

Comparison of Automotive and J1939 Diagnostics

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Agenda

- ❑ Diagnostics Legislation
- ❑ Diagnostic Standards
- ❑ Terminology
- ❑ Protocol Overview
- ❑ Fault Codes
- ❑ Sharing Diagnostic Data (ODX)
- ❑ Coverage of Diagnostics in Vector Tools

Vehicle Classifications

Vehicles divided into 8 classes based on Gross Vehicle Weight Rating

- ❑ Passenger Cars
- ❑ Classes 1 – 3 = Light Duty Vehicles (up to 14,000 lbs.)
- ❑ Classes 4 – 7 = Medium Duty Vehicles (14,001 – 33,000 lbs.)
- ❑ Class 8 = Heavy Duty Vehicles (Over 33,000 lbs.)

Typical groupings for CARB & EPA diagnostic legislation:

- ❑ Passenger Car & Light Duty Vehicles
- ❑ Medium & Heavy Duty Vehicles

Legislative Considerations

US – California Air Resources Board (CARB)

- ❑ CARB California Code of Regulations (CCR) 1968.1, (Vehicles < 14000 lbs.)
- ❑ CARB CCR 1968.2, (Vehicles < 14000 lbs.)
- ❑ CARB CCR 1971, Engine Manufacturer Diagnostics (EMD), (Vehicles > 14000 lbs.)
- ❑ CARB CCR 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD-OBD)

US – Environmental Protection Agency (EPA)

- ❑ EPA, Title 40, CFR 86.8005-4, Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Modification of Federal On-Board Diagnostic Regulations for: Light-Duty Vehicles, Light-Duty Trucks, Medium Duty Passenger Vehicles, Complete Heavy Duty Vehicles and Engines Intended for Use in Heavy Duty Vehicles Weighing 14,000 Pounds GVWR or Less (December, 2005)
- ❑ EPA, Title 40, CFR 86.005-17, (engines - 8500 to 14000 lbs.)
- ❑ EPA, Title 40, CFR 86.1806-05, (vehicles - 8500 to 14000 lbs.)

EU – European Commission (EC)

- ❑ EU (Directive 98/69/EC as amended by 99/102/EC, 2001/1/EC, 2001/100/EC and 2002/80/EC) (Vehicles <7600 lbs.)
- ❑ EU (July 2003 Planned Audit to Directive 88/77/EEC) (Vehicles > 7600 lbs.)
- ❑ Directive 2005/55/EC of the European Parliament and of the Council of 28 September 2005 as implemented by Commission Directive 2005/78/EC and amended by Commission Directive 2006/51/EC.

Diagnostic Standards

Typical Diagnostic Standards: Car/Truck – SAE/ISO

Current Standards:

	SAE	ISO	Manf Specific
Pass Car & LD Veh (KWP & UDS)	J1930 J1962 J1978 J1979 J2012 J2186 J2284 J2411 J2534	ISO11898 (5 parts) ISO15765(4 parts) ISO14230 (4 parts) ISO14229 (1 part) ISO15031 (7 parts) ISO22901 (2 parts)	Several
MD & HD Veh (J1939)	J1939 (12 parts) J2403	N/A	Several

In some cases multiple standards will be mixed on the same vehicle

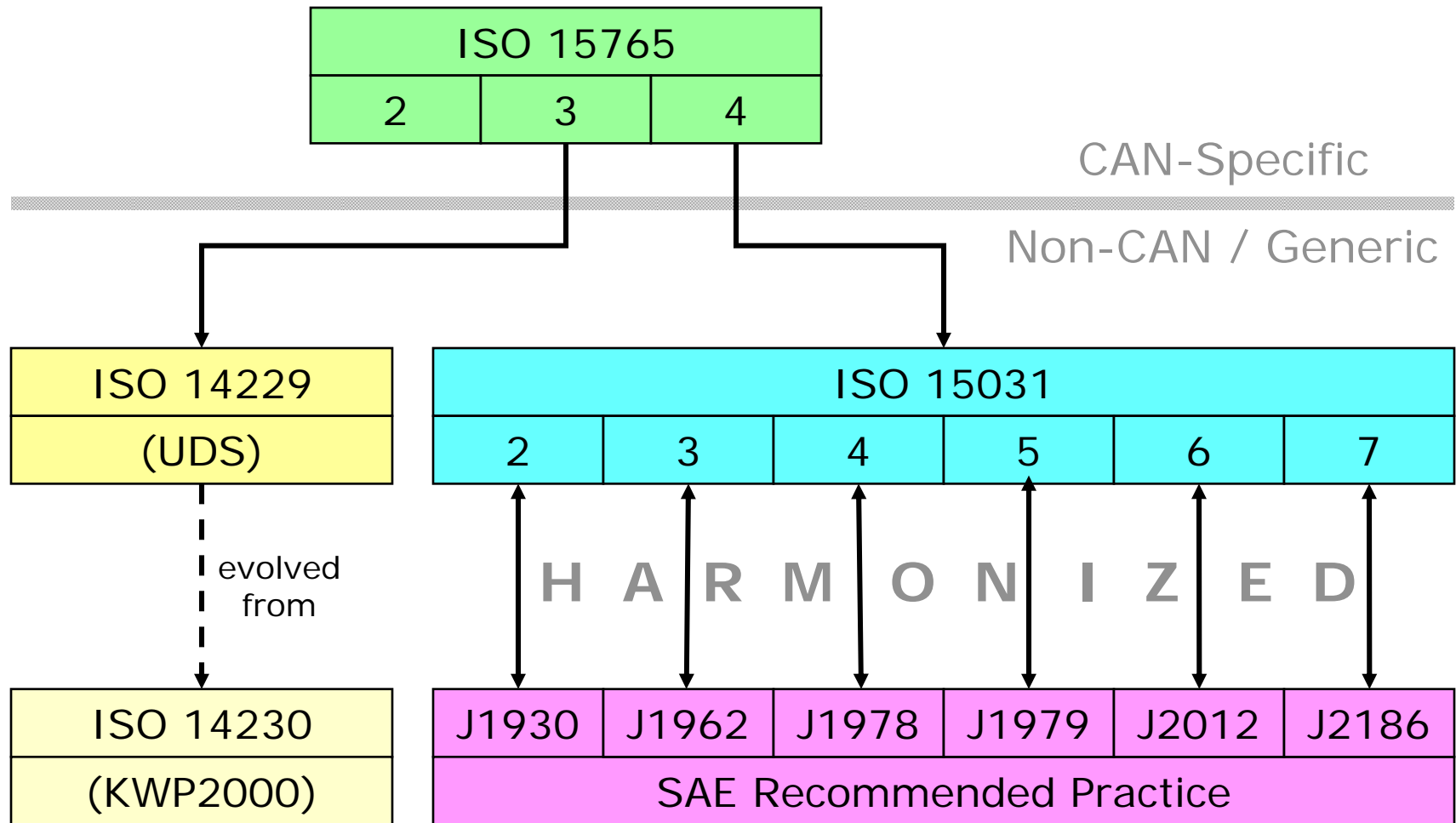
Diagnostic Standards: Past – Present - Future

	Pass Car & LD Veh	MD & HD Veh
Past	ISO9141 J1850	J1708 J1587
Present	J1930 J1962 J1978 J1979 J2012 J2186 J2284 J2411 J2534 ISO11898 ISO15765 ISO14230 ISO14229 ISO15031 ISO22901	J1939 J2403
Future	ISO27145 (WWH OBD) ??	J1939 ?? ISO27145 (WWH OBD) ??

Apples to Apples

OSI Layer		MD & HD Standards & OBD Legislated	Pass Car & LD Standards	Pass Car & LD OBD Legislated
N/A	Diagnostic Connector	SAE J1939-13	ISO 15765-3 ISO 14229-1	ISO 15031-3
7	Application	SAE J1939-71/73 SAE J1939-81	ISO 15765-3	ISO 15031-5 (SAE J1979)
6	Presentation		User Defined (GMW3110, GGDS, KWP2000, etc.)	ISO 15031-5 (SAE J1979)
5	Session		ISO 15765-3	
4	Transport Protocol		ISO 15765-2	ISO 15765-2
3	Network Layer	SAE J1939-31	ISO 15765-2	ISO 15765-4
2	Data Link	SAE J1939-21 (ISO 11898-1)	ISO 11898-1	ISO 15765-4 (ISO 11898-1)
1	Physical Layer	SAE J1939-11/15	User Defined (J2284, J2411, ISO11898-2/3, etc.)	ISO 15765-4 (ISO 11898-2)

Passenger Car Diagnostic Standard Reference Hierarchy



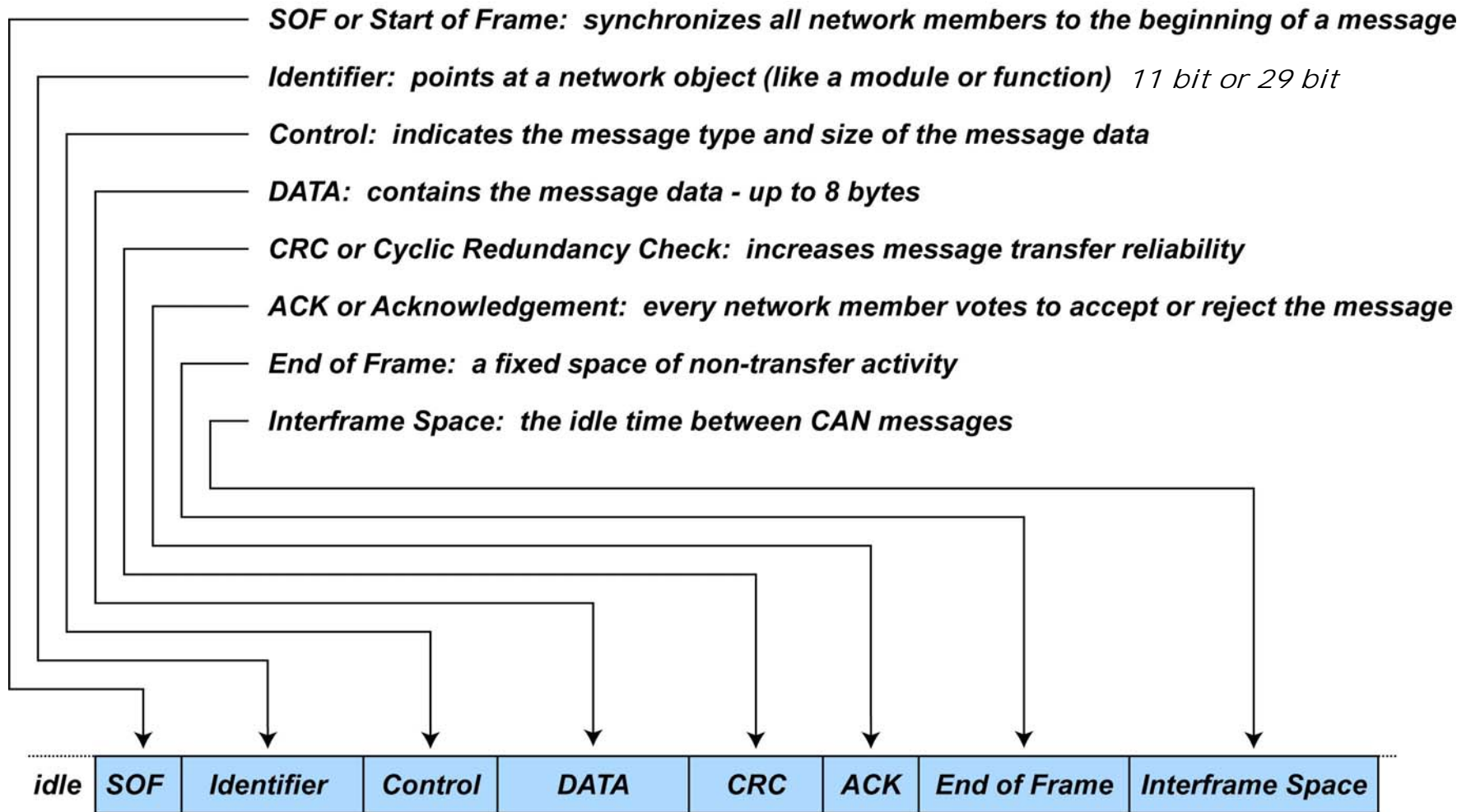
Terminology

Glossary of Terms (just scratching the surface)

J1939	KWP/UDS
ACL = Address Claiming BAM = Broadcast Announce Message DM = Diagnostic Message DP = Data Page DTC = Diagnostic Trouble Code ECU = Electronic Control Unit EDP = Extended Data Page FMI = Failure Mode Identifier NACK = Negative Acknowledgement PDU = Protocol Data Unit PG = Parameter Group PGN = Parameter Group Number SLOT = Scaling, Limit, Offset & Transfer function SPN = Suspect Parameter Number	DID = Data ID DTC = Diagnostic Trouble Code FTB = Failure Type Byte (UDS only) KWP = Key Word Protocol (ISO14230) LID = Local ID (similar to DID) NRC = Negative Response Code SID = Service ID UDS = Unified Diagnostic Services (ISO14229)

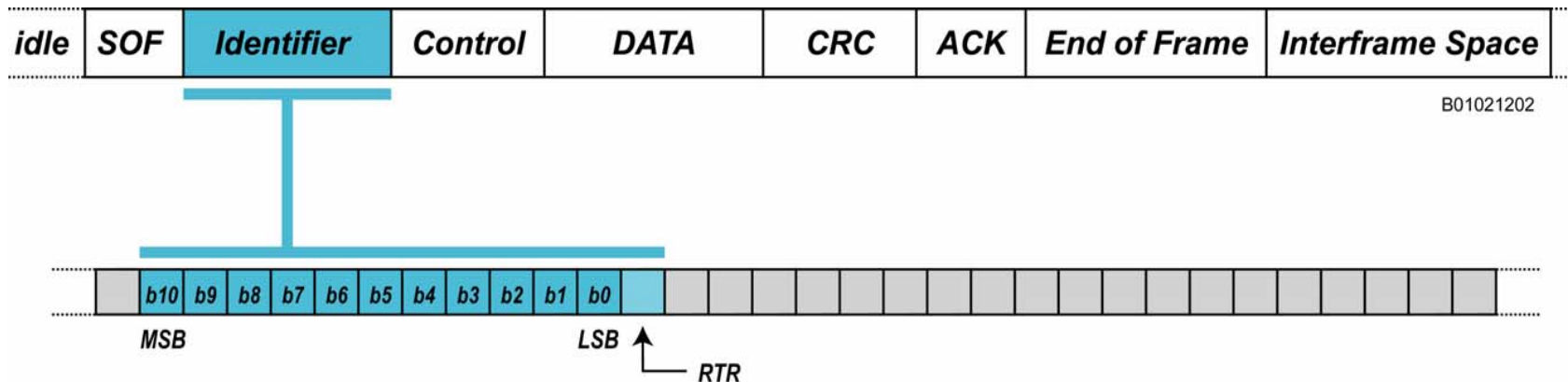
Protocol Overview

CAN Message Structure



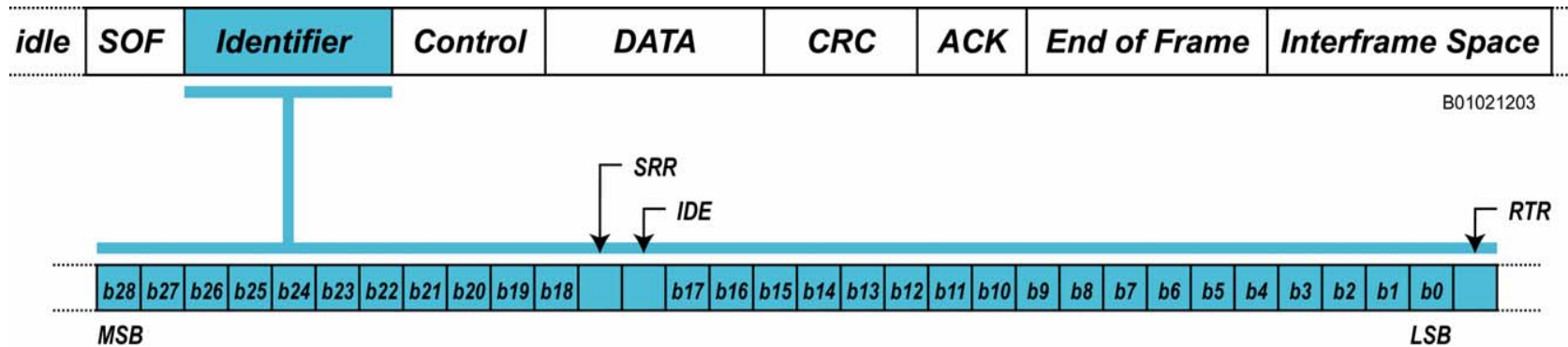
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Standard CAN Format: 11-Bit Identifier



- Typically usage for diagnostics: ECU Identification
 - Target ECU ID or Functional Request ID for diagnostic requests (source address not required since KWP & UDS only allow one diagnostic tester on the bus at one time)
 - Source ECU ID for diagnostic responses
 - Most OEMs have their own ID assignment standards

J1939 Extended CAN Format: 29-Bit Identifier

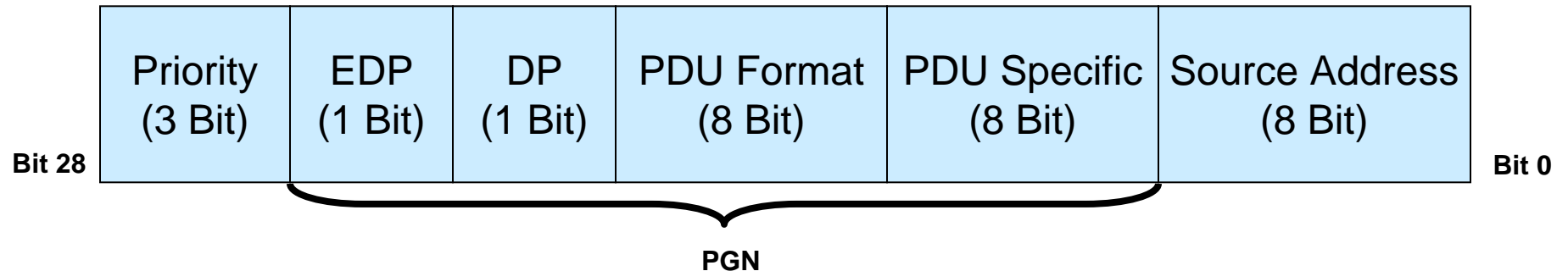


❑ Three Components – as defined by J1939:

- ❑ Message Priority
- ❑ Parameter Group Number (Used in J1939 to identify the type of data in the DATA area)
- ❑ Source Address

CAN Identifiers and the J1939 Parameter Group Number (PGN)

□ Interpretation of 29 Bit CAN Extended Identifier in J1939



- PDU Format < 0xF0 defines message as Peer-to-Peer. PDU Specific will be a Destination Address
- PDU Format => 0xF0 identifies message as broadcast. PDU Specific will be a Group Extension

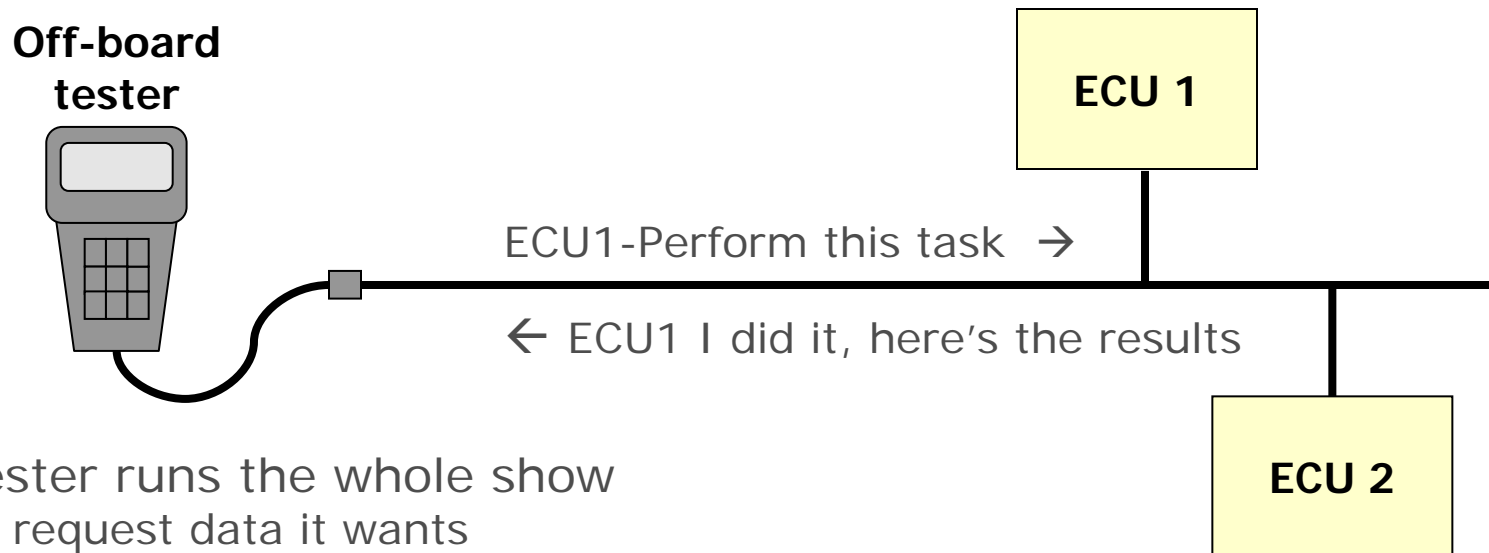
Typical Pass Car/LD Diagnostic Communication Model

Two possible diagnostic standards

- ❑ ISO14229 (UDS)
- ❑ ISO14230 (KWP)

The ECU only speaks when spoken to

- ❑ Listens for requests from tester
- ❑ Provides diagnostic data only on request
- ❑ Never sends a diagnostic request
- ❑ After assembly may never be used again



The tester runs the whole show

- ❑ Must request data it wants
- ❑ Must know ID of ECU to get data from
- ❑ ECUs provide data requested
- ❑ Does not listen to normal bus traffic

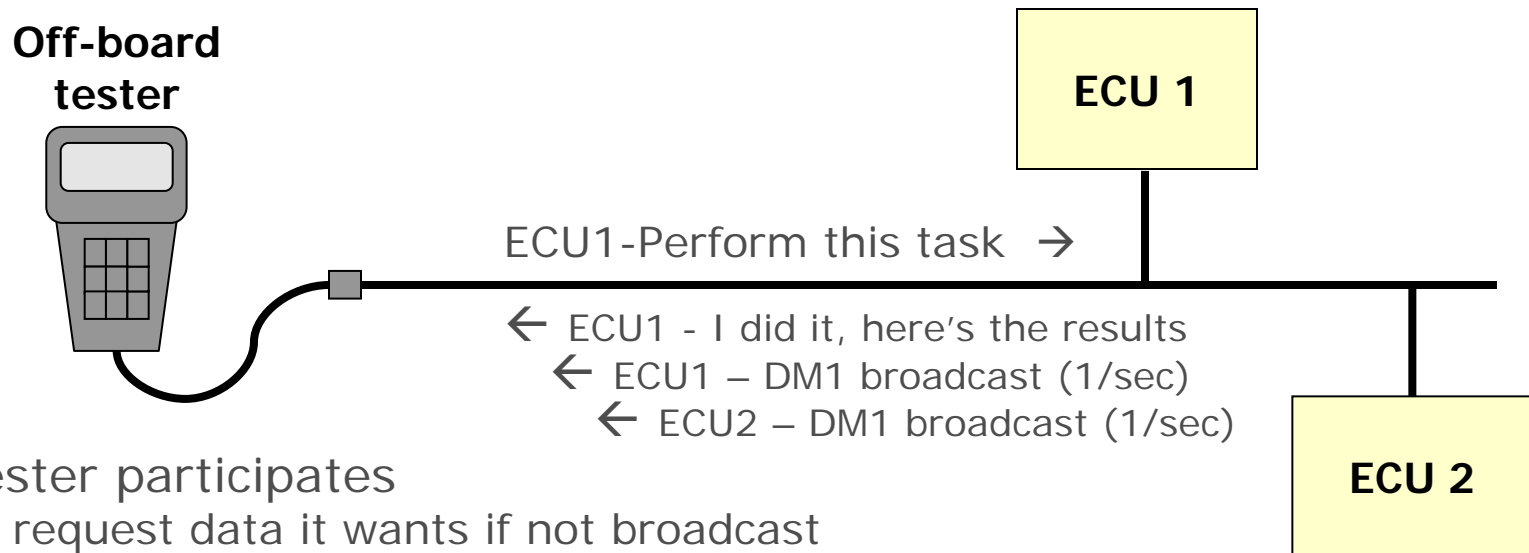
J1939 Diagnostic Communication Model

One diagnostic standard

- ❑ J1939

The ECU will broadcast information & respond upon receiving a request

- ❑ Listens for requests from tester
- ❑ Provides diagnostic data periodically (DM1)
- ❑ May send a diagnostic request



The tester participates

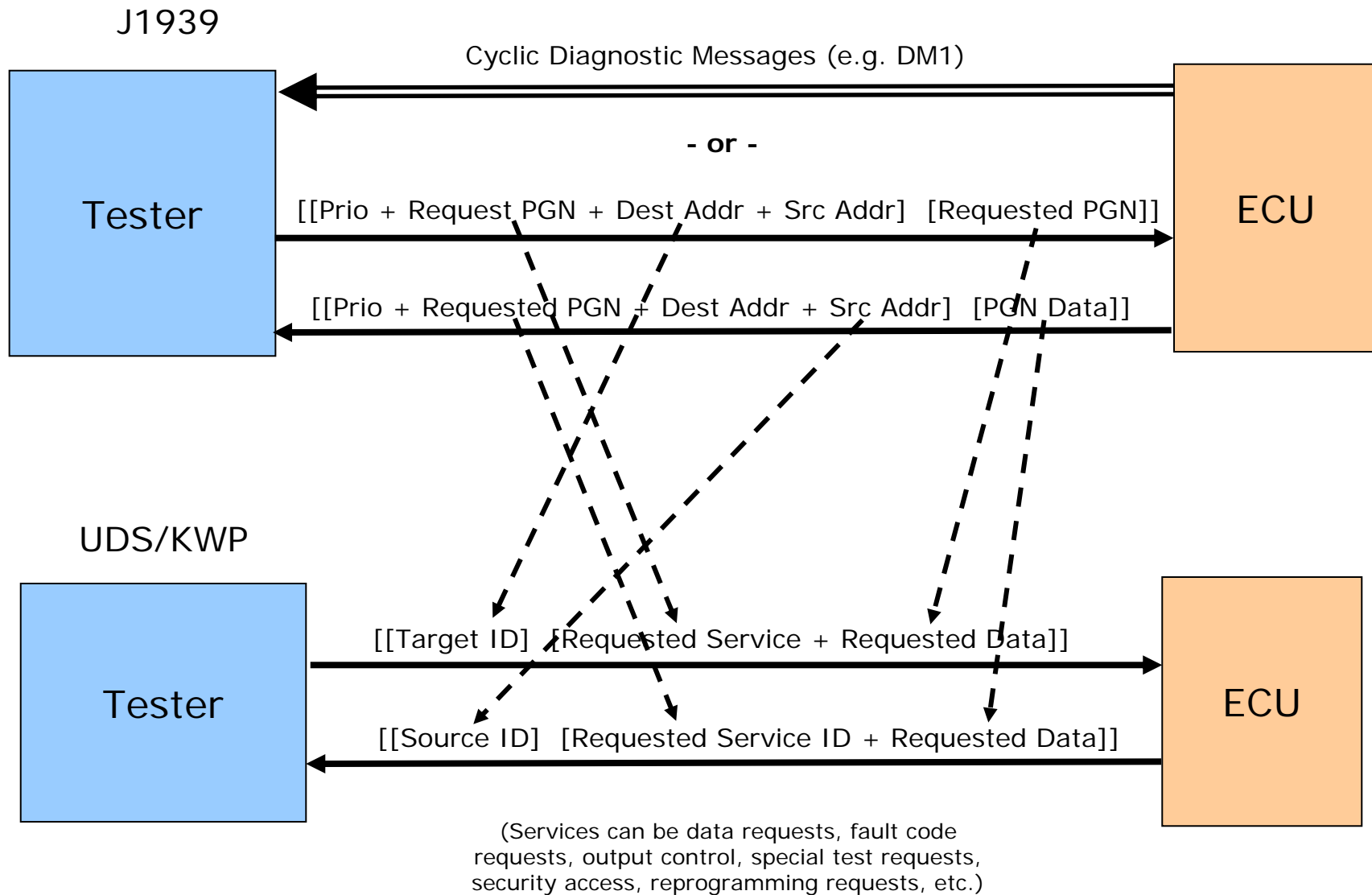
- ❑ Must request data it wants if not broadcast
- ❑ Must know ID of ECU to get data from
- ❑ ECUs provide data requested
- ❑ May listen for broadcast messages (e.g. DM1)

Addressing Scheme

ECU Addressing

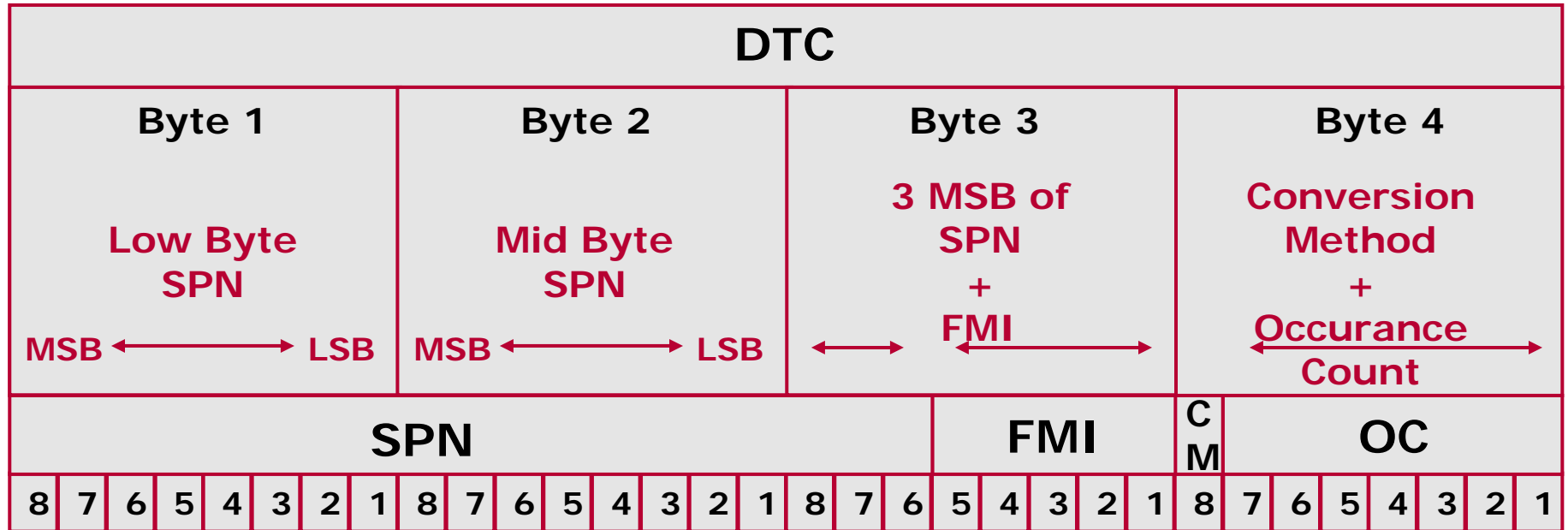
- ❑ Can use either 11-bit or 29-bit
- ❑ Most car applications use 11-bit
 - ❑ Each ECU has three CAN addresses for diagnostics
 - ❑ One for physical requests from tester
 - ❑ One for functional requests from tester (similar to broadcast request)
 - ❑ One for responses to tester
- ❑ The tester has to know the address for every ECU or send a Functional Request
- ❑ Most truck applications use J1939 29 bit IDs for diagnostics
 - ❑ Each ECU has one unique address for all messaging
 - ❑ The same address for source and destination
 - ❑ Two reserved addresses
 - ❑ Null (0xFE)
 - ❑ Global (0xFF)

UDS/KWP Message Compared to J1939 Message



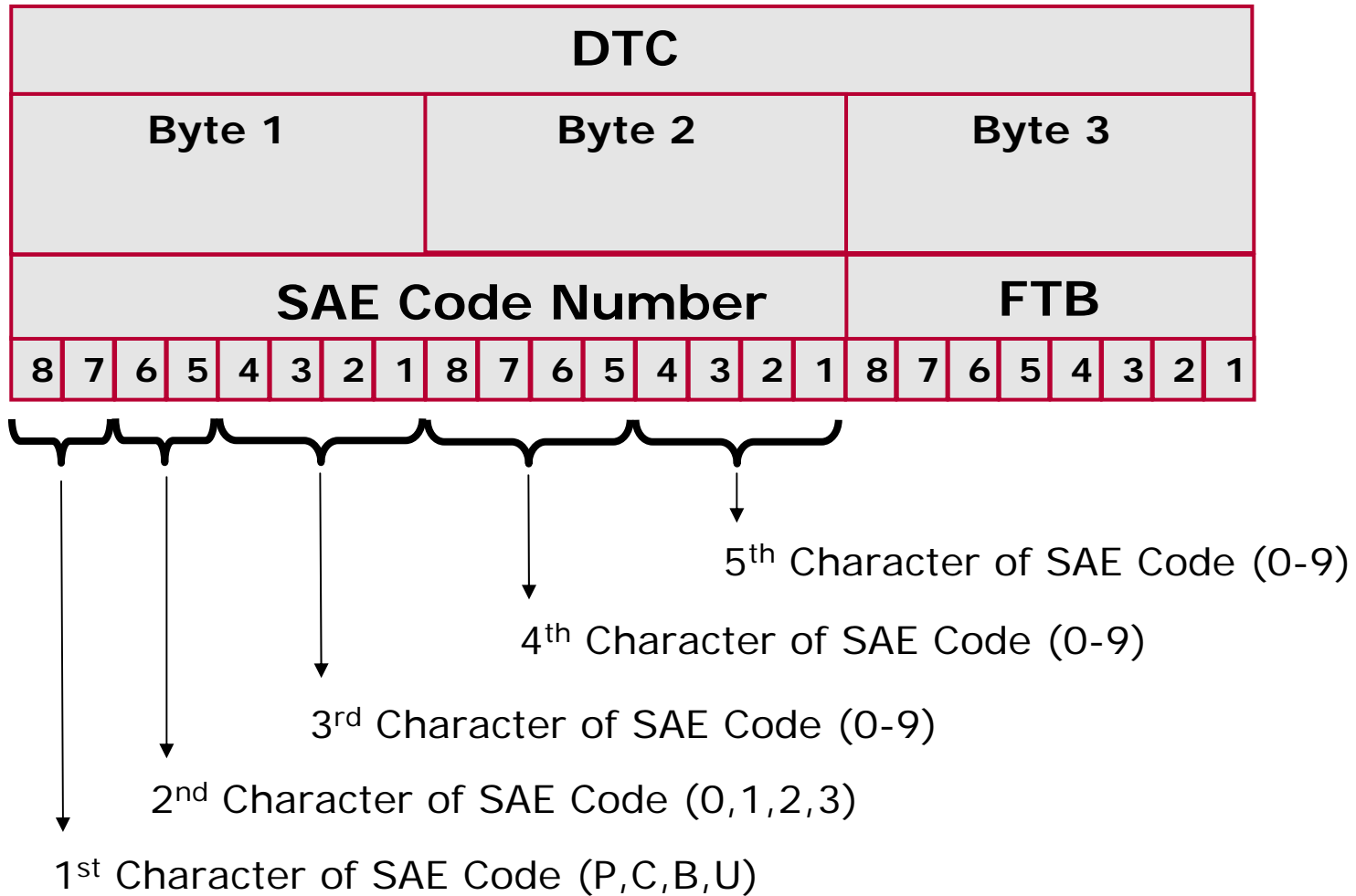
Fault Codes

J1939 Diagnostic Trouble Code



Conversion Method Bit Affects the Interpretation of the Byte Ordering of the SPN (0 since 1996)

ISO14229 (UDS) Diagnostic Trouble Code



Sharing Diagnostic Data (ODX)

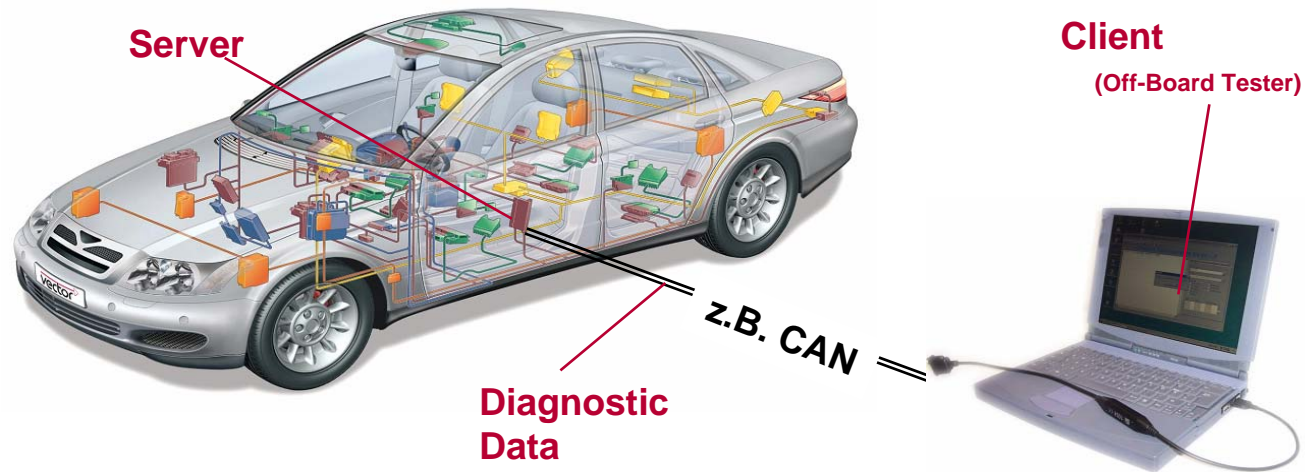
What is ODX?

Open Diagnostic data eXchange

What is ODX?

- ❑ Data format for exchange of diagnostic data
- ❑ Development within ASAM & will be an ISO standard
 - ❑ Jointly developed with ISO (International Standards Organization) – ISO22901-1
- ❑ ASAM = Association for Standardisation of Automation and Measuring Systems

Practical Application



Required Information

- ❑ Which ECUs? Access?
- ❑ Communication parameters?
- ❑ Which services are available?
- ❑ How are functions distributed across ECUs?
- ❑ How to change ECU configuration options?
- ❑ What data to flash to ECU?
- ❑ What jobs require simultaneous communication with multiple ECUs?

ODX

- ❑ VEHICLE-INFO-SPEC
- ❑ COMPARAM-SPEC
- ❑ DIAG-LAYER-CONTAINER
- ❑ FUNCTION-DICTIONARY
- ❑ ECU-CONFIG
- ❑ FLASH
- ❑ MULTIPLE-ECU-JOB-SPEC

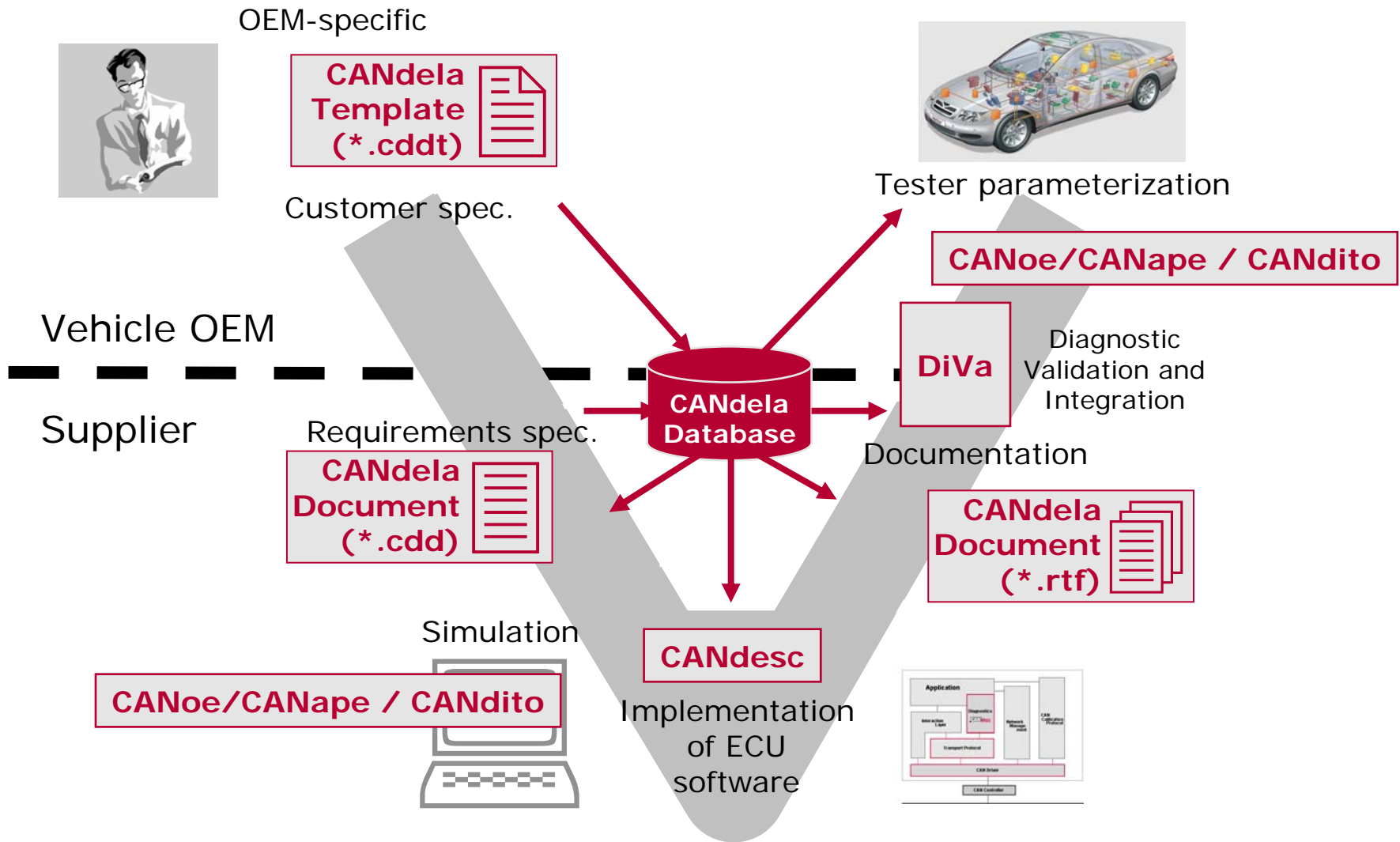
Application of ODX in Truck Development & Other Industries

- ❑ ODX was primarily developed for automotive diagnostic data exchange (UDS & KWP protocols)
 - ❑ These protocols are strictly request – response based
 - ❑ Data is not standardized (other than emissions related)
- ❑ Some interest exhibited to use ODX for J1939 diagnostic documentation
 - ❑ Many J1939 diagnostic messages are cyclic
 - ❑ Many require the use of the request PGN
 - ❑ The requested message is like the service ID in UDS or KWP
 - ❑ The PGN in the response is like the echoed service ID in UDS or KWP
- ❑ As more equipment becomes “CAN Connected” how will companies exchange diagnostic data efficiently?
 - ❑ Continued addition of standardized messages?
 - ❑ Mixed data buses (J1939 + UDS/KWP)?
- ❑ WWH OBD efforts focusing on UDS-like diagnostics

Diagnostics in Vector Tools

CANdela Diagnostic Process – for KWP & UDS

Unified Diagnostic Process with CANdela



Diagnostic Process – for J1939

J1939 Options for Several Tools



Industry General/OEM Specific



J1939
Template
(* .dbc)

Customer spec.

Tester parameterization

CANalyzer/CANoe/CANape

Vehicle OEM

Network
Database

CANoe

Diagnostic
Validation and
Integration

Supplier

Requirements spec.

ECU Messages
(* .dbc)

Documentation

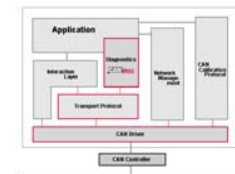
Network
Objects
(* .csv)

Simulation

GENy

Implementation
of ECU
software

CANoe



Summary

Summary of Some Major Diagnostic Differences

J1939 (MD & HD Truck)	Pass Car & LD Vehicles
All standards defined in J1939 parts	Many standards (primarily ISO14230, ISO14229 & ISO15031)
29 bit identifiers	Mostly 11 bit identifiers
Some messages broadcast regularly	No broadcast messages
Type of data in message defined within 29 bit identifier (PGN)	All information about data is in the data payload of the message
Many industry standard device names	Device names OEM dependent
Many parameters industry defined	Only emissions parameters standardized
Peer-to-Peer & broadcast requests	Same (physical / functional addressing)
4 byte fault codes	KWP = 2 byte, UDS = 3 byte fault codes
Four warning lamps defined	One warning lamp defined
Nine pin diag connector standard (J1939-13)	Sixteen pin diag connector standard (ISO15031-3 /J1962)

Thank you for your attention.

For detailed information about Vector
and our products please have a look at:

www.vector-cantech.com

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