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.

OBD/UDS

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 IUMPR to OBD.

OBD/UDS

- 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).

Freeze Frame First and Last Occurrence - OBD

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)

Spark Ignition Readiness Groups	Compression Ignition Readiness Groups
Misfire	Misfire
Fuel system	Fuel system
Comprehensive component	Comprehensive component
Catalyst	Non-Methane Hydrocarbon (NMHC) catalyst
Heated catalyst	Oxides of Nitrogen (NOx) after treatment
Evaporative system	Boost pressure system
Secondary air system	Exhaust gas sensor
Oxygen sensor	Particulate Matter (PM) Filter
Oxygen sensor heater	Exhaust Gas Recirculation (EGR) and/or Variable Valve Timing, Lift, and/or Control (VVT) system
Exhaust Gas Recirculation (EGR) and/or Variable Valve Timing, Lift, and/or Control (VVT) system	

OBD/UDS Amendments - Readiness

- **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

OBD/UDS Amendments - Readiness

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

ISO 14229-1

Different services/protocols are used for enhanced and OBD diagnostics

Request current data
Request freeze frame
.
.
.
Request Perm DTCs
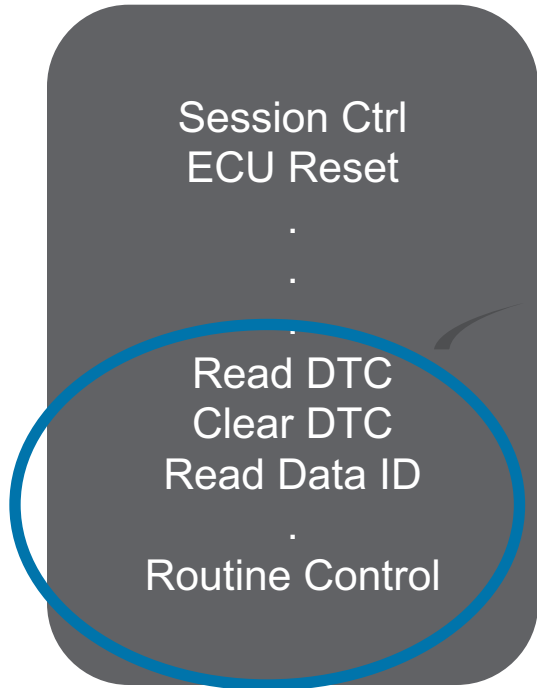
ECU data

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

In Discussion

ISO 14229-1

SAE J1979-2
(possible solution)

Same services/protocols are used for enhanced and OBD diagnostics

ISO 14229-1 box:
Session Ctrl
ECU Reset
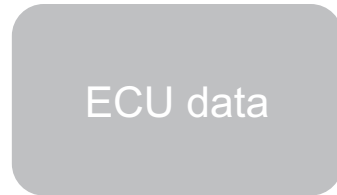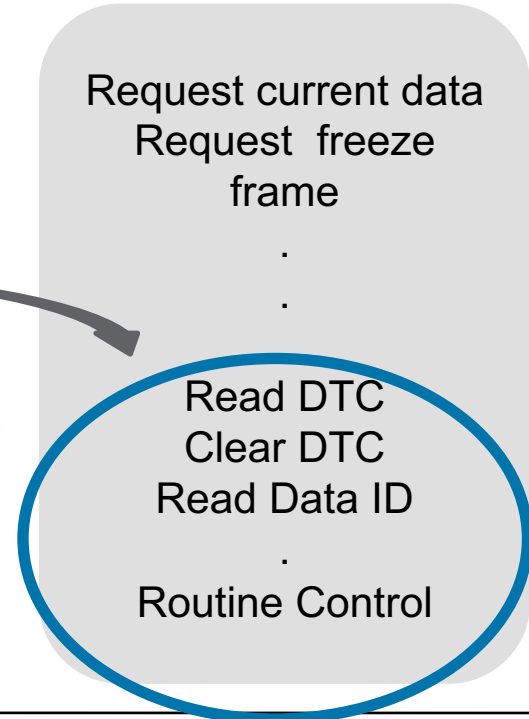
.
.
.

Read DTC
Clear DTC
Read Data ID
.
Routine Control

SAE J1979-2 box:
Request current data
Request freeze frame

.
.

Read DTC
Clear DTC
Read Data ID
.
Routine Control

ECU data

Overview Service-Mapping

SAE J1979			ISO 14229	
Service	**Name**		**Service**	**Name**
Read Out Data				
0x01	Request Current Powertrain Diagnostic Data		**0x22**	ReadDataByIdentifier, PID 0xF4/F5xx
0x09	Request Vehicle Information		**0x22**	ReadDataByIdentifier, PID 0xF8/F9xx
0x06	Request On-Board Monitoring Test Results for Specific Monitored Systems		**0x22**	ReadDataByIdentifier, PID 0xF6/F7xx
Fault Memory				
0x03	Request Emission-Related DTCs		**0x19 42 (08)**	reportWWHOBDDTCByMaskRecord (confirmed)
0x07	Request Emission-Related DTCs Detected During Current or Last Completed Driving Cycle		**0x19 42 (04)**	reportWWHOBDDTCByMaskRecord (pending)
0x0A	Request Emission-Related DTCs with Permanent Status		**0x19 55**	reportWWHOBDDTCWithPermanentStatus
0x02	Request Powertrain Freeze Frame Data		**0x19 04**	reportDTCSnapshotRecordByDTCNumber
0x04	Clear/Reset Emission-Related Diagnostic Information		**0x14**	
Control OBD System				
0x08	Request Control of On-Board System, Test or Component		**0x31 01**	StartRoutine, RID 0xE000 - 0xE1FF

Data - Changes in J1979 DA

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")

Type	Service	SAE J1979-Classic ID	SAE J1979-2-UDS ID
PID	0x01	0x00-0xFF	0xF400-0xF5FF
MID	0x06	0x00-0xFF	0xF600-0xF7FF
InfoType	0x09	0x00-0xFF	0xF800-0xF8FF

Data - Changes in J2012 DA

2 Byte Definition		3 Byte Definition			
DTC	Name	DTC	Component / System Name	FTB	Fault
P0001	Fuel Volume Regulator Control Circuit/Open	P0001	Fuel Volume Regulator Control	13	Circuit Open
P0002	Fuel Volume Regulator Control Circuit Range/Performance	P0001	ISO/SAE Reserved - Previously Defined for 2-Byte DTCs	92	Performance or Incorrect Operation
P0003	Fuel Volume Regulator Control Circuit Low	P0001	ISO/SAE Reserved - Previously Defined for 2-Byte DTCs	11	Circuit Short To Ground
P0004	Fuel Volume Regulator Control Circuit High	P0001	ISO/SAE Reserved - Previously Defined for 2-Byte DTCs	12	Circuit Short To Battery

- (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

		Supported	Remark
0	TestFailed	OBD	
1	TestFailedThisOperationCycle	OBD	Used for trigger condition for Freezeframe (latest occurence)
2	PendingDTC	OBD	
3	ConfirmedDTC	OBD	
4	TestNotCompletedSinceLastClear	OBD	DTC based readiness since last clear
5	TestFailedSinceLastClear	Optional for OEM	Not required for OBD
6	TestNotCompletedThisOperationCycle	OBD	DTCbased readiness this operation cycle
7	WarningIndicatorRequested	Optional for OEM	Not required for OBD

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.

Bobby Gruszczynski – Independent

Markus Zblewski – VW

Joakim Pauli – Volvo Truck

Marl Laleman – Ford

California Air Resources Board – multiple people