ON-BOARD-DIAGNOSTICS COMMUNICATION

The proposal for using UDS Services for OBD
What is UDS?

Defined in ISO 14229 - Unified Diagnostic Services (UDS)

Uses Services Modes 0x10 to 0xFF

Widely used by OEMs for enhanced diagnostics
OBD/UDS

Background:
• Industry concerned about limited number of remaining undefined 2-byte diagnostic trouble codes (DTC) and the need for additional DTCs for hybrid vehicles.
  – Indicating 2-byte DTCs will run out soon. P-Codes 7753 used, 3510 remain

• Industry proposed to CARB the implementation of UDS services
  – Provides 3-byte DTCs, significantly increasing number of DTCs that can be defined.
  – Has features for data access that improve usefulness of the generic scan tool (GST) to repair vehicles and provide needed information on in-use monitoring performance.
  – Combined GST and service information would enable technicians to execute all monitors in a more timely manner in inspection and maintenance (I/M) scenarios.
Background (cont.):
• SAE J1979-2: the proposed standard that documents select ISO 14229-1 (UDS) services that can be used for OBD communication on Controller Area Network (CAN) data links.
  – OBD/UDS includes the porting of classic J1979 Modes $01 to $0A as well as additional features such as DTC-specific readiness, test results and IUMP to OBD.
• Current Requirement:
  Only one freeze frame required (1968.2(g)(4.3.4)).
  Freeze frame for misfire and fuel system malfunctions have priority.

• Proposal: Add more freeze frame information to provide additional data for a repair technician to diagnose and repair an emission-related malfunction.
  – Require freeze frame for at least 5 DTCs, each with 2 frames per DTC (one for the 1st fault occurrence and the other for the most recent fault occurrence).
  – Eliminate freeze frame priority requirements.
  – 1st freeze frame - save all Parameter Identifiers (PIDs) required in 1968.2(g)(4.2.1)(A) on 1st fault occurrence.
  – 2nd freeze frame - update at least once per driving cycle anytime a fault occurs, and record all PIDs required in 1968.2(g)(4.2.1)(A).
1968.2(g)(4.2.1)(A)

- Calculated load value
- Number of stored confirmed fault codes
- Engine coolant temperature
- Engine speed
- Absolute throttle position
- Vehicle speed
- OBD requirements vehicle certified to
- MIL status
# OBD/UDS Amendments - Readiness (Current)

<table>
<thead>
<tr>
<th>Spark Ignition Readiness Groups</th>
<th>Compression Ignition Readiness Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misfire</td>
<td>Misfire</td>
</tr>
<tr>
<td>Fuel system</td>
<td>Fuel system</td>
</tr>
<tr>
<td>Comprehensive component</td>
<td>Comprehensive component</td>
</tr>
<tr>
<td>Catalyst</td>
<td>Non-Methane Hydrocarbon (NMHC) catalyst</td>
</tr>
<tr>
<td>Heated catalyst</td>
<td>Oxides of Nitrogen (NOx) after treatment</td>
</tr>
<tr>
<td>Evaporative system</td>
<td>Boost pressure system</td>
</tr>
<tr>
<td>Secondary air system</td>
<td>Exhaust gas sensor</td>
</tr>
<tr>
<td>Oxygen sensor</td>
<td>Particulate Matter (PM) Filter</td>
</tr>
<tr>
<td>Oxygen sensor heater</td>
<td>Exhaust Gas Recirculation (EGR) and/or Variable Valve Timing, Lift, and/or Control (VVT) system</td>
</tr>
<tr>
<td>Exhaust Gas Recirculation (EGR) and/or Variable Valve Timing, Lift, and/or Control (VVT) system</td>
<td></td>
</tr>
</tbody>
</table>
Proposal: Expand readiness group list to provide more comprehensive coverage of monitors in readiness.

- Include all monitors subject to the requirements of 1968.2(d)(3.1) & (3.2) (i.e., IUMPR requirements).
- Include all misfire and fuel system monitors.
OBD/UDS Amendments - Readiness

Proposed Readiness Groups

Catalyst
Heated Catalyst
Misfire
Evap System
Secondary Air System
Fuel System
Exhaust Gas Sensor
EGR
PCV
Engine Cooling System

Cold Start Emission Reduction Strategy
Variable Valve Timing
Direct Ozone Reduction System
Other
Non-Methane Hydrocarbon Conv Catalyst
Oxides of Nitrogen Converting Catalyst
Boost Pressure Control System
Nox Absorber
Particulate Matter Filter
Also

• New Readiness Completion Requirements
• DTC-Specific Information in Readiness
OBD/UDS Amendments – Test Results

- Current Requirement: Required to report test results for monitors listed in 1968.2(g)(4.5).
- Issue: Manufacturer-defined Test Identifiers (TIDs) are used to identify each test performed by an OBD monitor.
  - Difficult for vehicle repair technicians and CARB OBD staff to correlate TIDs to specific DTCs/monitors without detailed reference material often missing in service literature.
  - Monitor test results intended to help the vehicle repair technician identify systems that may be close to failing and to verify an emissions repair.
- Proposal: Report test results by DTC from all monitors subject to the IUMPR requirements except for CCM.
  - DTC-specific test results also required for all misfire and fuel system monitors, even though they are not subject to IUMPR requirements.
  - This new service will aid in the identification of monitor test results.
  - Allow only one set of test results/TID per DTC
  - DTC-specific test results service allow only one set of test results/TID per DTC. UDS data stream service allows more than one set of test results/TIDs per DTC for misfire monitor only.
Why move away from the status quo?

Further Arguments for Service Infrastructure Change

• OBD services are the same as enhanced diagnostic services.
• UDS allows for Authorization, Authentication, Secured Data Transmission (if needed) by using certificates handled by 3rd party.
• UDS is independent from CAN. It is can be used with other transport protocols, e.g. Ethernet.
• Advanced scan tools can easily deploy OBD as well as Enhanced diagnostics.
• UDS is the basis for ISO 27145, which is used for HD Euro VI.
Why move away from the status quo?

Arguments for UDS:

- allows for 3 byte DTCs + additional info using status byte (instead of 2 byte DTCs)
- allows for expanded PID/MIDs/TIDs/INFOTYPE ranges.
- supports multiple Freeze Frames, e.g. 5 frames.
- is compatible with service info, e.g. ODX, OTX...
  - ODX = Open Diagnostic Data Exchange, ISO 22901
  - OTX = Open Test sequence eXchange, ISO 13209
- Is already in use by most of vehicle manufacturers.
Today’s solution

SAE J1979 Classic

- Request current data
- Request freeze frame
- Request Perm DTCs

ISO 14229-1

- Session Ctrl
- ECU Reset
- Read DTC
- Clear DTC
- Read Data Identifier
- Routine Control

Different services/protocols are used for enhanced and OBD diagnostics.
ISO 14229-1

- Session Ctrl
- ECU Reset
- .
- .
- Read DTC
- Clear DTC
- Read Data ID
- Routine Control

Same services/protocols are used for enhanced and OBD diagnostics

SAE J1979-2

(possible solution)

- Request current data
- Request freeze frame
- .
- .

- Read DTC
- Clear DTC
- Read Data ID
- Routine Control

ECU data
## Overview Service-Mapping

<table>
<thead>
<tr>
<th>SAE J1979</th>
<th>ISO 14229</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Service</strong></td>
<td><strong>Name</strong></td>
</tr>
<tr>
<td>Read Out Data</td>
<td></td>
</tr>
<tr>
<td>0x01</td>
<td>Request Current Powertrain Diagnostic Data</td>
</tr>
<tr>
<td>0x09</td>
<td>Request Vehicle Information</td>
</tr>
<tr>
<td>0x06</td>
<td>Request On-Board Monitoring Test Results for Specific Monitored Systems</td>
</tr>
<tr>
<td>Fault Memory</td>
<td></td>
</tr>
<tr>
<td>0x03</td>
<td>Request Emission-Related DTCs</td>
</tr>
<tr>
<td>0x07</td>
<td>Request Emission-Related DTCs Detected During Current or Last Completed Driving Cycle</td>
</tr>
<tr>
<td>0x0A</td>
<td>Request Emission-Related DTCs with Permanent Status</td>
</tr>
<tr>
<td>0x02</td>
<td>Request Powertrain Freeze Frame Data</td>
</tr>
<tr>
<td>0x04</td>
<td>Clear/Reset Emission-Related Diagnostic Information</td>
</tr>
<tr>
<td>Control OBD System</td>
<td></td>
</tr>
<tr>
<td>0x08</td>
<td>Request Control of On-Board System, Test or Component</td>
</tr>
</tbody>
</table>
Data Identifier (DID): 2 byte identifier for a data item, e.g. PID, OBDMID, InfoType (see table)

Routine Identifier (RID): 2 byte identifier for a routine (e.g. "EVAP leakage test")

<table>
<thead>
<tr>
<th>Type</th>
<th>Service</th>
<th>SAE J1979-Classic ID</th>
<th>SAE J1979-2-UDS ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID</td>
<td>0x01</td>
<td>0x00-0xFF</td>
<td>0xF400-0xF5FF</td>
</tr>
<tr>
<td>MID</td>
<td>0x06</td>
<td>0x00-0xFF</td>
<td>0xF600-0xF7FF</td>
</tr>
<tr>
<td>InfoType</td>
<td>0x09</td>
<td>0x00-0xFF</td>
<td>0xF800-0xF8FF</td>
</tr>
</tbody>
</table>
Data - Changes in J2012 DA

<table>
<thead>
<tr>
<th>2 Byte Definition</th>
<th>3 Byte Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTC</strong></td>
<td><strong>Name</strong></td>
</tr>
<tr>
<td>P0001</td>
<td>Fuel Volume Regulator Control Circuit/Open</td>
</tr>
<tr>
<td>P0002</td>
<td>Fuel Volume Regulator Control Circuit</td>
</tr>
<tr>
<td>Range/Performance</td>
<td>ISO/SAE Reserved - Previously Defined for 2-Byte DTCs</td>
</tr>
<tr>
<td>P0003</td>
<td>Fuel Volume Regulator Control Circuit Low</td>
</tr>
<tr>
<td>P0004</td>
<td>Fuel Volume Regulator Control Circuit High</td>
</tr>
</tbody>
</table>

- (limited) backward compatibility
- Recycle "formerly used" DTCs (70%)
- 3 byte = 2 byte DTC + Failure Type Byte (FTB)
- 3 byte DTC definition with FTBs allows more precise pin-pointing of different faults.
- additional byte (Status of DTC) is defined in UDS
# DTC Status bits

<table>
<thead>
<tr>
<th></th>
<th>Supported</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>TestFailed</td>
<td>OBD</td>
</tr>
<tr>
<td>1</td>
<td>TestFailedThisOperationCycle</td>
<td>OBD</td>
</tr>
<tr>
<td>2</td>
<td>PendingDTC</td>
<td>OBD</td>
</tr>
<tr>
<td>3</td>
<td>ConfirmedDTC</td>
<td>OBD</td>
</tr>
<tr>
<td>4</td>
<td>TestNotCompletedSinceLastClear</td>
<td>OBD</td>
</tr>
<tr>
<td>5</td>
<td>TestFailedSinceLastClear</td>
<td>Optional for OEM</td>
</tr>
<tr>
<td>6</td>
<td>TestNotCompletedThisOperationCycle</td>
<td>OBD</td>
</tr>
<tr>
<td>7</td>
<td>WarningIndicatorRequested</td>
<td>Optional for OEM</td>
</tr>
</tbody>
</table>
OBD/UDS Proposed Implementation Timeline

• Proposal: To require implementation of UDS services on all LD and MD OBD II vehicles.
  – Option to start as early as 2022MY.
    • Excludes UDS IUMPR amendments.
    • Must be able to verify standardization requirements (in case SAE J1699 not yet updated to accommodate UDS).
  – 2026+MY: Must meet all UDS amendments, including IUMPR (except as provided below for hybrids).
    • Hybrid vehicles: 30/60/100% 2026-2028MY phase-in of IUMPR requirements for hybrid components.
    • For IUMPR issues, may be granted deficiencies, but no fines for 2026-2028MY.
People that either willingly or unwillingly contributed to this information but should be credited here for their good work and dedication.

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Joakim Pauli – Volvo Truck
Marl Laleman – Ford
California Air Resources Board – multiple people