On-Board-Diagnostics - OBDonUDS/J1979-2 - A Brave New World

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About Bob:

Bob has a BSEE from Lawrence Technological University. For over 30 years, Bob has been involved in the design and implementation of embedded electronic powertrain control systems. Bob has a United States Patent for his work in misfire detection systems and has been involved in numerous “first in the world starts” of new vehicle powertrain applications. Bob has also been involved in the development and testing of On Board Diagnostics Systems and publications in the area of OBD Communications techniques.

Bob is currently OBD Communication Expert - Retired. His former duties included investigation and analysis of OBD communication issues in the field both for I/M and Service. He is Past Chairman of the SAE E/E Diagnostics Committee and is also Past Chairman of the J1962 Vehicle Diagnostic Connector Task Force and J1978 Scan Tool Task Force. He is co-author of the J1699-2 Test Cases for OBD-II Scan Tools and I/M Test Equipment and author of the J3138 Diagnostic Link Connector Security Recommended Practices. Bob is a past member of the SAE Executive Standards Committee.

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Rationale For Unified Diagnostic Services - UDS

- **Initial discussion time frame – Approximately 2012-2013**
- **Determination – SAE J2012 would use up all P-codes by 11/2020**
- **Internal discussion regarding solutions**
  - Dispense with P-B-C-U designators (see later slides)
  - Move to 3-byte DTCs only (2-byte + FTB)
  - Switch to UDS
  - Others…
- **Outcome – Switch to UDS**
  - Already in use by several OEMs
  - Allows/defines enhanced diagnostics
- **Also – Interim solution – dispense with "area of vehicle system" designator – beginning in 2017**

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Rationale For UDS

- **Original J2012 intent to have separation of vehicle systems and subsystems**
- **Systems:**

System	Code Categories	Hex Value
Body	B0xxx - B3xxx	8xxx – Bxxx
Chassis	C0xxx - C3xxx	4xxx - 7xxx
Powertrain	P0xxx - P3xxx	0xxx - 3xxx
Network	U0xxx - U3xxx	Cxxx – Fxxx

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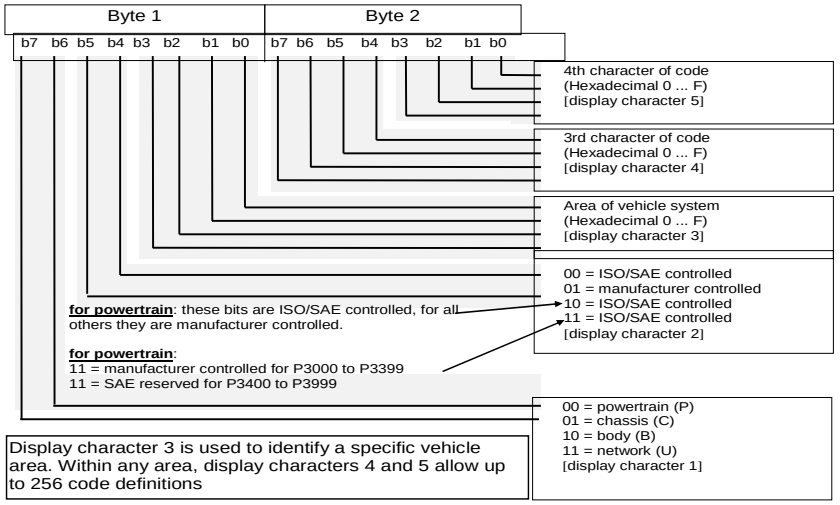
Rationale For UDS



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Rationale For UDS

- **Discussion moved to Alliance and Global Automakers groups and OEMs agreed (mostly)**
- **Once decided by Committee and the OEM groups, CARB buy-in was needed**
- **CARB initial discussion time frame – Approximately 2014**
- **Original discussion centered on remediation of DTC issue**
- **However, UDS encompasses more than just DTCs**
  - DIDs (Data identifiers), equivalent to J1979 PIDs
  - DTCs actually 4-bytes (FTB + status byte)
  - Enhanced data
  - Authentication, etc…

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Rationale For UDS

- **Original intent was to provide exactly the same information as available through J1979 (OBD-related PIDs, Vehicle information, etc…)**
- **However, CARB became interested in the enhanced features**
- **OEMs balked at providing extra data**
  - Enhanced data in UDS not standardized (only data areas and message formats)
  - OEMs differ in implementation/data definitions
- **Small group meetings have been taking place to discuss CARB requests and compromises to finish the transition.**
- **CARB regulation featuring UDS (referenced as J1979-2) completed 2022**
  - **Phase-in begins MY2023, ends MY2027 (may be extended)**

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What is UDS?

- **Protocol which can be compared to SAE J1979**
- **Defined in ISO 14229 - Unified Diagnostic Services (UDS)**
  - ISO is the owner of this standard
  - SAE has worked out a “co-ownership” deal
  - J1979-2 will be the new SAE document defining “OBD on UDS”
- **Uses Services / Modes 0x10 to 0xFF**
- **Is already used by many OEMs**
- **Allows/defines enhanced diagnostics**

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Why move away from the status quo?

Arguments for Service Infrastructure

- OBD service data are the same as OBD data for 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.

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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. 4 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 many of vehicle manufacturers.

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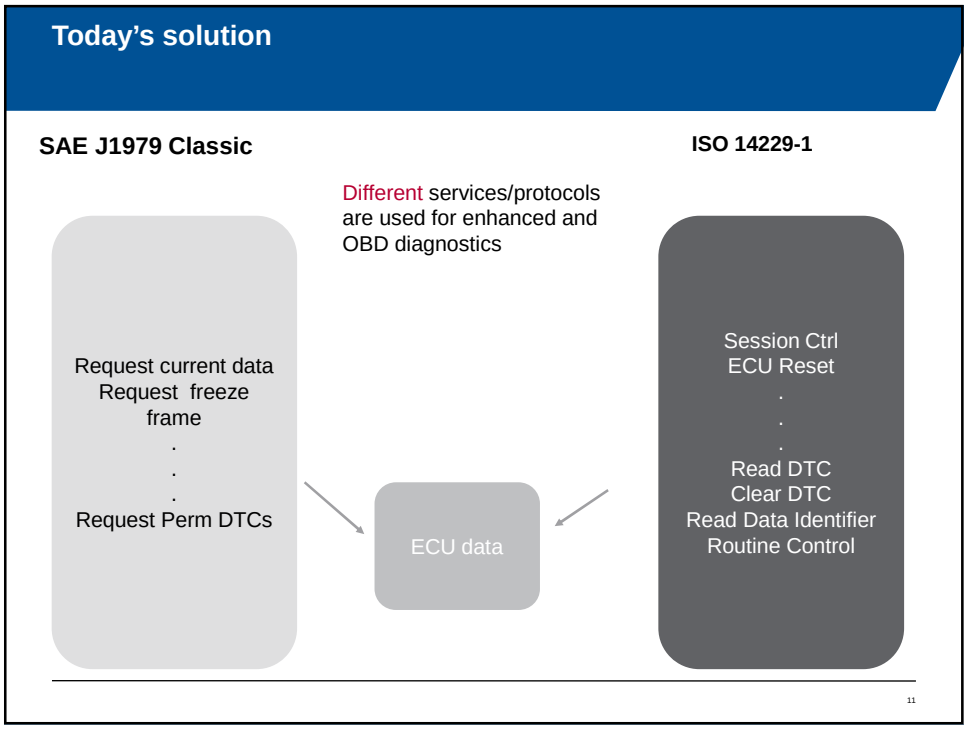
Today's solution
SAE J1979 Classic
ISO 14229-1
Different services/protocols are used for enhanced and OBD diagnostics
Request current data
Request freeze frame
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.
.
Request Perm DTCs
ECU data
Session Ctrl
ECU Reset
.
.
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Read DTC
Clear DTC
Read Data Identifier
Routine Control
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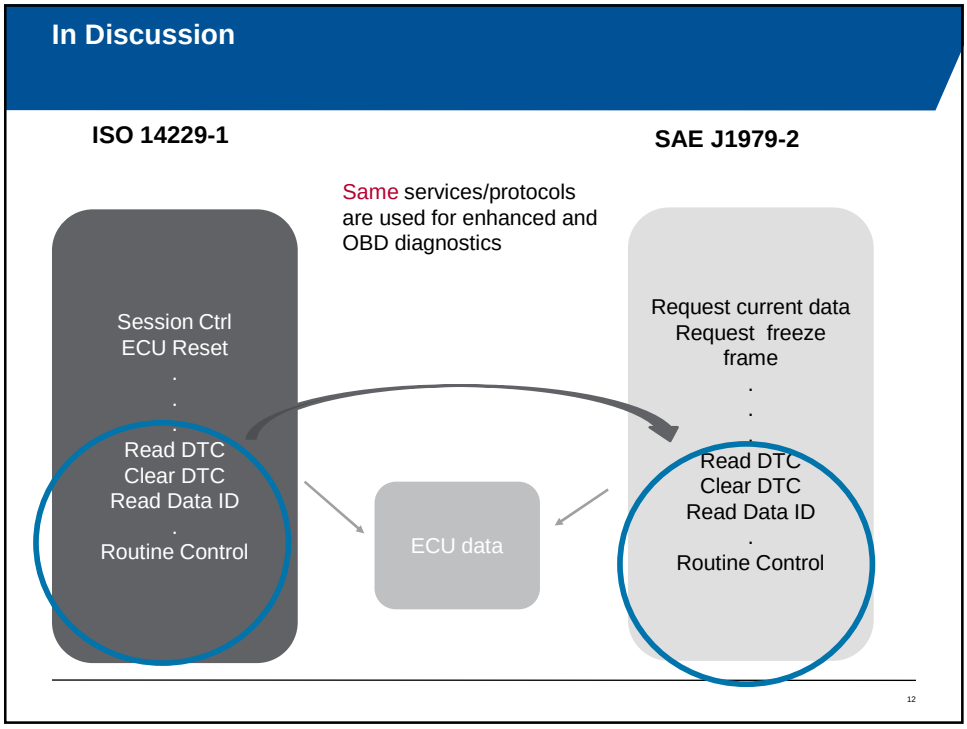
In Discussion
ISO 14229-1
SAE J1979-2
Same services/protocols are used for enhanced and OBD diagnostics
Session Ctrl
ECU Reset
.
.
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Read DTC
Clear DTC
Read Data ID
.
Routine Control
ECU data
Request current data
Request freeze frame
.
.
.
Read DTC
Clear DTC
Read Data ID
.
Routine Control
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Overview of Service-Mapping (in Discussion)

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**	reportWWHOBDDTCWithPermanent Status
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

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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-UDS ID
PID	0x01	0x00-0xFF	0xF400-0xF5FF
MID	0x06	0x00-0xFF	0xF600-0xF7FF
InfoType	0x09	0x00-0xFF	0xF800-0xF8FF

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Data - Changes in J1979 DA – New Data

- **Vehicle Operation Data**
  - Engine Run/Idle Time
  - Distance/Fuel Used
  - Positive Kinetic Energy/Engine output Energy
  - Propulsion System Active
- **PHEV Data**
  - Distance Traveled
  - Fuel Used
  - Grid Energy Used
- **Active Aero Features**
- **Off-Cycle Credit Technology**
- **Heavy Duty GHG and Nox Binning**
- **Extended Data Items – Still in discussion (mostly battery and EV-related)**

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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

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Status Bits

Bit 0 => This Bit is “Test Failed”. This bit is set to 1 if the fault is active. It is set to 0 if the fault is passive or sporadic.

Bit 1 => This Bit is “Test Failed This Operation Cycle”. This bit is set to 1 if the fault has occurred anytime during the current operation cycle.

Bit 2 => This Bit is for a “Pending DTC”. This bit is set to 1 if the fault is pending. Pending DTCs become active only if they reoccur a certain number of times in a certain number of drive cycles. The number of reoccurrences and the number of drive cycles depends on the fault.

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Status Bits

Bit 3 => This Bit is “Confirmed DTC”. This bit is set to 1 if the fault is active and matured. This bit indicates that the fault has been continuously active for a specific monitoring routine and is matured enough in the current operation cycle so that it can be said confirmed.

Bit 4 => This Bit is “Test Not Completed Since Last Clear”. This bit is set to 1 if the monitoring routine for this fault has not completed since the last time the DTCs were cleared.

Bit 5 => This Bit is “Test Failed Since Last Clear”. This is set to 1 if the monitoring routine has reported that test has failed in any operation cycle at least once after clearing the DTC action is performed.

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Status Bits

Bit 6 => This Bit is “Test Not Completed This Operation Cycle”. This bit is set to 1 if the monitoring routine has not run during the current operation cycle.

Bit 7 => This Bit is “Warning Indicator Requested/MIL on”. This bit is set to 1 if the MIL light is turned on.

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Readiness Groups

Readiness Group Identifier (RGID)

Byte Value	Description
0x00	No Readiness Group
0x01	Catalyst Monitor
0x02	Heated Catalyst Monitor
0x03	Misfire Monitor
0x04	Evaporative System Monitoring
0x05	Secondary Air System Monitoring
0x06	Fuel System Monitoring
0x07	Exhaust Gas Sensor Monitoring
0x08	Exhaust Gas Recirculation (EGR) System Monitoring
0x09	Positive/Crankcase Ventilation (PCV) System Monitoring
0x0A	Engine Cooling System Monitoring
0x0B	Cold Start Emission Reduction Strategy Monitoring

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Readiness Groups

0x0C	Variable Valve Timing, Lift, and/or Control (VVT) System Monitoring
0x0D	Direct Ozone Reduction (DOR) System Monitoring
0x0E	Comprehensive Component Monitoring
0x0F	Other Emission Control or Source System Monitoring
0x10	Non-Methane Hydrocarbon (NMHC) Converting Catalyst Monitoring
0x11	Oxides of Nitrogen (NOx) Converting Catalyst Monitoring
0x12	Boost Pressure Control System Monitoring
0x13	NOx Adsorber Monitoring
0x14	Particulate Matter (PM) Filter Monitoring
0x15-0xFF	Reserved

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What effect will it have?

- **OEMs will need to:**
  - Update current UDS implementations or,
  - Implement UDS services via J1979-2
- **Tool vendors will be most affected**
  - Need to support new services and data
  - Need to be able to display information in a logical manner
  - J1978 (J1979 equivalent for tools) will be updated to reflect changes to J1979
    - Meetings to begin 2Q 2022
- **Technicians will have new and different data for use in diagnosis**
  - More PIDs
  - More vehicle data
  - Updated readiness groups
  - Updated DTC information

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Thank You!!

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