Unified Diagnostic Services (UDS) – ISO 14229

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UDS and OBD Positioning in the ISO/OSI Layer Model

International Standard Organization's Open System Interconnect 7 Layer Communication Model

Layer	Description	Standards for UDS	Standards for OBD
"8"	Diagnostic Application	User	ISO 15031-5
7	Application Layer	ISO 14229-1 / ISO 15765-3	ISO 15031-5
6	Presentation Layer	Not applicable	Not applicable
5	Session Layer	Not applicable	Not applicable
4	Transport layer	ISO 15765-2	Not applicable
3	Network Layer	ISO 15765-4	ISO 15765-4
2	Data Link Layer	ISO 11898-1	ISO 15765-4
1	Physical Layer	ISO 11898-2 / ISO 11898-3	ISO 15765-4

*) The bus physics used is to be selected by the user. Therefore, several standards for different physical layer for e.g. High-Speed- (ISO 11898-2) or Fault-Tolerant-CAN (ISO 11898-3) can be used

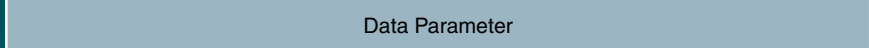## Diagnostic Messages - Structures and Types
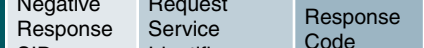
Request without Sub-Function or Positive Response: Service Identifier | Data Parameter

Requests with Sub-Function Byte: Service Identifier | Sub-Function Byte | Data Parameter

UUDT-Responses: Data Parameter

Negative Responses: Negative Response SID | Request Service Identifier | Response Code

The Sub-Function Byte of UDS

Services without Sub-Function-Byte: $84, $23, $24, $2A, $2E, $3D, $14, $2F, $34, $35, $37

Suppress Positive Response Message Indication Bit

Bit 7 | Sub-Function (Bit 6 to 0) — Services with Sub-Function Byte: $10, $11, $27, $28, $3E, $83, $85, $87, $2C, $19, $31

Bit 7, Bit 6 | Sub-Function (Bit 5 to 0) — Services with Sub-Function Byte and Storage State Parameter : $86

Storage State

Bit 7: suppressPosRspMsgIndicationBit
This Bit defines whether a positive response of the ECU is wanted
0' = FALSE: the ECU shall send a response, that is, no suppression of a positive response shall be done
1' = TRUE: Suppression of the positive response, that is, the ECU must not send a positive response
Negative responses shall be send by the ECU independent of this bit

Bit 6 to 0: sub-function parameter value
The Bits 0 to 6 contain the value for a Sub-Function parameter for diagnostic services

Remark:
A service, which uses the suppressPosRspMsgIndicationBit only, shall set the value of the Sub-Function parameter to to 0 to support the sending of the bit 7
The Bits 0 to 6 are meaningless then

Periodic Message Types of UDS

Responses in a CAN data field according to ISO 15765-3

Unacknowledged Segmented Data Transfer (USDT)

Type 1	PCI	Response Service Identifier	Periodic Data Identifier	Data (≤ 5 Byte in single frame)
Type 2	PCI	Periodic Data Identifier		Data (≤ 6 Byte in single frame)

Unacknowledged Unsegmented Data Transfer (UUDT)

Type 1	Response Service Identifier	Periodic Data Identifier	Data (≤ 6 Byte)
Type 2	Periodic Data Identifier		Data (≤ 7 Byte)

Responses can be of two different formats/types:
Type 1: with Response Service Identifier
Type 2: without Response Service Identifier
The type is respected by the Service $2A Read Data by Periodic Identifier

Service Overview

Functional Unit	SID	Available in Default Session	Available for RoE	Has Sub-Function	Service Name	Mnemonic
Diagnostic and Communication Management	$10	✓		✓	Diagnostic Session Control	DSC
	$11	✓		✓	ECU Reset	ER
	$27			✓	Security Access	SA
	$28			✓	Communication Control	CC
	$3E	✓		✓	Tester Present	TP
	$83			✓	Access Timing Parameter	ATP
	$84				Secured Data Transmission	SDT
	$85			✓	Control DTC Setting	CDTCS
	$86	✓		✓	Response On Event	ROE
	$87			✓	Link Control	LC
Data Transmission	$22	✓	✓		Read Data By Identifier	RDBI
	$23	✓			Read Memory By Address	RMBA
	$24	✓			Read Scaling Data By Identifier	RSDBI
	$2A	✓			Read Data By Periodic Identifier	RDBPI
	$2C	✓		✓	Dynamically Define Data Identifier	DDDI
	$2E	✓			Write Data By Identifier	WDBI
	$3D	✓			Write Memory By Address	WMBA
Stored Data Transmission	$14				Clear Diagnostic Information	CDTCI
	$19	✓	✓		Read DTC Information	RDTCI
Input Output Control	$2F				Input Output Control By Identifier	IOCBI
Remote Activation of Routine	$31	✓	✓		Routine Control	RC
Upload Download	$34				Request Download	RD
	$35				Request Upload	RU
	$36				Transfer Data	TD
	$37				Request Transfer Exit	RTE

Functional Units

Diagnostic and Communication Management
Services to manage the connection between testers and ECUs

Data Transmission
Services to transmit data from and to the ECU

Stored Data Transmission
Services to transmit stored data from the ECU to the Tester
Primarily, these data are error memory content and environment data

Input Output Control
Services to control output and read input devices of the ECU

Remote Activation of Routine
Function stored in the ECU can be triggered by these services

Upload & Download
These services serve to transport larger content of memory areas of ECUs to the Tester, but as well to the ECU send by the Tester

Common Response Codes

Hex	Mnemonic	Description
10	GR	General reject
11	SNS	Service not supported
12	SFNS	Sub-Function not supported
13	IMLOIF	Incorrect message length or invalid format
14	RTL	Response too long
21	BRR	Busy repeat request
22	CNC	Conditions not correct
24	RSE	Request sequence error
25	NRFSC	No response from sub-net component
26	FPEORA	Failure prevents execution of requested action
31	ROOR	Request out of range
33	SAD	Security access denied
35	IK	Invalid key
36	ENOA	Exceeded number of attempts
37	RTDNE	Required time delay not expired
38-4F	RBEDLSD	Reserved by Extended Data Link Security Document
70	UDNA	Upload/Download not accepted
71	TDS	Transfer data suspended
72	GPF	General programming failure
73	WBSC	Wrong Block Sequence Counter
78	RCRRP	Request correctly received, but response is pending
7E	SFNSIAS	Sub-Function not supported in active session
7F	SNSIAS	Service not supported in active session

All values not described are reserved for future definition
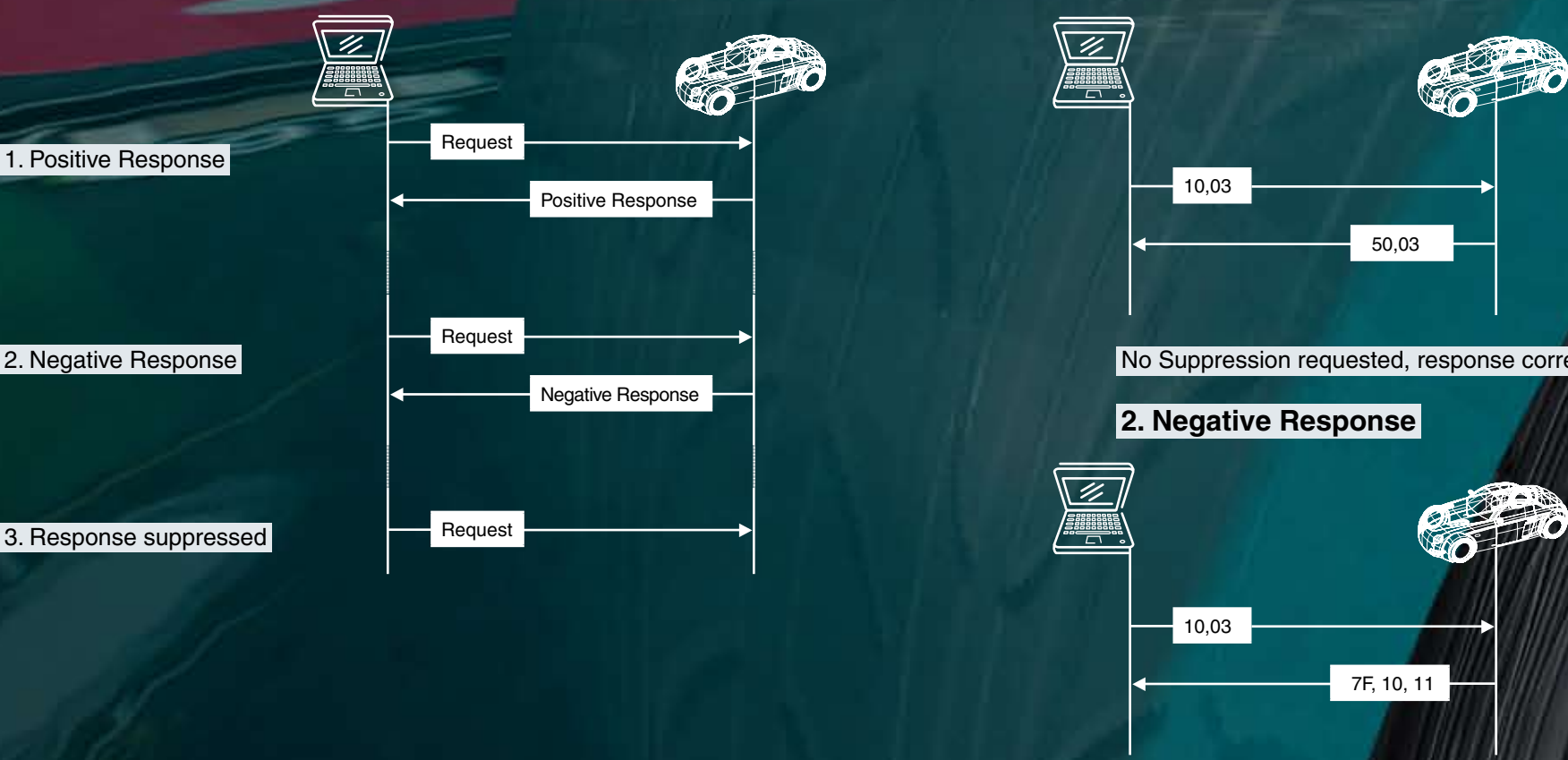
Specific conditions driven Response Codes

Hex	Mnemonic	Description
81	RPMTH	rpm too high
82	RPMTL	rpm too low
83	EIR	Engine is running
84	EINR	Engine is not running
85	ERTTL	Engine run-time too low
86	TEMPTH	Temperature too high
87	TEMPTL	Temperature too low
88	VSTH	Vehicle speed too high
89	VSTL	Vehicle speed too low
8A	TPTH	Throttle/Pedal too high
8B	TPTL	Throttle/Pedal too low
8C	TRNIN	Transmission range not in neutral
8D	TRNIG	Transmission range not in gear
8F	BSNC	Brake switch(es) not closed
90	SLNIP	Shifter lever not in park
91	TCCL	Torque converter clutch locked
92	VTH	Voltage too high
93	VTL	Voltage too low

All values not described are reserved for future definition

Error Memory Functions

1) Erase Error Memory ($14 Clear Diagnostic Information)
Parameter 1: Service ID = $14
Parameter 2: Diagnostic Trouble Code (DTC) with three byte length

2) Sub-Functions for Service $19 Read DTC Information

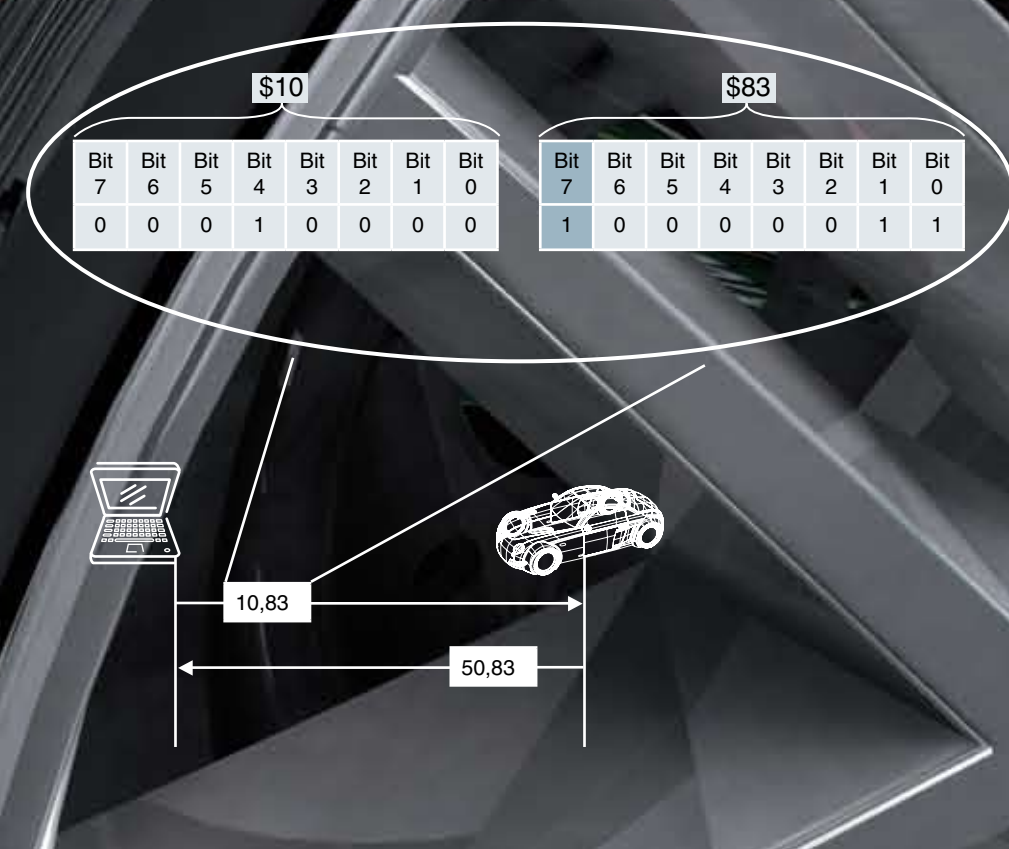| Hex	Description
01	Report number of DTC by Status Mask
02	Report DTC by Status Mask
03	Report DTC Snapshot Identification
04	Report DTC Snapshot Record by DTC number
05	Report DTC Snapshot Record by Record number
06	Report DTC Extended Data Record by DTC number
07	Report number of DTC by Severity Mask Record
08	Report DTC by Severity Mask Record
09	Report Severity Information of DTC
0A	Report Supported DTC
0B	Report First Test Failed DTC
0C	Report First Confirmed DTC
0D	Report Most Recent Test Failed DTC
0E	Report Most Recent Confirmed DTC
0F	Report Mirror Memory DTC by Status Mask
10	Report Mirror Memory DTC Extended Data Record by DTC number
11	Report number of Mirror Memory DTC by Status Mask
12	Report number of Emissions Related OBD DTC by Status Mask
13	Report Emissions Related OBD DTC by Status Mask
14	Report DTC Fault Detection Counter
15	Report DTC with Permanent Status

Simple/Polling Diagnostic Services

These services consist of one request and one response (max.) for physical addressing, or a group of responses for functional addressing

Three Potential Polling Communication Flows when using the Sub-Function Byte

1. Positive Response
2. Negative Response
3. Response suppressed

Erroneous Communication with Sub-Function Byte
Suppression requested (Bit 7 of Byte 2 is set to "1", but response is sent by the ECU)
No Suppression requested, response correctly sent by ECU

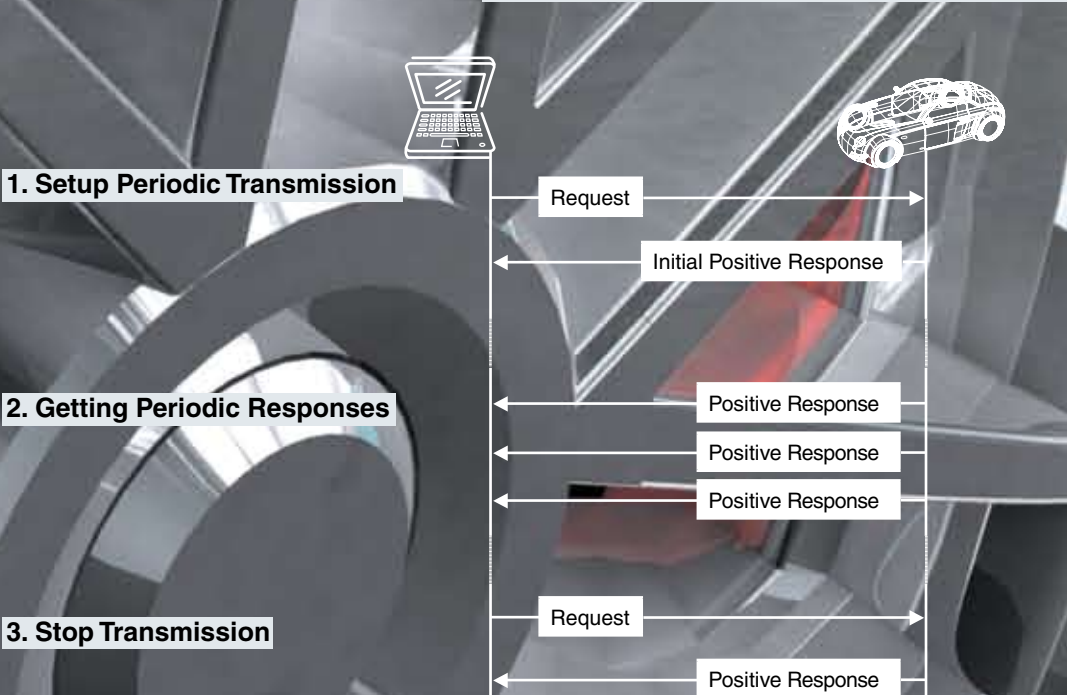## Periodic Service Execution (Service $2A)

For one Request follows one initial Response. After that, periodically more responses will follow. The sending can be stopped by using a simple diagnostic service

Service parameter "Transmission Mode"
The frequency of the data transmission can be configured using the the Transmission Mode. The UDS-Standard defines abstract values as:
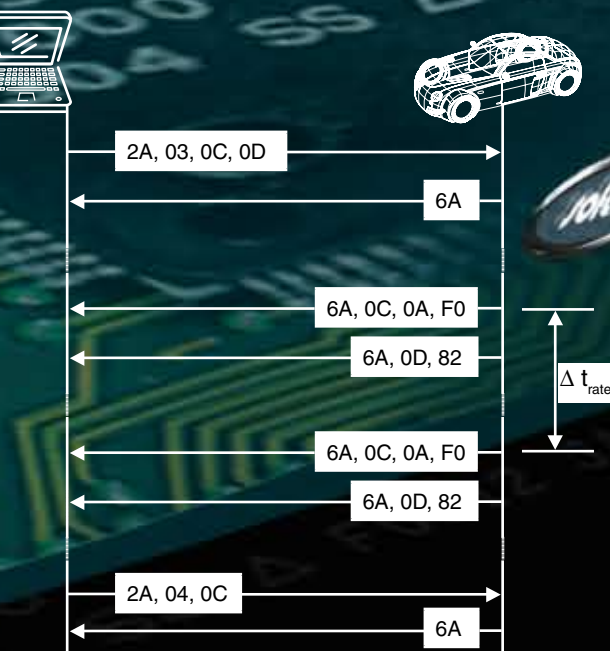Slow = $01
Medium = $02
Fast = $03
Stop sending = $04
The real values in Hertz for each frequency need to be defined between OEM and ECU supplier
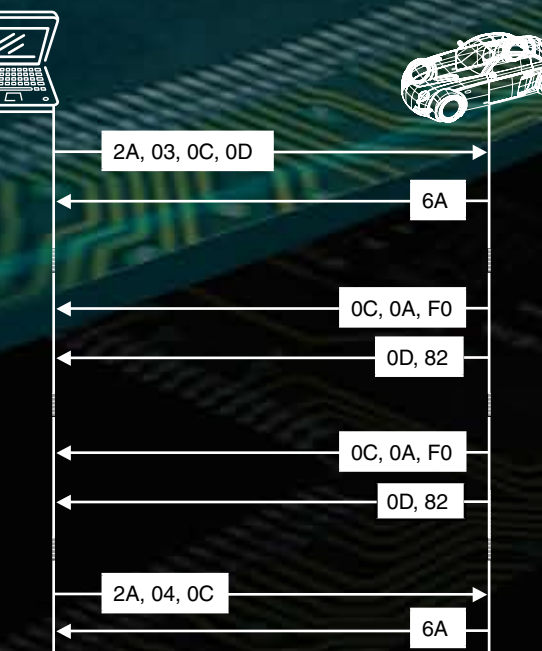
Generic Periodic Communication Flow
1. Setup Periodic Transmission
2. Getting Periodic Responses
3. Stop Transmission

Type 1 Communication Flow — A Response Service-ID is sent by the ECU
1. Setup Periodic Transmission for two Measurements ($0C, $0D)
2. Getting periodic Measurements
3. Stop Transmission of Measurement $0C only

Type 2 Communication Flow — NO Response Service-ID is sent by the ECU

UDS Response Handling

Specifics
- All services, which have a parameter "Sub-Function" support the "Response-Suppression-Handling".
- All services to read data do not support this feature
- A service, which uses the suppressPosRspMsgIndicationBit of the Sub-Function Byte only, must set the other bits of the Sub-Function Byte to 0, to support the transmission of the Bit 7
- SuppressPositiveResponseMsgIndicationBit = TRUE
  - Suppression of the positive response
  - All negative responses are send nevertheless
- For functional requests, some specific negative responses are always to be suppressed, independent of the value of the Suppress Positive Response Message Indication Bit:
  - Service not supported (NRC $11)
  - Subfunction not supported (NRC $12)

"Respond-to"-Services
- ReadDataByIdentifier ($22)
- ReadDTCInformation ($19)
- RoutineControl ($31)
- InputOutputControlByIdentifier ($2F)

Session Handling

Standardized values of Parameter "Diagnostic Session Type"
S01 Default Session
S02 Programming Session
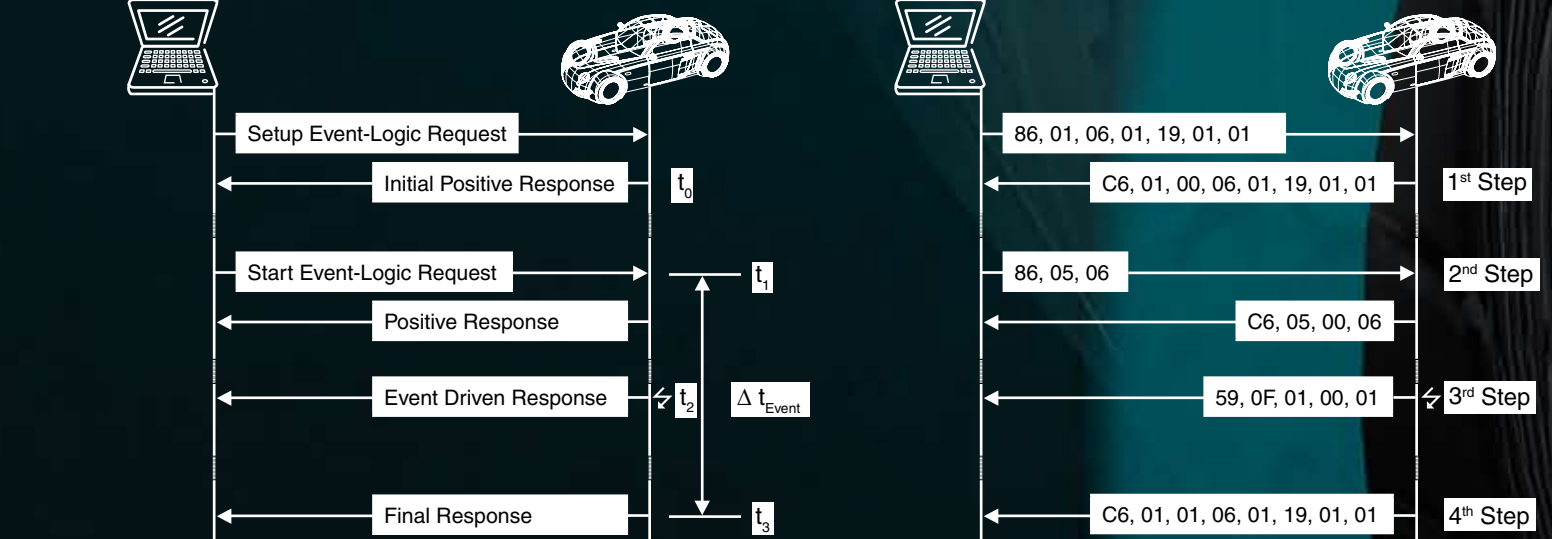S03 Extended Diagnostic Session
S04 Safety System Diagnostic Session

Response on Event – RoE (Service $86)

For one or two setup and start Requests one or two initial Responses are given, followed by 0 to n event-driven Responses depending on the number of occurrences of tracked events. The distance between several events is non-deterministic.
- The RoE mechanism can be activated in any Session, including the Default-Session.
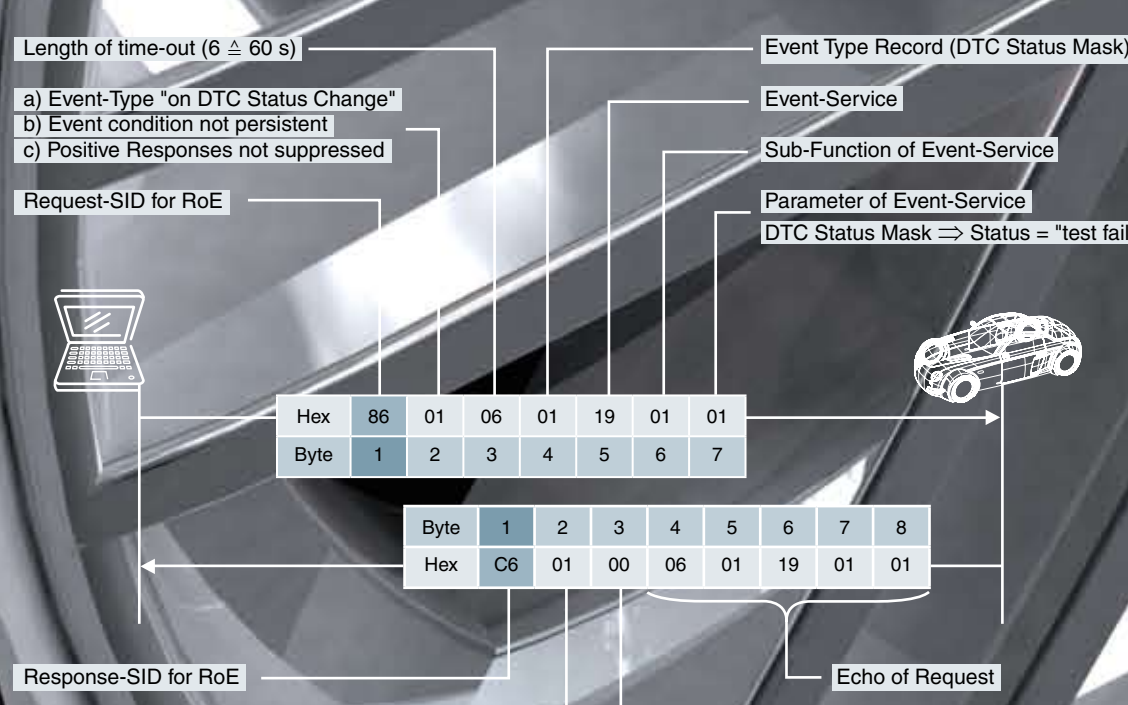- It does not need Tester Present messages to stay active
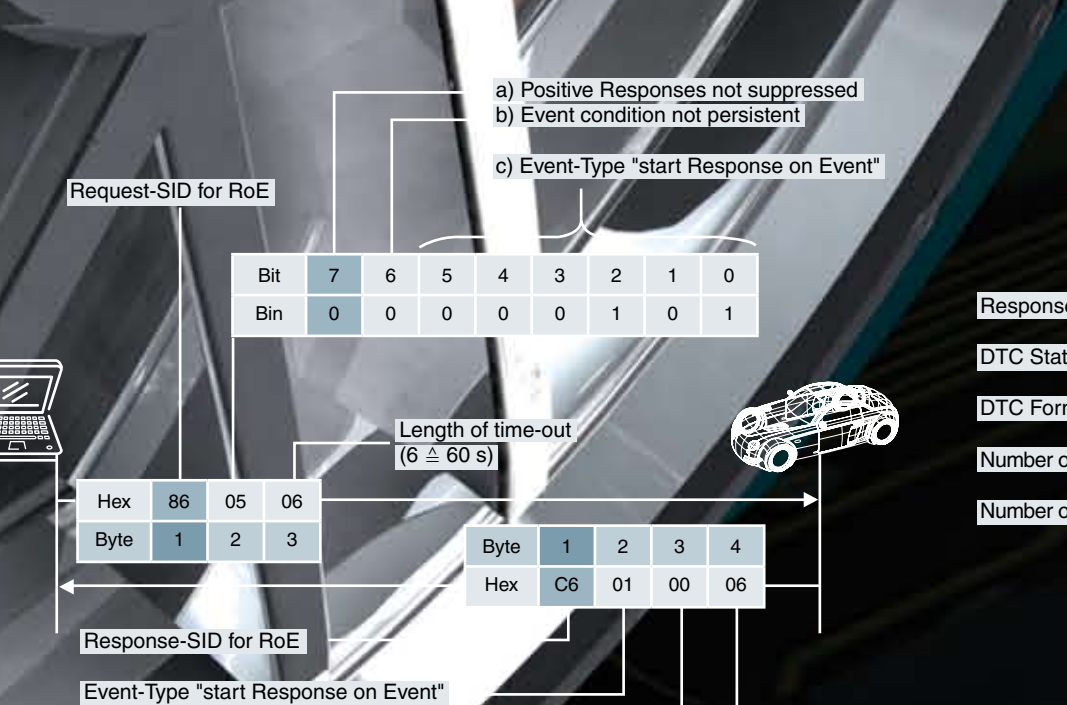
Generic Event-Driven Communication Flow
- Setup Event-Logic Request
- Initial Positive Response
- Start Event-Logic Request
- Positive Response
- Event Driven Response
- Final Response

Example: DTC Status Change Communication Flow
- 86, 01, 06, 01, 19, 01, 01 — 1st Step
- C6, 01, 00, 06, 01, 19, 01, 01
- 86, 05, 06 — 2nd Step
- C6, 05, 06
- 59, 0F, 01, 00, 01 — 3rd Step
- C6, 01, 01, 06, 01, 19, 01, 01 — 4th Step

Pre-defined values for parameter Event Type (6 Bits)
S0 Stop Event-Logic
S1 Event on change of error memory, e.g. number of errors matching to mask has increased
S3 Event on change of measurement's value, which is described by a data identifier
S5 Start Event-Logic
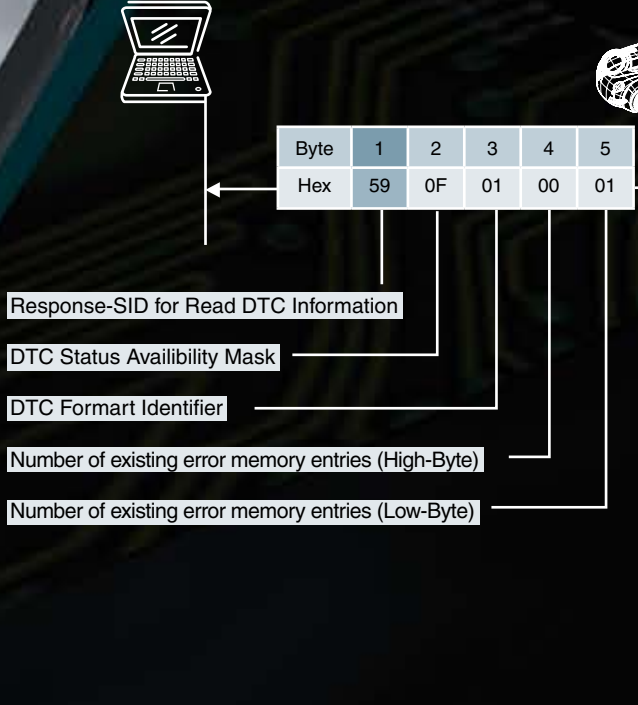S6 Clear Event-Logic

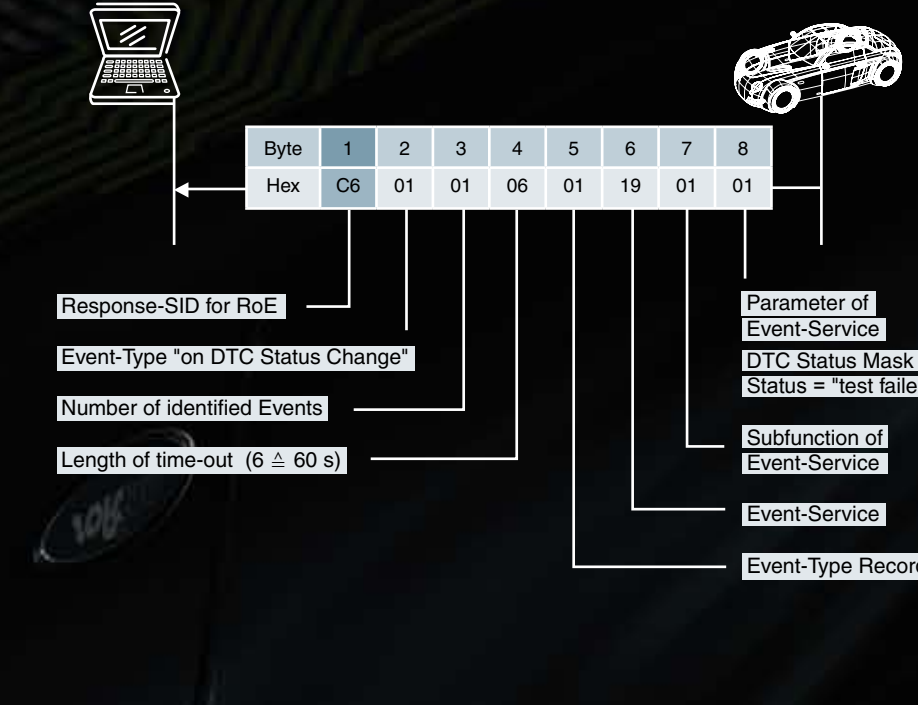## RoE Example - DTC Status Change
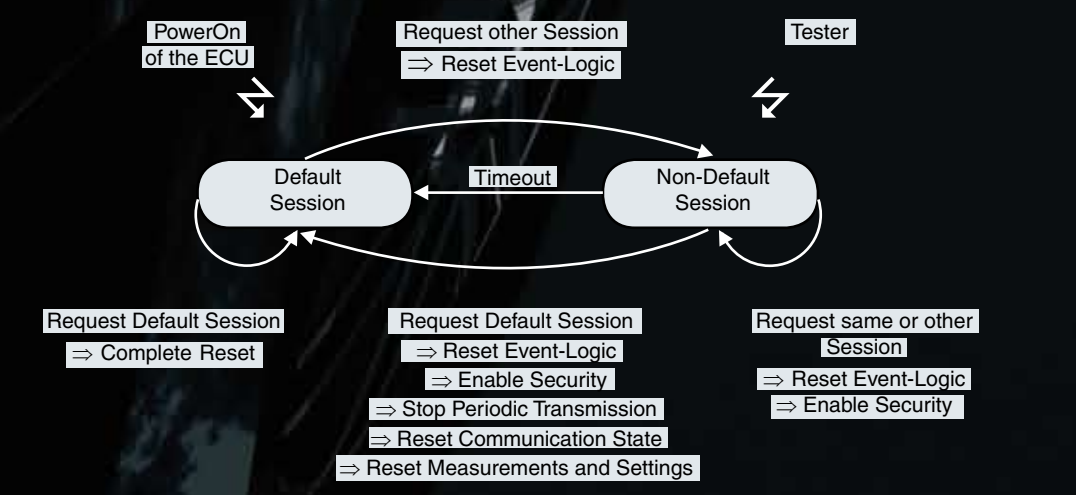
1st Step – Setup of Event-Logic
Length of time-out (6 ≤ 60 s)
a) Event-Type "on DTC Status Change"
b) Event condition not persistent
c) Positive Responses not suppressed
Request-SID for RoE

2nd Step – Start of Event-Logic
a) Positive Responses not suppressed
b) Event condition not persistent
c) Event-Type "start Response on Event"
Request-SID for RoE

3rd Step – Event occurs
Response-SID for Read DTC Information
DTC Status Availability Mask
DTC Format Identifier
Number of existing error memory entries (High-Byte)
Number of existing error memory entries (Low-Byte)

4th Step – Event Windows expires
Response-SID for RoE
Event-Type "on DTC Status Change"
Number of identified Events
Length of time-out (6 ≤ 60 s)