ODX Process from the Perspective of an Automotive Supplier

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Abstract

Vehicle systems, especially the ECU networks, are getting more and more complex. In combination with that the diagnostic requirements are also increasing.

This leads also to increasing efforts in development, production and service for diagnostics. The diagnostic functionality using proprietary diagnostic description formats for specification, software development, production, tester configurations and documentation is hardly controllable any longer. Therefore the use of standardized electronic description formats for diagnostics and flash programming data in all areas is essential.

According to this background the “Open Diagnostic Data EXchange” (ODX) was created and today standardized in ISO 22901. This machinery readable exchange format based on XML (“eXtensible Markup Language”) offers re-usable and inheritance concepts which open the possibility also to describe ECU variants, e.g. different software revisions.

The challenge to introduce ODX formats for system suppliers as ZF Friedrichshafen AG is to fulfill all different requirements of vehicle manufacturers for ECU diagnostics to data formats and software tools. In addition to ODX also other formats like CDD (‘CANdiata Diagnostic Data’ file format defined by company ‘Vector Informatik GmbH’) or proprietary formats like XLS (‘Microsoft Excel’) or XML are requested by the vehicle manufacturers.

Hence at ZF Friedrichshafen AG a specific CDD template was defined which allows the transfer of ZF specific data descriptions to the individual vehicle manufacturer defined data formats. By means of ODX export features in tooling a re-use in different standardized ODX tools and other formats is possible.

1 ODX

1.1 What’s ODX?

ODX is the abbreviation for ‘Open Diagnostic data eXchange’ and is standardized in ISO 22901.

The ODX data model of ECU diagnostics and programming data is specified in UML (“Unified Modelling Language”). The implementation format is defined in XML.

Based on this language instruments the diagnostic interface of an electronic control unit is described in electronic form. This format includes detailed specifications of diagnostic protocol inclusive communication parameters and detailed service requests.
and responses with scaling formulas and physical units. For service purposes diagnostic trouble codes ("DTCs") descriptions completed with their characterizations like fault symptoms, system reactions, repair instructions, etc. can be added. Methods to define data process sequences to get information from ECU’s are defined in so called ‘jobs’. Further information about the vehicle communication interface (VCI) like connector and pinout details in addition to the physical layer are described. To complete an ECU specification also ECU configuration data is defined (e.g. for ECU programming sequences supplemented with functional descriptions).

All this mentioned information is part of ODX. On the other side it’s important to know that ODX descriptions are not content of the ECU software.

1.2 Targets of ODX

“The purpose of … ISO 22901 is to define the data format for transferring Electronic Control Unit (ECU) diagnostics and programming data between the system supplier, vehicle manufacturer and service dealerships and diagnostic tools of different vendors”.

1.3 Benefit for ODX users

One benefit for ODX users is to have a standardized diagnostic description format which can be used all over the world from all parties in the automotive world. The ODX description goes along with an ECU in development, production and service.

The describing language is not restricted to English; possibilities to have multi-lingual descriptions are given.

This way ODX can reduce the effort for implementation and updating of diagnostic tools.

2 Importance of ODX for automotive suppliers and their customers

Both ECU system suppliers and vehicle manufacturers have benefits using ODX data partially with different focus.

Benefits for ECU suppliers:
- Consistent description of ECU diagnostic data stream and protocol in a standardized format
- Single source data in development, production and service
Re-use of diagnostic jobs for ECU programming, for diagnostic trouble code handling, for handling special data transfers to ensure data plausibility

Documentation can be generated from XML description

Use of purchasable tools for editing and testing of ODX data
- ODX editors with special features (data semantic checkers, export and format conversions, different data views, etc.)
- Automatic Test generation from ODX data ("data driven tests")

Configuration of different testing tools (e.g. development tester/service tester by scalable ODX data)

Possible use of code generation tools for configuration of software components ("data driven software implementation")

Benefits for Vehicle manufacturer:
Some of above mentioned benefits are also valid for vehicle manufacturers. In addition there are benefits in
- Reduced effort in authoring and editing of diagnostic data streams
  - manufacturer defines diagnostic description format which can be used both at manufacturer and supplier side
  - Less manual process steps, e.g. direct use of ODX data supported from suppliers, fewer data conversions, manual coding etc.
- Machinery readable format to transfer to diagnostic database
- Reduced effort for diagnostic data verification
- Re-utilization of verified data in development, EndOfLine and service testers
- Less cost in diagnostic data distribution

Benefits for test equipment manufacturer, franchise and aftermarket dealerships
- less effort needed to implement tool software by using a generic data driven approach ("data driven tool configuration")
- Reuse of same ODX data as manufacturers ("reuse of verified diagnostic data")
- Focus more on utilization and applying of diagnostic data less on data semantic, plausibility, etc.
- use of vehicle manufacturer independent diagnostic tools are possible
vehicle manufacturer specialities are “implemented” in ODX
- standardized description formats for DTC supports efficient manufacturer independent extended diagnostics (“comprehensible and comparable diagnostics”)

2.1 Prospects in development process with introduction of ODX

Good prospects for using ODX as diagnostic data descriptions are:

- Reduce effort for implementation tests and ECU tests of diagnostic features (time/cost efficiency)
- Increase test depth, reproducibility of tests (“better test quality”)
- Better support by (specialized) diagnostic tools
- Generation of supplier internal and OEM documentation
- Possible use of ODX for configuration of software components
- Possible use of single-source diagnostic features in related development departments, production and service

Figure 1: Use of ODX in different applications
2.2 Today’s proceeding for diagnostic descriptions

Today manufacturers and system suppliers have often their own formats and data structures to describe diagnostic data streams. Each party uses the diagnostic data descriptions for their own processes connected with special data generations, conversions and processing. Within a company oftentimes there are also data conversions necessary in the process chain in development, production and service. Additional enhanced proprietary documents will be created on basis of former created non-standardized documents in other process steps.

A lot of manual effort is necessary for creation, testing and maintenance for such describing and documenting data. The request for standardized, machinery readable, reusable and exchangeable data is considerable.

2.3 Optimized proceeding for diagnostic descriptions after introduction of ODX

With the introduction of ODX the use of a standardized description can be established. In development departments the preprocessing of different requirements documents must be handled as before to get a diagnostic data description on ODX format for further single-source use. After the mandatory creation of the diagnostic data descriptions the concentration can be on processing and managing of the data in successive processes. Linked with the mentioned advantages above the hope of reduced efforts is reasonable.

![Figure 2: Process after introduction of ODX](image)
3 Workflow with diagnostic data descriptions – Perspective of an OEM

3.1 Challenge for system suppliers in spite of ODX standardization

Although with ODX standardization the qualifications for the above mentioned requirements for an electronic diagnostic data format description are fulfilled, there are some challenges for system suppliers.

On the one hand the ODX scope allows different OEM characteristics in the data description structures. On the other hand not all OEM use the ODX standard for diagnostic data descriptions. There are also tool specific quasi-standards like the format CDD or demands for proprietary formats based on office formats like Microsoft Excel.
3.2 Today’s OEM requirements for diagnostic data descriptions

ZF Friedrichshafen AG is confronted to the different OEM requirements with the diagnostic data description formats:

- CDD
- Different ODX templates (based on ODX standard)
- Different ODX standard versions
- Customer specific formats, e.g. XML or Microsoft Excel
- Often there are specific tools needed to fulfill the different OEM requirements which cause additional effort in time and cost.

<table>
<thead>
<tr>
<th>CDD</th>
<th>ODX Template</th>
<th>ODX</th>
<th>Proprietary</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Customers</td>
<td>1 Customer</td>
<td>2 Customers</td>
<td>2 Customers</td>
</tr>
</tbody>
</table>

Figure 4: Snapshot of current requested diagnostic data descriptions

4 Introduction of an electronic diagnostic data description at ZF Friedrichshafen AG

With reflection of the mentioned challenge and OEM requirements the question arises how ZF can benefit from.

Before this question can be answered some preconditions and constraints must be considered.
4.1 Constraints

In most ZF products containing an electronic control unit a ZF specific diagnostic protocol exists. This ZF diagnostic protocol exists in parallel to OEM specific diagnostic protocol with ‘ZF characteristics’. This allows ZF using other diagnostic protocols with different functionalities, different data streams with additional data, sometimes on different physical data channels etc. This way the ZF diagnostics works mostly vehicle manufacturer independent over all customers and is valid for a long term.

Following items therefore must be regarded in addition to OEM diagnostic requirements:

- Additional ZF (project) specific diagnostic protocol
- Defined amount of diagnostic services which are independent from OEM’s
- Possibly different data structures and data streams with different content, e.g. additional measurements, routines, functionalities, other DTC numberings, etc.
- Possibly different physical communication channel
  - Software must handle ZF logins, diagnostic protocol changes, ZF diagnostics definitions
- By use of diagnostic protocol UDS (“Unified diagnostic services”) or KWP2000 (“Keyword Protocol 2000”) the use of ODX is possible
  - two different diagnostic data descriptions are necessary
    (One for OEM and one for ZF internal use)

5 Improvement of development process with standardized diagnostic data descriptions

Because of predominant use of CDD files by ZF customers, ZF developed a CDD template for diagnostic protocols KWP2000 and UDS.

ECU diagnostic documentation can be generated from the diagnostics data descriptions. With export functionalities the support for native use of ODX data, also in different ODX standardization versions, is ensured. Thus also the possibility to use ODX with available purchasable tools on the market is possible. The ODX data can be further processed in production, e.g. at end of line (ECU programming) or in service tools…

In combination with ZF’s own diagnostic software components and additional ZF tools it’s today possible to support a partially automated CDD creation. In newer pro-
jects diagnostic data descriptions can be reused, converted and transferred to OEM CDD templates.

![Diagram of ZF data handling with standardized diagnostic data descriptions](image)

The CDD files can directly be used in Software development e.g. via Vector tools.

Automated diagnostic validation of ECU’s inclusive test generation from CDD data is established (“data driven validation tests”)

### 6 Conclusion

By use of electronic diagnostic data descriptions ZF benefits not only in software development, but also in production and service. Improvements in the complete process chain where ECU diagnostic descriptions are in use makes the diagnostic applications transparent, convenient and effective with higher software quality.

For ZF this means:
- The increasing complexity of vehicle systems (diagnostic systems) is controllable for ZF by means of CDD
- Quality of diagnostics in ZF products is significantly improved
- OEM requirements for diagnostic descriptions can be fulfilled by transformation of ZF data
● Use of single-source data

● Manageable diagnostics (a found error in diagnostic data descriptions will be fixed at once and spread out afterwards to all parties using this data)
  - Test depth rises up
  - Data structures are harmonized
  - Wording and descriptions are harmonized

6.1 Progress potentials and continuous steps

Continuing development and automation in process chain can bring up further improvements for creation, processing and testing of diagnostic data descriptions. This includes continuous optimizations in ZF CDD templates for better use and support for creation and maintenance of vehicle manufacturer CDD or other data formats. More and more ZF projects are using this kind of diagnostic descriptions to manage the complexity of data streams and diagnostic contents.

Further process improvements are in consideration for extended features like ‘ECU variant specific documentation’ or data input/output interfaces, e.g. for diagnostics databases, and so on. This offers a wide scope for further applications of diagnostics.

Even older projects can benefit from this considered way of description. Especially if there are software modifications in planning because of maintenance or bug fixes they can be validated with a deeper test coverage which leads to better software and thus to a higher product quality. Nevertheless the effort to create such electronic diagnostic descriptions must be considered in the ratio to the planned modifications in diagnostic software.

7 References

● ISO 22901-1:2008, Road vehicles - Open diagnostic data exchange (ODX), Part 1: Data model specification,