



Diagnose 2011 ff.  
Diagnostics 2011 ff

5. Vector Congress, Stuttgart  
2010-12-01 + 02

# Agenda

## > Unified Diagnostic Services

AUTOSAR Diagnostic Basic Software Components

Diagnostic Data Management and Exchange

AUTOSAR Methodology meets Diagnostics

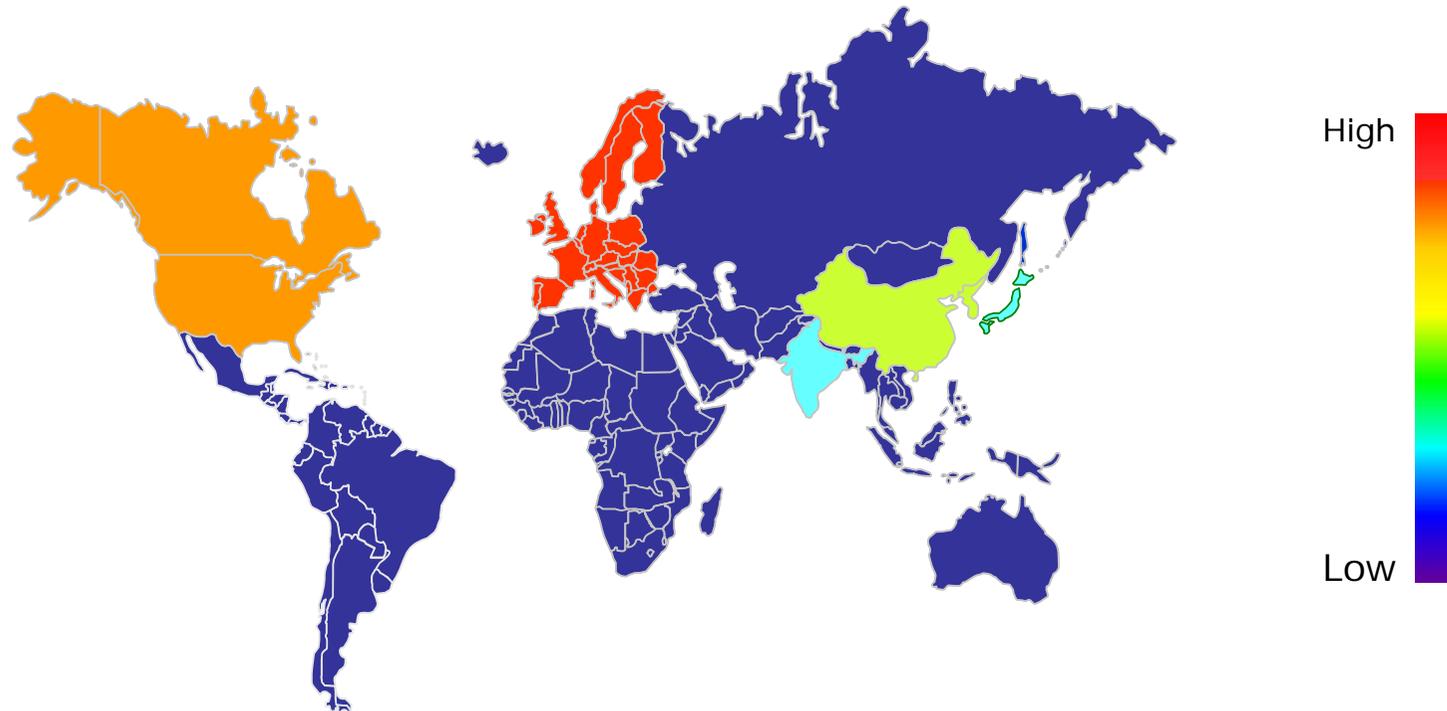
Upcoming Standardization Activities

Conclusion

# Unified Diagnostic Services

Acceptance *(simplified)*

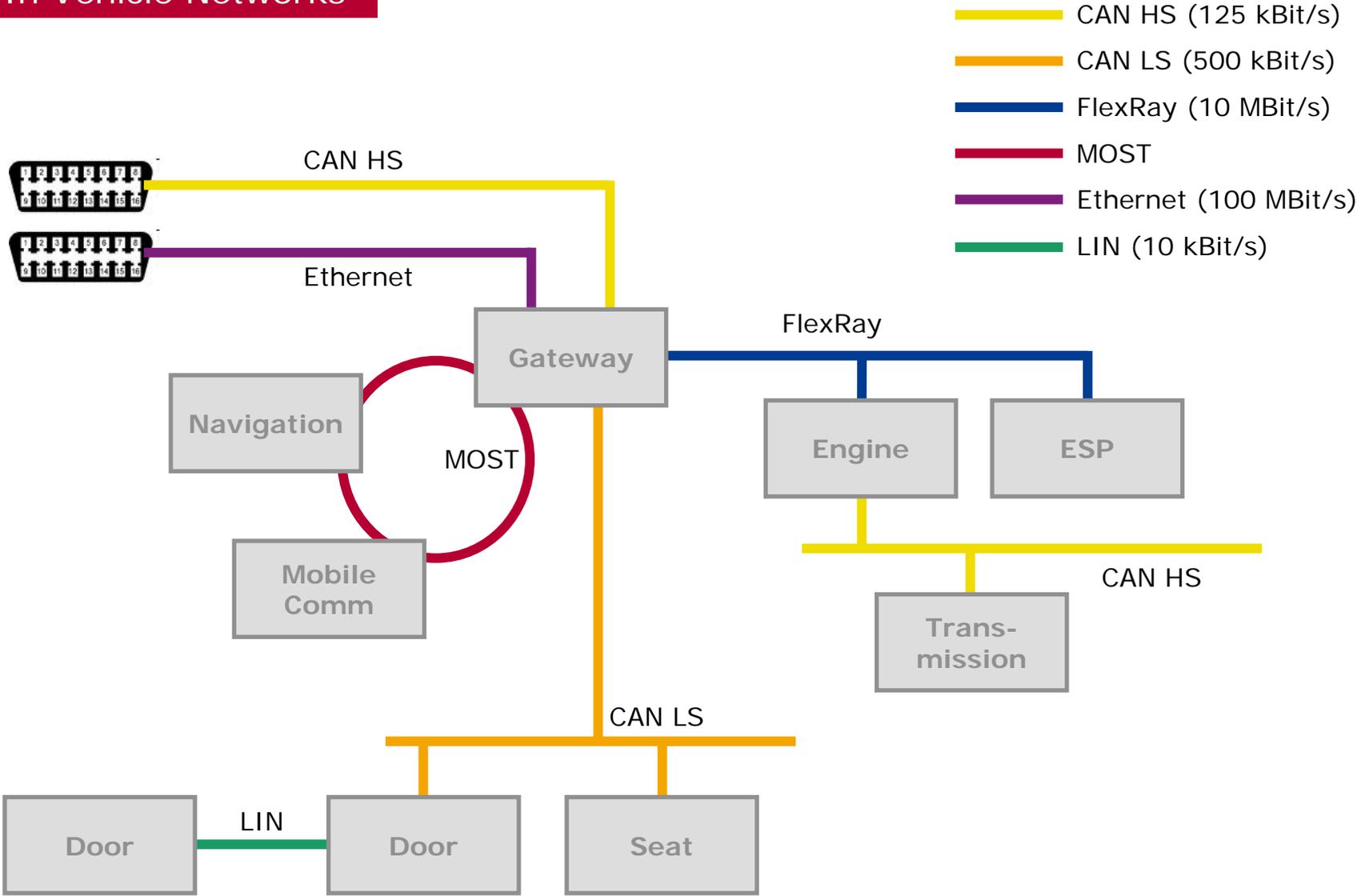
- ▶ ISO 14229-1 Unified Diagnostic Services (UDS)



Diagnostic implementations converge!

# Unified Diagnostic Services

## In Vehicle Networks



# Unified Diagnostic Services

## WWH-OBD

- ▶ World Wide Harmonized On-Board-Diagnostics (WWH-OBD)
- ▶ Initiated by the United Nations
- ▶ Requirements:  
Global Technical Regulation 5 (GTR5)
- ▶ Commercial vehicles at first,  
further vehicles later
- ▶ Goal: Mid/long term replacement of local OBD regulations
- ▶ Regulation of diagnostic communication and emissions.  
For a start, emission limits shall be regulated by local authorities
- ▶ Related standards: ISO 27145 and SAE J1939-73, ...

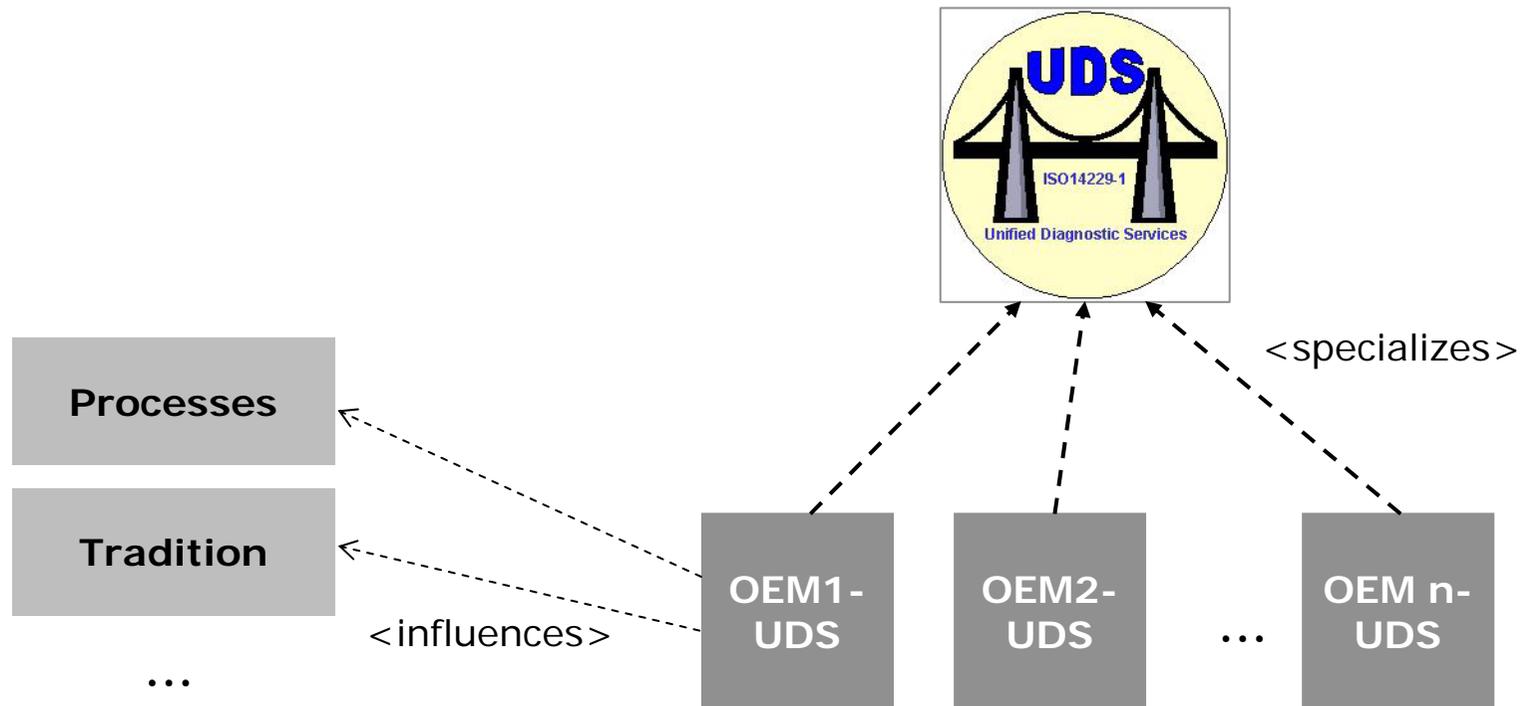


UDS will also be used for emission-related diagnostic communication.

# Unified Diagnostic Services

## Customized Specifications

- ▶ Each OEM has his own UDS and Fault Memory specification
  - > based on the international standard
  - > quite different in terms of structure, coverage and contents



# Unified Diagnostic Services

## Examples of Specification Differences

- ▶ Error Handling: Which negative response code when?
- ▶ Reaction on certain invalid (functional) requests
- ▶ Sequence/behavior to unlock ECU (security access)
- ▶ Behavior when multiple testers send concurrent requests
- ▶ Fault memory instances: Engineering, history, ...
- ▶ Trouble code assignment (OBD vs. enhanced diagnostics)
- ▶ Set/Reset conditions of trouble code status bit
- ▶ Strategies for displacement and aging
- ▶ Clear trouble codes – synchronous or asynchronous

There is room for further convergence.

# Unified Diagnostic Services

Status of Work: ISO 14229

UDS is broadened for new networks and enhanced by clarifications.



International Organization for Standardization

## ISO/TC22/SC3/WG1 Data Communication

### Status Report TF5 to WG1

### Status of Work: ISO 14229 UDS

#### Unified Diagnostic Services (UDS)

<div style="background-color: #e0ffe0; padding: 2px; font-size: x-small;">Published, under revision (same for all protocols)</div>	<div style="border: 1px solid gray; padding: 5px; margin-bottom: 5px;"> <b>ISO 14229-1:2006 Road vehicles – Unified diagnostic services</b>                      Part 1: Specification and requirements                 </div>				
<div style="background-color: #ffffe0; padding: 2px; font-size: x-small;">New, standardized service primitive interface (same for all protocols)</div>	<div style="border: 1px solid gray; padding: 5px;"> <b>ISO 14229-2:2010 Road vehicles – Unified diagnostic services</b>                      Part 2: Session layer services                 </div>				
<div style="background-color: #ffffe0; padding: 2px; font-size: x-small;">New implementation parts</div>	<table style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <td style="width: 25%; border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 14229-3:2010 Road vehicles – Unified diagnostic services                      Part 3: UDS on CAN implementation                 </td> <td style="width: 25%; border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 14229-4:2010 Road vehicles – Unified diagnostic services                      Part 4: UDS on FlexRay implementation                 </td> <td style="width: 25%; border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 14229-5:2010 Road vehicles – Unified diagnostic services                      Part 5: UDS on Internet Protocol implementation                 </td> <td style="width: 25%; border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 14229-6:2010 Road vehicles – Unified diagnostic services                      Part 6: UDS on K-Line implementation                 </td> </tr> </table>	ISO 14229-3:2010 Road vehicles – Unified diagnostic services Part 3: UDS on CAN implementation	ISO 14229-4:2010 Road vehicles – Unified diagnostic services Part 4: UDS on FlexRay implementation	ISO 14229-5:2010 Road vehicles – Unified diagnostic services Part 5: UDS on Internet Protocol implementation	ISO 14229-6:2010 Road vehicles – Unified diagnostic services Part 6: UDS on K-Line implementation
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#### Protocols

<div style="background-color: #e0ffe0; padding: 2px; font-size: x-small;">Renaming to DoXYZ or CoXYZ</div>	<div style="background-color: #e0ffe0; padding: 2px; font-size: x-small; text-align: center;">under revision</div>	<div style="background-color: #ffffe0; padding: 2px; font-size: x-small; text-align: center;">New development</div>	<div style="background-color: #ffffe0; padding: 2px; font-size: x-small; text-align: center;">New development</div>	<div style="background-color: #e0ffe0; padding: 2px; font-size: x-small; text-align: center;">under revision</div>
<div style="border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 15765-1, -2, -4 Road vehicles – Diagnostic communication over CAN (DoCAN)                 </div>	<div style="border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 10681-1, -2 Road vehicles – Communication over FlexRay (CoFR)                 </div>	<div style="border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 13400-1, -2, -3 Road vehicles – Diagnostic communication over Internet Protocol (DoIP)                 </div>	<div style="border: 1px solid gray; padding: 2px; font-size: x-small;">                     ISO 14230-1, -2 Road vehicles – Diagnostic communication over K-Line (DoK-Line)                 </div>	

Presenter Gangolf Feiler/Concepts & Services Consulting, 2010-04-22
5
ISO TC22/SC3/WG1 Nxxxx

# Agenda

Unified Diagnostic Services

> **AUTOSAR Diagnostic Basic Software Components**

Diagnostic Data Management and Exchange

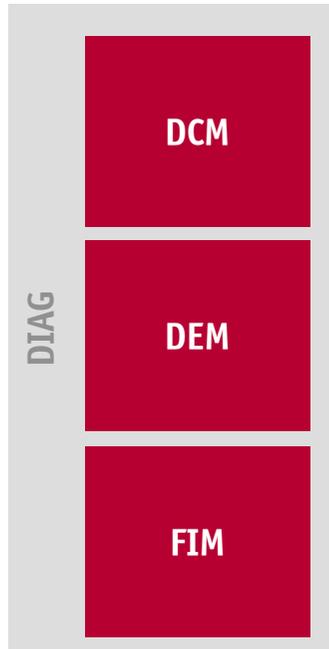
AUTOSAR Methodology meets Diagnostics

Upcoming Standardization Activities

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# AUTOSAR Diagnostic Basic Software Components

## DCM, DEM and FIM



- ▶ DCM: Diagnostic Communication Manager  
Standardization of a component
  - ▶ DEM: Diagnostic Event Manager  
Standardization of API, functionality and configuration. Significant parts of the behavior are OEM specific.
  - ▶ FIM: Function Inhibition Manager  
Standardization of a component
- 
- ▶ Different UDS and Fault Memory specifications result in different variants of DCM and DEM
  - ▶ Specific Post-Build features are expensive. What is required?

# AUTOSAR Diagnostic Basic Software Components

## DCM

► Scope:

	SID	DID	Data
Request:	22	FF EE	
Response:	62	FF EE	AA BB CC
ASR-Version	2.1	3.x	4.x

Quite different approaches in different versions!

# AUTOSAR Diagnostic Basic Software Components

## Differences in DCM Versions

- Some protocol services are explicitly excluded („limitations“)

Diagnostic service name (ISO 14229-1)	Service Id (hex)	AUTOSAR Extension	SWC has to ...
<b>Diagnostic and Communication Management Functional Unit</b>			
DiagnosticSessionControl	10		... grant service execution
ECUReset	11	X	... grant service execution
SecurityAccess	27		... calculate seed/key for each security level
CommunicationControl	28	X	... grant service execution
TesterPresent	3E		-
ControlDTCSetting	85		-
<b>Data Transmission Functional Unit</b>			
ReadDataByIdentifier (RDBI)	22		... handle data acquisition for each DataId
ReadMemoryByAddress	23	X	...handle memory access
ReadDataByPeriodicIdentifier	2A		internal, but data acquisition is done through RDBI
DynamicallyDefineDataIdentifier	2C		internal, but data acquisition is done through RDBI
WriteDataByIdentifier	2E		... handle data access for each DataId
WriteMemoryByAddress	3D	X	...handle memory access
<b>Stored Data Transmission Functional Unit</b>			
ReadDTCInformation	19		-
ClearDiagnosticInformation	14		-
<b>Input/Output Control Functional Unit</b>			
InputOutputControlByIdentifier	2F		... has to control I/O for each DataId
<b>Remote Activation Of Routine Functional Unit</b>			
RoutineControl	31		... start (/stop/request result) for each RoutineId
<b>Upload/Download Functional Unit</b>			
RequestDownload	34	X	-
RequestUpload	35	X	-
TransferData	36	X	...handle memory access
RequestTransferExit	37	X	-

Version 3.0

- Gaps in the specification needs to be filled (...)

Avoid further divergence, harmonize implementations!

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Unified Diagnostic Services

AUTOSAR Diagnostic Basic Software Components

**> Diagnostic Data Management and Exchange**

AUTOSAR Methodology meets Diagnostics

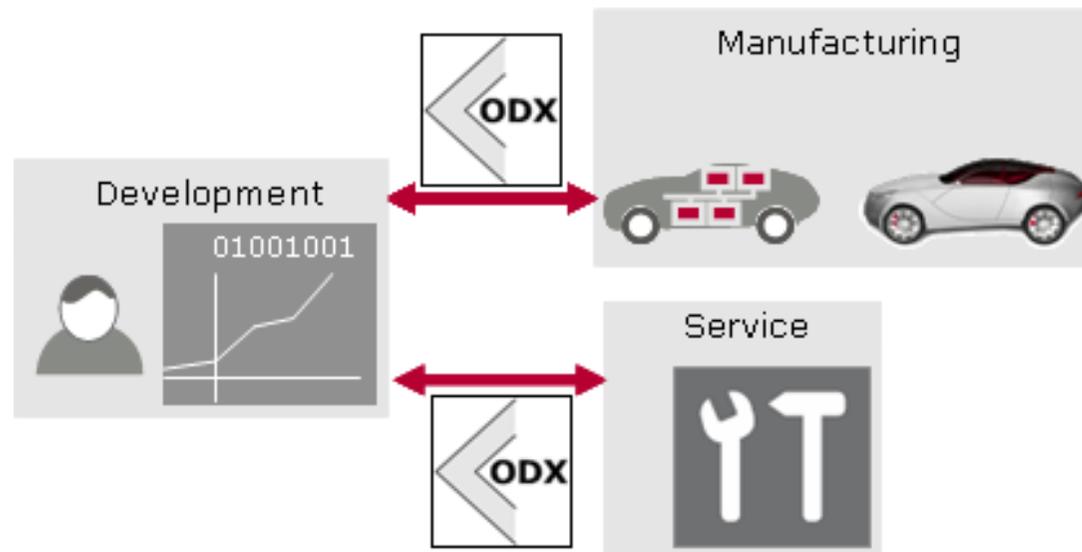
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# Diagnostic Data Management and Exchange

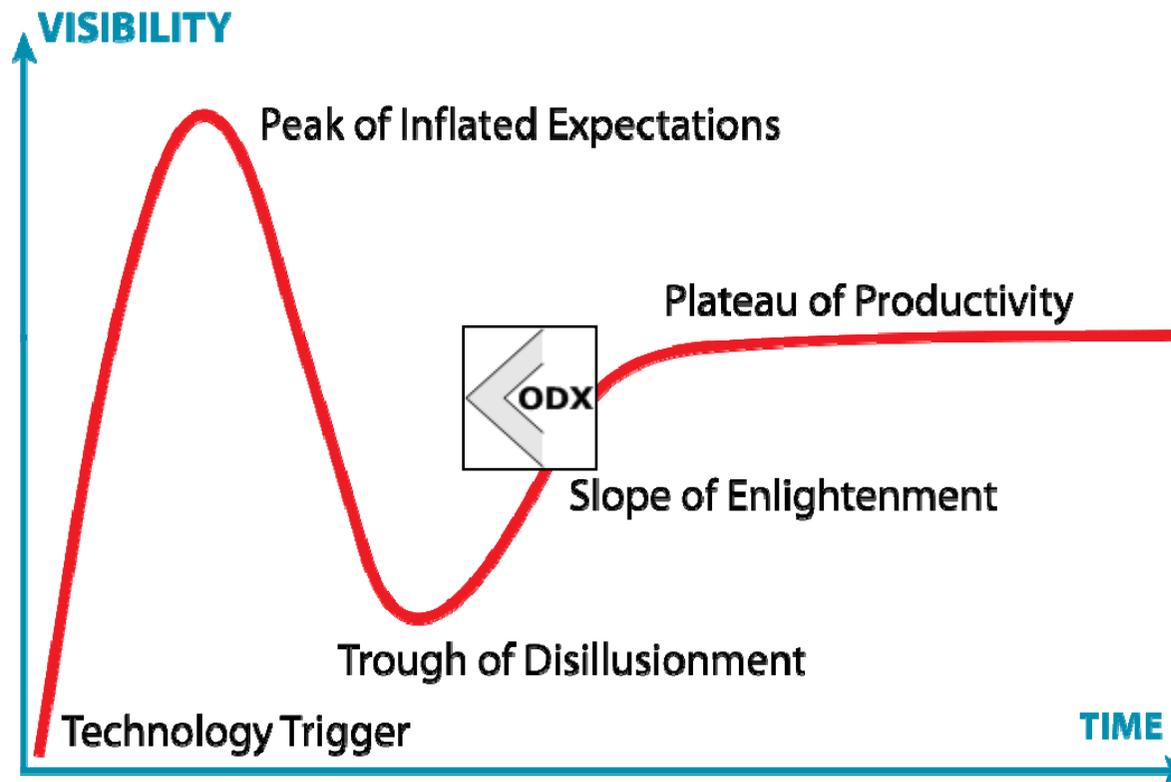
## ODX

- ▶ ODX = Open Diagnostic Data Exchange Format
- ▶ Goals
  - ▶ One data exchange format for diagnostics
  - ▶ Machine readable
  - ▶ Single source of information



# Diagnostic Data Management and Exchange

The Hype Cycle (by Jackie Fenn, Gartner)



Source: wikipedia.org

- ▶ ODX is heavily used - to overcome process borders
  - > OEM-OEM cooperation for vehicle rebranding or component reuse
  - > Data supply of manufacturing and/or service tool chain (most often not based on native ODX)
  - > Data supply of related processes, e. g. for ECU configuration
  - > Data supply of additional engineering tools (e. g. to overcome borders between formats of different software vendors)

ODX is quite established, even though  
(most often) not in the way it was promoted some years ago.

## What caused the disillusionment?

- ▶ Very high expectations, even different ones from different parties
- ▶ The standard was released despite of lots of open items and known issues.
- ▶ 3 different versions of ODX are currently used productively. A switch is expensive due to version incompatibility.
- ▶ Quite complex specification, also because some core topics can be modeled in different flavors.
- ▶ Some technical decisions could have been more pragmatic (consider cost-benefit ratio).

### Open questions

- ▶ Shall ODX be used for diagnostic data exchange and/or as a format of the central diagnostic data repository?
- ▶ Shall engineers exchange data exclusively in ODX format or is ODX used to establish firewalls between processes and tools?
- ▶ Shall ODX be edited (by humans) or shall ODX be generated (out of other data and/or formats)?
- ▶ Shall ODX data represent a diagnostic tester data supply, a specification or even a set of requirements?

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> **AUTOSAR Methodology meets Diagnostics**

Upcoming Standardization Activities

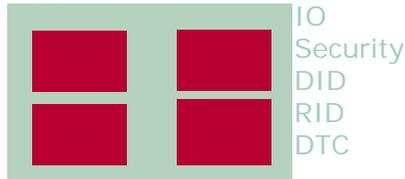
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# AUTOSAR Methodology meets Diagnostics

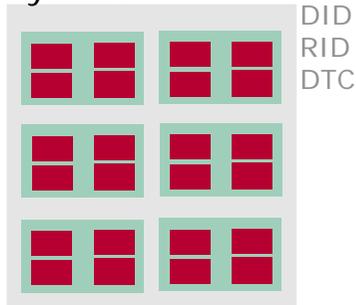
Software  
Component



ECU



System



## ▶ The AUTOSAR approach

- > Driven by functions
- > Functions are implemented in software components
- > Strictly top-down

## ▶ Diagnostics

- > System related (~10%)
- > ECU related (~20%)
- > Function related (~70%)
- > Mixture of top-down and bottom-up approach

# AUTOSAR Methodology meets Diagnostics

## Static View



Tooling e. g.  
❑ Word, Excel  
❑ DOORS  
❑ CANdelaStudio  
❑ ODX-Editor, e. g.  
    ODXStudio  
PDF, Excel, ODX

Diagnostic Demand   
Vehicle, ECUs, Functions

What data is required by OEM?  
(independent from diagnostic protocol)  
❑ Dedicated DTCs  
❑ Data objects (later DIDs),  
❑ Some IO control and remote functions



Tooling e. g.  
❑ CANdelaStudio  
❑ ODX-Editor, e. g.  
    ODXStudio  
ODX

Diagnostic Specification   
Diagnostic capabilities

What data is required on system level?  
❑ IDs = DID, CID, RID, ...  
    with length, coding, interpretation  
❑ DTCs plus extended data records  
❑ Data position on message  
❑ Session/Security dependencies



Tooling e. g.  
❑ DaVinci Dev (?)  
Part of System  
Description

Diagnostic "Mapping"  
Relation between Spec and SWC 

How to accomplish requirements?  
❑ Intermediate scaling/port scaling  
❑ Connections of ID to value/variable/port



Tooling e. g.  
❑ DaVinci Dev (?)  
❑ Simulink/Targetlink  
Part of System  
Description

Diagnostic Offering   
SWC diagnostic capabilities

What data is available in SWC?  
❑ ECU values/variables/features/ports  
    with internal scaling  
❑ Monitors, events/DTCs  
❑ Implemented as part of SWC

# AUTOSAR Methodology meets Diagnostics

## Example

Read the window position

Diagnostic Demand



Vehicle, ECUs, Functions

Read window position  
UDS service RDI 0x22  
identifier 0x5555  
conversion: %, resolution: 1

Diagnostic Specification



SWC diagnostic capabilities

OEM

Supplier

Diagnostic Offering



SWC diagnostic capabilities

Window position: Port *WinPos*  
2-byte value (Intel)  
scaling: 0.1%

Integrator

Diagnostic "Mapping"

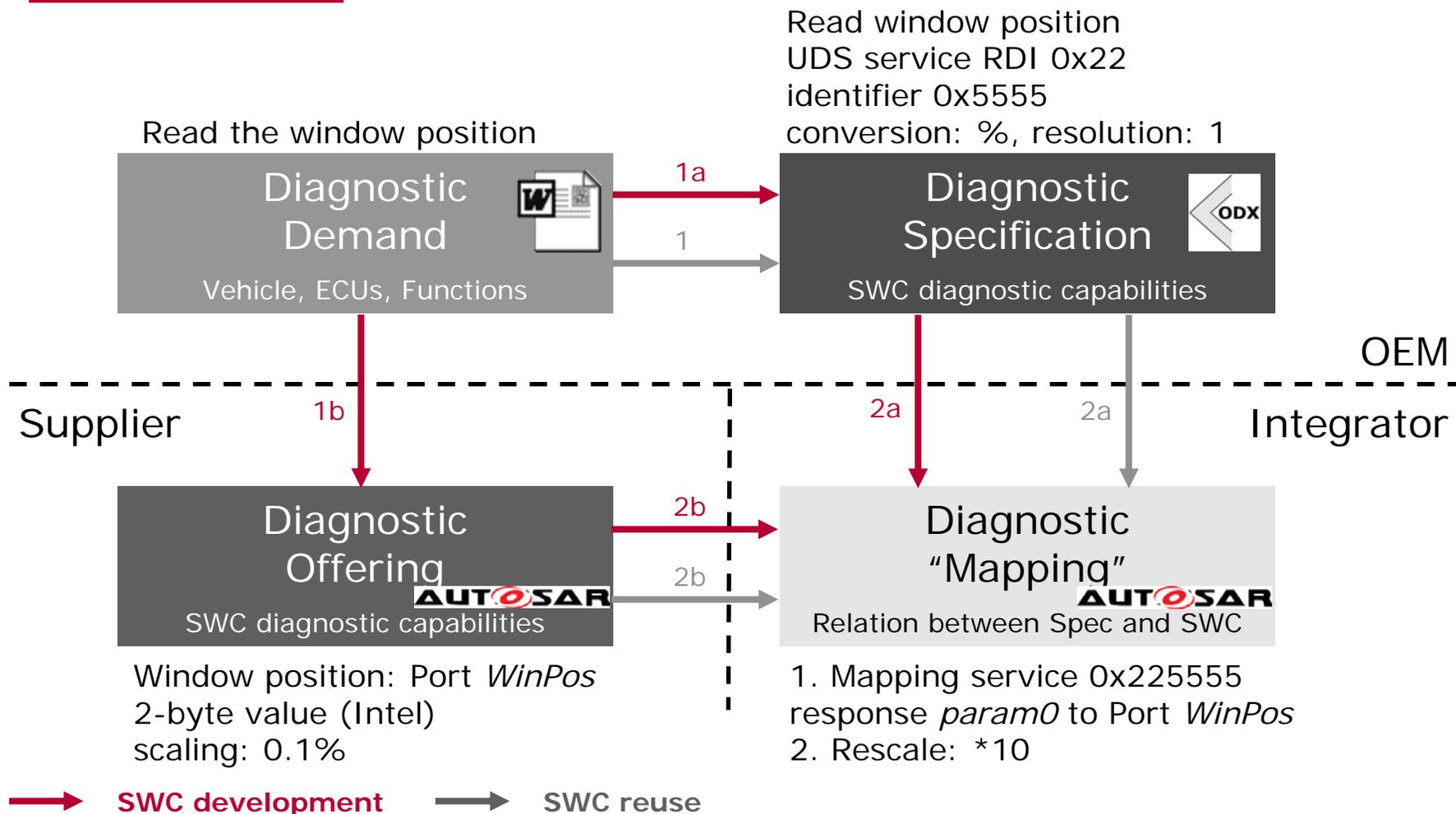


Relation between Spec and SWC

1. Mapping service 0x225555  
response *param0* to Port *WinPos*
2. Rescale: \*10

# AUTOSAR Methodology meets Diagnostics

## Dynamic View



Do also consider diagnostics when setting up new processes and tools!

# Agenda

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AUTOSAR Methodology meets Diagnostics

**> Upcoming Standardization Activities**

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# Upcoming Standardization Activities

## OTX – Open Test Sequence Exchange Format

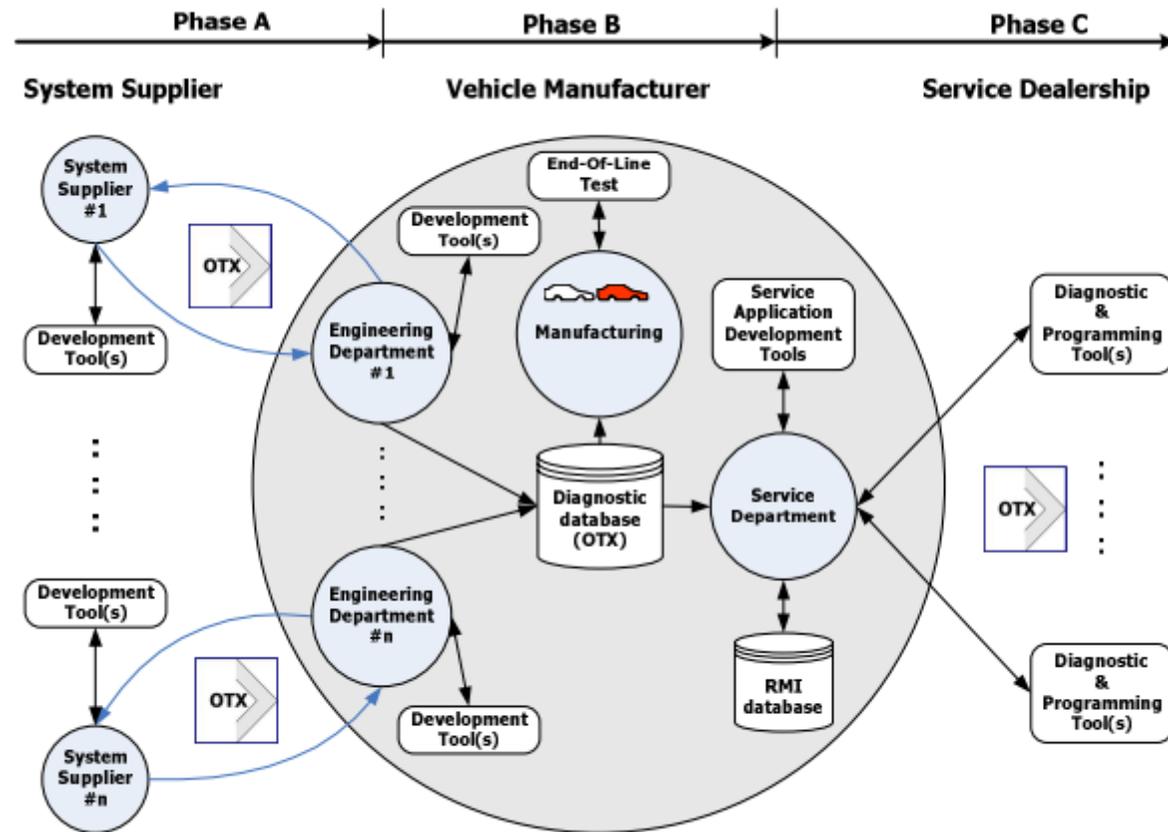
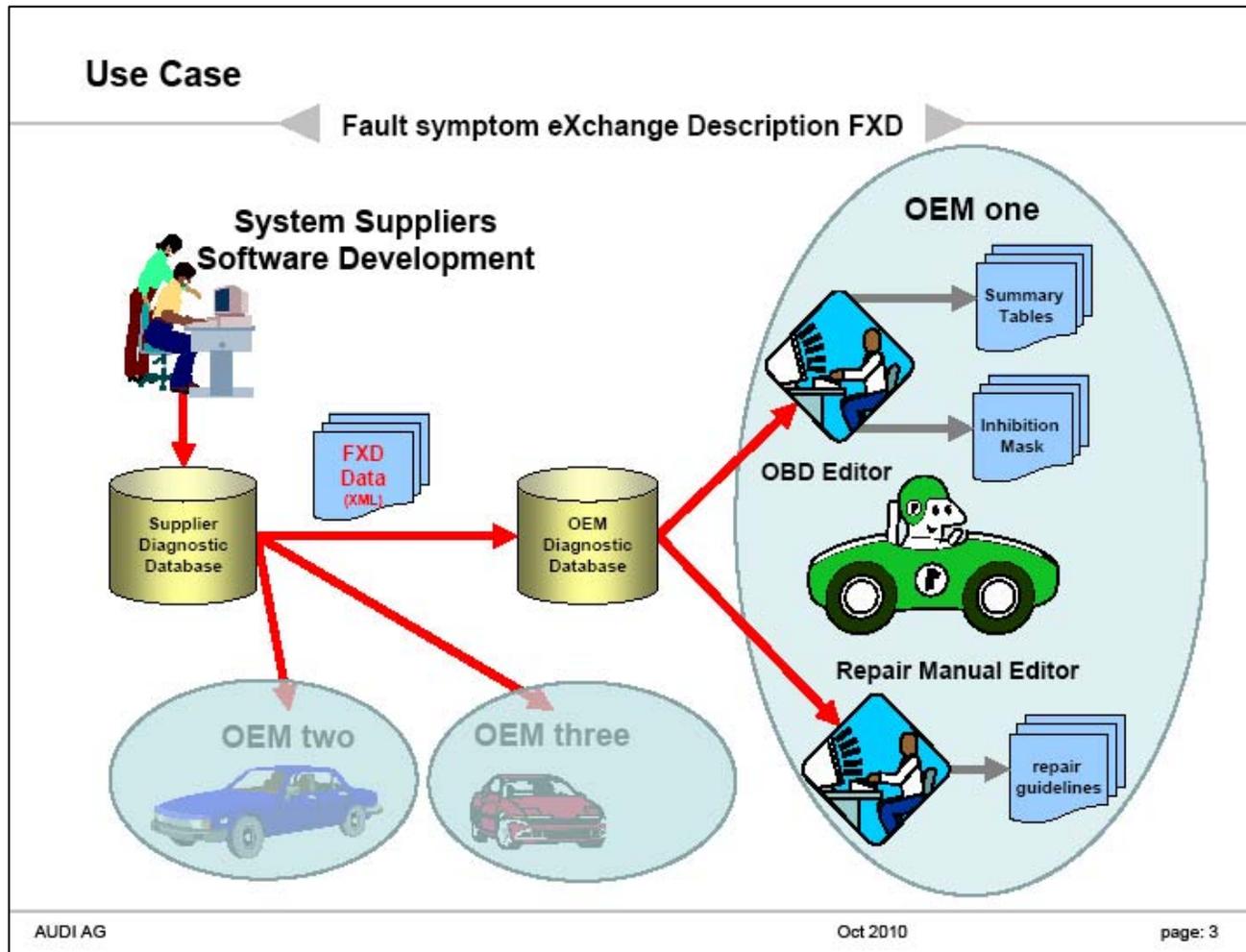


Figure 3 — Example of OTX process chain

Source: ISO/DIS 13209-1

# Upcoming Standardization Activities

## FXD – Fault Symptom Exchange Description



Source: ISO WG1 Berlin 10/2010

# Conclusion

- ▶ The main direction of diagnostics is related to standards. Harmonization is considered to be the #1 priority.
- ▶ There are several standards with significant inter-dependencies. We need to ensure compatibility.
- ▶ Standardization will keep us busy for the next years: Upcoming standards, revisions and integration.
- ▶ Standardization enables solutions, but is not the solution itself.

Vector will continue  
to actively contribute to standardization and  
to work on innovative, efficient and user-oriented solutions.



Thank you for your attention.

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[www.vector.com](http://www.vector.com)

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