MICROSAR Diagnostic Solution

OEM and legislated vehicle diagnostics
ISO 14229 (UDS) and ISO 15031 (OBD-II)

UDS and OBD are established standards for diagnostics over common vehicle networks.

Diagnostics provides access to emission related legislative data, fault memory, ECU data and triggers ECU functions.

Efficient realization of OEM specific diagnostic requirements and workflows.
Standard ISO 14229 and ISO 15031

ISO 14229 in a nutshell

**Standardized diagnostics**
- Idea: Unified way for diagnostic testers to address ECU diagnostic functionalities
- Solution: Standardized handshake communication between testers and ECU
- Peer-to-peer and broadcast communication over all commonly used vehicle networks
- Storing and reading fault memory
- Diagnostic service processing

**Typical diagnostic requests**
- Access to ECU fault memory
- Read/Write ECU data
- Access to ECU functionality
- Control ECU communication behavior

ISO 15031 (OBD-II) in a nutshell

**Mandatory by legislation for all ECUs with emission related functionality**
- Mandatory communication with external scan tool (e.g. operated by police officer)
- Standardized communication protocol over CAN or K-Line
- Standardized services, content and fault memory behavior
- 3 OBD ECU Types: Master, Primary and Secondary

**Typical diagnostic requests**
- Access to vehicle information
- Access to emission related information
- Access to emission related fault memory
- Control emission related vehicle functions
MICROSAR Diagnostics

**MICROSAR** for ISO 14229 (UDS)
- Supports most OEM diagnostic specifications
- Fault memory behavior adaptable to OEM specific requirements
- Easy configuration via import of common diagnostic databases:
  - AUTOSAR Diagnostic Extract (Main Method)
  - CANdelaStudio
  - ODX / PDX
- Integrated in DaVinci Configurator Tooling

**MICROSAR** for ISO 15031 (OBD-II)
- Field proven embedded standard solution
- Complies with common legal regulations
- Support for comprehensive and major monitors
- Master OBD ECU upon individual verification
- Common solution for different ECU projects
- Solution for OBD-II and WWH-OBD
- Integrated in DaVinci Configurator Tooling

**Dedicated BSW modules**
- **Dcm** UDS, OBD-II and WWH-OBD diagnostic messages handling and processing.
- **Dem** Fault memory manager which is called by system monitors and stores faults in a database. Provides interface to the Dcm to fulfill diagnostic requests. Parallel support of UDS and OBD-II.
- **Fim** Enables or disables system functions based on vehicle fault conditions.
- **vDrm** Vector solution for On-Board testers for Over-the-Air applications or vehicle internal tester.
- **vDES** Diagnostic Event Synchronizer for fault memories distributed over multiple µCs
Agenda

- **MICROSAR Diagnostic Solution**
  - MICROSAR UDS Solution
  - MICROSAR OBD II and WWH-OBD Solution
  - MICROSAR Diagnostic Tooling
  - MICROSAR Diagnostic Event Synchronizer
  - MICROSAR Diagnostic Request Manager
  - Diagnostics & Legislated OBD Support in Vector Tools
### MICROSAR Diagnostic Solution

**AUTOSAR Modules for Diagnostics**

#### FIM
- J1939OCM
- vORM

#### DEM
- vOES

#### DCM
- MEMIF

#### OBD affected modules
- FIM
- DEM
- DCM

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**Modules Implemented by MICROSAR**

MICROSAR is the Vector implementation of the AUTOSAR Standard.
MICROSAR Diagnostic Solution

- MICROSAR UDS Solution
  - MICROSAR OBD II and WWH-OBD Solution
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  - MICROSAR Diagnostic Event Synchronizer
  - MICROSAR Diagnostic Request Manager
  - Diagnostics & Legislated OBD Support in Vector Tools
Main Diagnostic Modules

**Diagnostic Communication Manager**
- Receive and Send diagnostic messages
  - UDS
  - OBD-II / WWH-OBD
- Application layer timing
- Diagnostic service dispatching
- Diagnostic service processing
- UDS session & security handling

**Diagnostic Event Manager**
- Monitor result processing
- Counter & time based event debouncing
- Event mapping to DTC(s) (incl combined events)
- DTC Status bit management
- Snapshot/Freeze Frame capturing and storage
- Extended Data reporting
- Fault info reporting to Dcm
- Flexible DTC unlearning (aging)

**Note:** A SAE J1939 DCM is also available
Main Diagnostic Modules

**Diagnostic Event Manager – Optional Legislated OBD Functionality**

- Support for US (J1979) and EU (ISO 15031/ISO 27145) requirements
- In Use Monitor Performance Ratio (IUMPR) calculation
- Mode $06 Diagnostic Test Result (DTR) management
- J1979 Mode data management
- DTC handling (healing & aging) according to legislated requirements
- Handling of Permanent DTCs
- Legislated Freeze Frame storage and reporting
- Auto generation of responses for all requested data managed by DCM/DEM (e.g. DTC readiness, IUMPR, freeze frame data...)
MICROSAR Diagnostic Solution

Functional Overview

Diagnostics

- RTE: Function Inhibition state
- SWC: Monitor SWC
- Monitor SWC
- Fault Reporting
- Read
- Write
- Start Routine

Diagnostics

- Fim: Report Event State
- IMUPR Locking
- Dem: Request FreezeFrame, DTC, ...
- Provide FreezeFrame, DTC, ...
- Rx
- Tx

Network Services

- PduR
- CAN
- ETH
- ...

Memory Services

- NvM: Store/Retrieve FreezeFrames, DTCs ...

AUTOSAR Diagnostics is network independent
**MICROSAR Diagnostic Solution**

**Simplified Dem Functions**

- **Monitor** (in Application)
  - Report: Passed or Failed

- **Debouncing**
  - e.g. 10 consecutive failed

- **Increment IUMPR Numerator**
  - Max once per cycle

- **Set Readiness**
  - Bit 6 “TestNotCompletedThis OperationCycle 1 -> 0”

- **On qualified Failed**
  - Status Bit Update (Pending/Confirmed)
  - Start FreezeFrame Capturing
  - Permanent DTC Entry?
  - Aging / Healing

- **Denominator Conditions Met**

- **Cycle**

- **IUMPR**

- **DEM Diagnostic Event Manager**
  - Decouples monitors from DTC processing
  - Diagnostic protocol Independent
  - Legislation independent
## Supported Diagnostic specifications

### OEM-Vector

- Implementation of UDS compliant diagnostics
- For all projects without UDS deviations
- Configurable within constraints of UDS standardization

### OEM-specific

- For OEMs with diagnostic requirements, beyond the scope of UDS and AUTOSAR
- Supported diagnostics of more than 12 different OEMs
- Support multiple diagnostic specification versions for the same OEM

### OEM-independent diagnostic solution

- Customized OEM-specific workflows
Agenda

MICROSAR Diagnostic Solution
MICROSAR UDS Solution

MICROSAR OBD II and WWH-OBD Solution

- MICROSAR Diagnostic Tooling
- MICROSAR Diagnostic Event Synchronizer
- MICROSAR Diagnostic Request Manager
- Diagnostics & Legislated OBD Support in Vector Tools
MICROSAR OBD II and WWH-OBD Solution

MICROSAR OBD Solution for ECU Projects

- Engine Control
- Transmission Control
- Exhaust Gas Recirculation
- Catalytic Converter
- Intake Air Management
- Fuel System

- Climate Control
- Power Electronics
- Battery Management
- Selective Catalytic Reduction
- Brake Control
- Integrated Starter Generator
- E-Motor Control

Classic OBD systems
Systems new to OBD
Systems with MICROSAR OBD solution
## Supported OBD ECU Domains

### Master ECU
- Major Monitors
- Comprehensive Monitors
- Calculates environmental/status data for other OBD ECUs
- Monitors and stores emission related data
- Responsible for illuminating the MIL

### Primary ECU
- Comprehensive Monitors
- Major Monitors
- Monitors and stores emission related data

### Secondary ECU
- Supported by standard MICROSAR solution
- Supplementary Emission Related Functions
- Emission Related Information Stored in Master / Primary

### Realized via Application
- Secondary ECU

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### Diagram

- **Scan Tool**
- **CGW (Central Gateway)**
- **CCU (Climate Control Unit)**
- **ECM (Engine Control Module)**
- **TCM (Transmission Control Module)**
- **OBD Master**
- **MIL (Malfunction Indicator Light)**
- **Powertrain**
- **0x7DF**

1) Primary ECUs typically have only Comprehensive Monitors
MICROSAR OBD Solution Provides

- Coverage of OBD BSW requirements
- High level of maturity
- Single source solution
- Scalable

Primary OBD ECUs are
- not directly emission related
- typically “Primary OBD ECUs”
- increasing number of OBD ECUs in hybrid vehicles

Monitor Electronic Powertrain Components
- can cause a measurable emissions increase
- used for other OBD monitors
- monitoring input for circuit and rationality faults
- monitoring output for functional faults

Field proven in 100+ ECU projects
- 7+ different OEMs
MICROSAR OBD II and WWH-OBD Solution

Functional Range

Main Features
- OBD-DTC status calculation
- Legislative Freeze Frame and PID $02
- In Use Monitor Performance Ratio (IUMPR) tracking
- MIL-Groups
- OBD-II Modes $01 - $0A
- WWH-OBD Services 0x14, 0x19, 0x22, 0x31

Supported Diagnostic Standards
- UDS (ISO14229-x)
- OBD II (SAE J1979)
- WWH-OBD (ISO 27145-x)
- J1939 (SAE J1939)

OBD II specific
- Permanent DTC handling

WWH-OBD specific
- DTC Classes (A, B1, B2, C)
- Activation Mode calculation
- Single B1 counter
- Continuous-MI counter
- PID $91 ECU OBD System Information

<table>
<thead>
<tr>
<th>PIDs</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$01</td>
<td>Monitor status since DTCs cleared</td>
</tr>
<tr>
<td>$02</td>
<td>DTC that caused freeze frame data storage</td>
</tr>
<tr>
<td>$1C</td>
<td>OBD requirements to which vehicle is designed</td>
</tr>
<tr>
<td>$21</td>
<td>Distance travelled while MIL is activated</td>
</tr>
<tr>
<td>$30</td>
<td>Number of warm-ups since DTCs cleared</td>
</tr>
<tr>
<td>$31</td>
<td>Distance since DTCs cleared</td>
</tr>
<tr>
<td>$41</td>
<td>Monitor status this driving cycle</td>
</tr>
<tr>
<td>$4D</td>
<td>Engine run time while MIL is activated</td>
</tr>
<tr>
<td>$4E</td>
<td>Engine run time since DTCs cleared</td>
</tr>
</tbody>
</table>
Agenda

MICROSAR Diagnostic Solution
MICROSAR UDS Solution
MICROSAR OBD II and WWH-OBD Solution

**MICROSAR Diagnostic Tooling**

MICROSAR Diagnostic Event Synchronizer
MICROSAR Diagnostic Request Manager

Diagnostics & Legislated OBD Support in Vector Tools
MICROSAR Diagnostic Tooling

Diagnostic Workflow at a Glance

**PREEvision**
- CANdelaStudio
  - Diagnostic Data File
    - .cdd
    - .odx
    - DEXT

**OEM**
- .arxml
- ECU-C

**Diagnotic Workflow at a Glance**

- **MICROSAR Diagnostic Tooling**
- **DaVinci Developer**
  - **Software Component Description Files**
    - .arxml
      - Contains software component information
  - **DaVinci Configurator Pro**
    - **BASE-ECU-C**
      - .arxml
    - **ECU Configuration Description**
      - .arxml

- **Header and Code Files**
  - .h
  - .c
  - B5W configuration
  - RTE
  - SWC

- **Generated Code**
  - Derive EcuC
  - Import

- **ECU Extract**
  - provided by OEM
- **DBC FIBEX LDF**
  - Communication provided by OEM.
- **OEM specific pre-configuration provided by Vector**
Agenda

MICROSAR Diagnostic Solution
MICROSAR UDS Solution
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MICROSAR Diagnostic Tooling

▶ MICROSA R Diagnostic Event Synchronizer
MICROSAR Diagnostic Request Manager
Diagnostics & Legislated OBD Support in Vector Tools
Diagnostic Event Synchronizer (vDES)

The vDES module allows to collect and synchronize Dem events reported on a different µC. It is a key functionality for diagnostics on ECUs with multi controller architecture (System on Chip).
MICROSAR Diagnostic Event Synchronizer

Overview

- CDD for MICROSAR 4
- **vDES** used on master and slave µC
- Master and slave role assigned per configuration
- Events are locally debounced in Dem on slave µC
- Qualified events (PASSED or FAILED) are transmitted to vDES on master µC
- **vDES** on master µC reports qualified events to Dem
- Synchronizes DTC clearing between master and slave µC
- Master µC does snapshot record data capturing
- Transparent to diagnostic testers

The **vDES** allows fault memory handling over multiple controllers.
MICROSAR Diagnostic Event Synchronizer

Transmission of qualified events

- Events are reported in a high frequency
- Local debouncing to obtain a qualified state (PASSED or FAILED)
- Transmission of qualified states only
- Considerable bandwidth reduction
MICROSAR Diagnostic Solution
MICROSAR UDS Solution
MICROSAR OBD II and WWH-OBD Solution
MICROSAR Diagnostic Tooling
MICROSAR Diagnostic Event Synchronizer

**MICROSAR Diagnostic Request Manager**

Diagnostics & Legislated OBD Support in Vector Tools
MICROSAR Diagnostic Request Manager

On-Board Diagnostics

**Diagnostic Request Manager (vDRM)**

The **vDRM** module sends diagnostic requests and receives responses. In a MICROSAR stack it provides access to the vehicle diagnostics.

It is used to implement an on-board tester inside a dedicated ECU.

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**Use Case Remote Diagnostic Tester**

**Use Case Internal Diagnostic Tester**
MICROSAR Diagnostic Request Manager

Overview

- CDD for MICROSAR 4
- **vDRM** provides an API for the application to send UDS services
- Behaves like external connected diagnostic tester
- Sends diagnostic requests to local Dcm and remote ECUs
Application Interface

- Diagnostic Service API from vDRM to Application

### UDS service specific

- **Dedicated APIs for common UDS diagnostic requests:**
  - 0x10 (Diagnostic Session Control)
  - 0x11 (ECUReset)
  - 0x19 0x02 (ReportDTCByStatusMask)
  - 0x19 0x04 (ReportDTCSnapshotRecordByDTC#)
  - 0x22 (ReadDataByIdentifier)
  - 0x27 (SecurityAccess)
  - 0x28 (CommunicationControl)
  - 0x31 (RoutineControl)
  - 0x34 (RequestDownload)
  - 0x36 (TransferData)
  - 0x37 (TransferExit)
  - 0x3E (TesterPresent)
  - 0x85 (ControlDTCSetting)

- **Further service APIs on demand**

### Raw Diagnostic Data

- **Application Interface to send raw UDS message**
  - CddDrm_SvcSend(connection, txBuffer)

- **Flexible for various use cases**
  - Transmission of any diagnostic request
  - Dynamic or hard coded diagnostic sequences
  - Embedded Scripting with e.g. LUA
MICROSAR Diagnostic Request Manager

Local and Remote Diagnostic

- Diagnostic request via PduR API to local Dcm
- Diagnostic request via PduR Gateway to any ECU in the vehicle
Agenda

MICROSAR Diagnostic Solution
MICROSAR UDS Solution
MICROSAR OBD II and WWH-OBD Solution
MICROSAR Diagnostic Tooling
MICROSAR Diagnostic Event Synchronizer
MICROSAR Diagnostic Request Manager

- Diagnostics & Legislated OBD Support in Vector Tools
Diagnostics & Legislated OBD Support in Vector Tools

At a Glance

- CANdelaStudio
  - Author Diagnostic Specification
  - Create CDD, ODX or OEM specific
- CANdela Diagnostic Data
- ODX Data
- Indigo (+remote)
  - Vehicle and System Diagnostics
  - OBD II: Mode & Data Display
- CANoe.DiVa
  - Auto Validate ECU Diagnostics
  - OBD II: Mode & Data Validation
- CANalyzer/CANoe/CANape
  - Test Functions and Diagnostics
  - OBD II: Mode & Data Display
- vFlash (+station, +remote, +OTA)
  - Update ECU SW
- Other: J2534 PassThru & D-PDU
  - API Drivers for HW interfaces

Training & Engineering Services for perfect fit

- MICROSAR DCM/DEM
  - Generate ECU SW Diagnostics
  - OBD II: DCM & DEM OBDII
For more information about Vector and our products please visit
www.vector.com

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