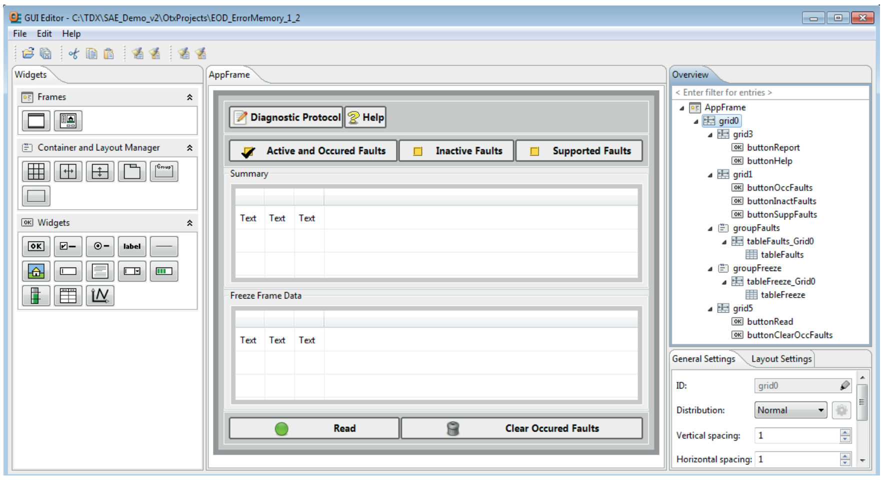

Figure 6 : GUI Editor

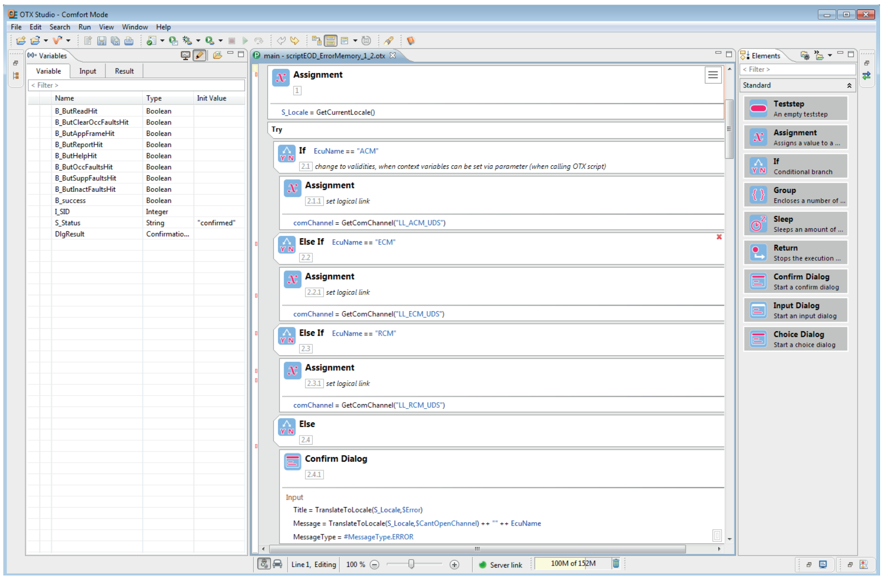

Figure 7 : OTX Wizard

Figure 8: Softing TDX.workshop – Individualization Examples

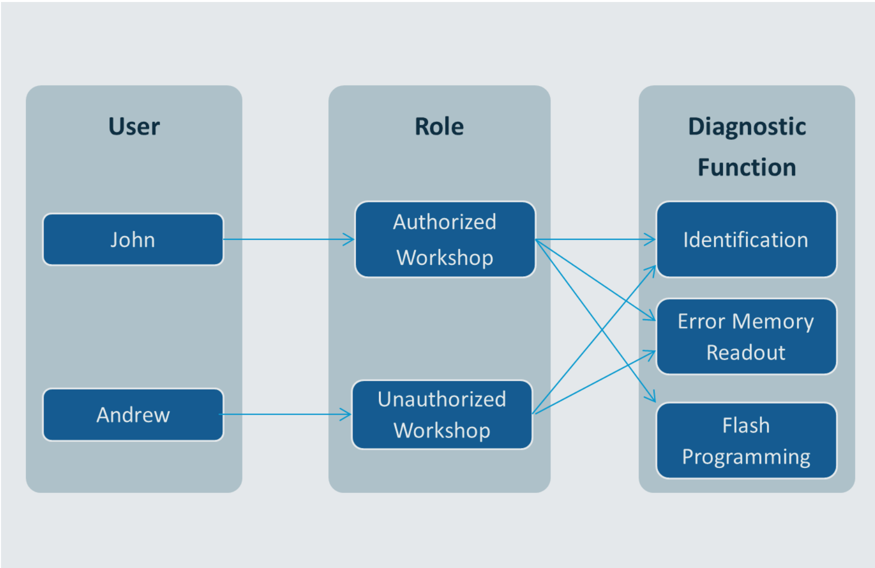

Figure 9: The Role Model

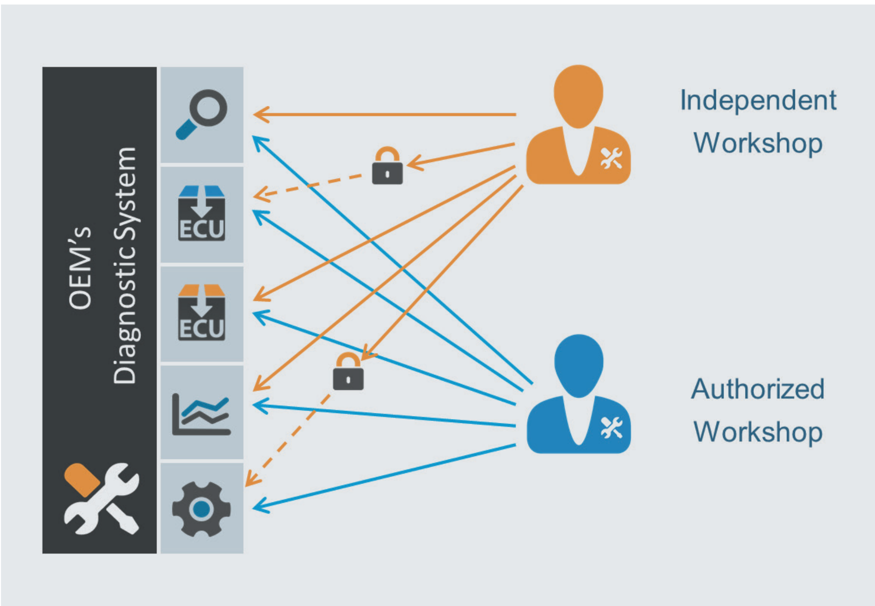

Figure 10: Content Protection with Role Model

The Role Model and Protection of Proprietary Content

By applying the role model in a TDX diagnostic system configuration (TDX project), the supplier of the diagnostic system can define and control credentials for the specific user groups (e.g. administrator, developer, technician in production, technician in the workshop etc.).

The authorization for specific roles can be defined for each diagnostic function contained in a TDX project (Figure 9).

All users entitled to use the diagnostic system are assigned a role: This controls the kind of tasks they are allowed to perform (or not) with the diagnostic system (e.g. identification - yes, measurement - yes, flashing – no, etc.).

The role model is especially important for the re-use of OTX scripts. A vehicle test used in development or production could also be used in authorized workshops but not in independent ones. Typical examples of execution restriction are the flashing of ECUs, vehicle coding and parametrization of the ECUs (Figure 10).

For the protection of the diagnostic sequences, functions and diagnostic execution environment (Softing TDX.workshop) itself, two independent protection mechanisms are provided. For the ODX, OTX and TDX project a special OEM-specific encryption is used. This ensures that diagnostic content from one OEM cannot be used or read by other OEMs without a proper license.

The OEM-specific content licensing, if applied, still allows the use of content from different OEMs in a single application. This feature is very useful for system integrators and workshops that need diagnostic solutions covering system components from different suppliers.

The application itself is protected by special application enveloping protection technology which protects the application against hacking attempts. On the one hand this provides protection against unauthorized copying and license violation, and on the other it protects diagnostic content encryption from reverse engineering.

Maintenance of the Diagnostic System in the Field

Softing TDX provides separated update for content and application. The update can be performed online or offline, depending on the availability of the Internet infrastructure in the field. With this approach, the content can be updated very rapidly, which is of significant importance in the case of safety relevant updates or vehicle recalls.

Summary

As a modular, OTX-based diagnostic system solution, Softing TDX certainly provides many benefits for workshop diagnostics.

First of all there is clear investment safety due to the long-term orientation and use of standardized and exchangeable software components. The latter is very important for increasing the number of cooperation projects between OEMs and component suppliers. The standardization is very important since the pace of technology change in the IT industry is much faster than in the automotive and related industries.

For this reason and because of the standardized components used, such as OTX runtime, ISO MVCI server and D-PDU API, Softing TDX guarantees long-term stability and maintainability of supplier-created diagnostic solutions. Together with the industry proven tools, such as DTS Venice and OTX Studio, Softing TDX offers efficient and flexible creation of modular and scalable diagnostic system solutions. www.softing.com

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