

**Test Control Interface Specification**

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| --- | --- |
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# Scope

This document provides the message interface and protocol to be used between a Test System (TS) and a System Under Test (SUT). The protocol is defined using ASN.1 and referenced in Appendix A.

The intent of this document is to provide an overview of the protocol. It explains the architecture of the protocol, main use cases and how the messages are structured. Details of the type definitions are not described in this document. Instead, the reader is required to review the ASN.1 definition.

# References

## Normative References

The following referenced documents are necessary for the application of the present document.

[1] WAVE802.11-TSS&TP (V0.5.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — 802.11 Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 2/23/2016

[2] WAVEMCO-TSS&TP (V0.4.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — Multi-channel Operation Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 2/22/2016

[3] WAVENS-TSS&TP (V0.6.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — Networking Services Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 1/6/2016

[4] WAVE-16092-TSS&TP (V0.6.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — Security Services Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 2/22/2016

[5] J2945/1-TSS&TP (V0.3.0): “Conformance test specifications for SAE J2945/1 - On-board System Requirements for V2V Safety Communications Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 2/26/2016

[6] “DSRC Proxy”, (V0.5.0), Revision date: 11/6/2015.

[7] IEEE Std. 802.11™-2012: “Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications”.

[8] IEEE Std 1609.3-2016 “IEEE Standard for Wireless Access in Vehicular Environments (WAVE) — Network Services”.

[9] SAE J2945/1 (J2945/1\_201603): “On-Board System Requirements for V2V Safety Communications”.

[10] SAE J2735 (2016-01): “Dedicated Short Range Communication (DSRC) Message Set Dictionary”.

[11] IEEE Std 1609.2-2016 “IEEE Standard for Wireless Access in Vehicular Environments (WAVE) — Security Services”.

[12] IEEE Std. 1609.4-2016 “IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Multi-Channel Operation”.

## Informative References

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EG 202 798 (V1.1.1): "Intelligent Transport Systems (ITS); Testing; Framework for conformance and interoperability testing".

[i.2] ETSI ETS 300 406 (1995): "Methods for testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

# Abbreviations

For the purposes of the present document, the following abbreviations apply:

ABS Anti-lock Braking System

ASN Abstract Syntax Notation

BSM Basic Safety Message

CH Channel

CPU Central Processing Unit

DSRC Dedicated Short Range Communications

GPS Global Positioning System

ICMP Internet Control Message Protocol

IEEE Institute of Electrical and Electronics Engineers

IP Internet Protocol

ISO International Organization for Standardization

ITS Intelligent Transport Systems

IUT Implementation Under Test

NTP Network Time Protocol

OER Octet Encoding Rules

PC Personal Computer

PDU Protocol Data Unit

PSID Provider Service Identifier

RCPI Received Channel Power Indicator

RX Receive

SAE Society of Automotive Engineers

SUT System Under Test

TCI Test Control Interface

TCIA Test Control Interface Application

TCP Transport Control Protocol

TP Test Purposes

TRI Tester Radio Interface

TS Test System

TX Transmit

UC Use Case

UDP User Datagram Protocol

UPER Unaligned Packed Encoding Rules

WAVE Wireless Access in Vehicular Environments

WME WAVE Management Entity

WSA WAVE Service Advertisement

WSM WAVE Short Message

# Test System

## Architecture

The Test System used to support tests listed in [1], [2], [3], [4], and [5] is described in Figure 1. The test system is designed to simulate valid and invalid protocol behaviors, and analyze the reaction of the IUT.

Test System

Test Management Software

System Under Test (SUT)

IUT

Test Interface

Application

Test Control Interface link

(DSRC)

Test Radio Interface

(Ethernet) (Et

Figure 1: General Architecture

## Hardware equipment

The system is implemented according to Figure 2. The test system is comprised of Test Management Software running on a PC (or laptop). The PC is physically connected to the SUT via an Ethernet cable supporting an IP-based connection to transfer control and test data to and from the SUT. This connection corresponds to the Test Control Interface as depicted on Figure 1. The Wired Ethernet connection may be substituted by a wired USB cable as long as it supports IPv4-based data exchanges (e.g. support of RNDIS protocol) or a wireless Ethernet connection if the SUT does not support a wired connection.

The Test System connects to an external DSRC radio using a separate wired Ethernet link. The DSRC radio is used to transfer wireless data messages between the Test System and the SUT. This interface is depicted as the Test Radio Interface on Figure 1.

Test Management Software

running on PC

SUT

IP-based connection

DSRC

radio



DSRC over

wireless or wired

connection

Figure 2: Test System Implementation

### Test System

The main hardware component of the Test System is a standard PC. Its role is to host the execution of the Test Management Software, manage the test flow and generate test reports. To construct a Test System, the following points must be considered:

* No firewall interference with traffic generated by the Test System and/or SUT.
* Use of a synchronized time reference for the SUT and the test system. The Test System may be synchronized to UTC via a Network Time Protocol (NTP), whereas the SUT may use GPS for time synchronization and be adjusted to UTC via data post processing.
* The Test System processes have to be granted unrestricted control to the telecommunication hardware.

Time synchronization between the Test System and the SUT must be checked before starting any test session, as it can be the source of unpredictable SUT behavior and generate incoherent results. For example, most protocol messages feature a time tag used by the receiver to determine if the information it carries is still valid; if the test system is not synchronized, all messages it sends will be considered either as coming from the future or past, and be discarded.

The Test System must be equipped with at least one network interface supporting IPv4 protocol link independent of DSRC protocol link in order to exchange control and test data messages with the SUT.

TCI message exchanges are established using UPD over IPv4-based protocols. Any references to the IPv6 protocol are used in regards to the DSRC wireless exchanges since the IPv4 protocol is not supported for DSRC over-the-air transmissions.

## DSRC radio

To monitor and test DSRC message exchanges, a DSRC radio that fully supports the IEEE 802.11 standard [7] is included in the Test System. The DSRC radio acts as a bridge and passes all messages to and from the Test System which performs message encoding/decoding and verification. The interface between Test System and DSRC radio is covered in a separate document [6].

## Interface Requirements

### Test System Interface (TS 🡨🡪 SUT)

This clause lists requirements for the Test System Interface between the Test System and the Test Control Interface Application (TCIA) running on the SUT:

* The Test System shall communicate with the SUT using the commands described in this document.
* All commands shall be issued using UDP messages. Commands can be used to change the SUT state, operating mode, configure data on the SUT, stimulate the SUT, and observe how the SUT responds to external stimulations.
* The Test System shall send UDP messages to the SUT using IPv4 protocol. The SUT will run the TCIA. This application will decode commands received via UDP messages and use the appropriate software interface to execute the command.
* The TCIA shall listen for the command coming from the Test System using the UDP port (**13001**).
* The TCIA shall send the responses to the Test System UDP port from which the initial *SetInitialState* request came from.

### Interface to DSRC Radio (TS 🡨🡪 DSRC Radio)

This clause lists requirements for the interface between the TS and the DSRC radio.

* The SUT communicates to the DSRC radio using DSRC wireless protocol
* The DSRC radio translates the received WSM messages and sends them to the TS using UDP protocol.
* The DSRC radio receives UDP packets from the TS and transmits them as WSM over DSRC protocol.
* The conversion between the WSM and UDP protocol is performed as described in [6].

### Constraints

This document only describes the interface between the Test System and the TCI Application. Implementation details of the TCI Application or the SUT is outside the scope of this document.

# TCI Message Protocol

This document primarily focuses on the Test Control Interface as depicted on Figure 1. The communication between the Test System and the SUT is achieved using messages flowing using a UDP protocol.

The message exchange format is laid out as follows

* **Request**: This message is initiated from the Test System to the SUT in order to stimulate the SUT to trigger requested functionality.
* **Response**: This message is sent from the SUT to the Test System indicating an acceptance of the *Request* by the SUT. Acceptance means ability of the SUT to decode and interpret the message in order to initiate a sequence of changes at the SUT.
* **ResponseInfo**: This message is sent from SUT to the Test System and contains parameter information requested by SUT, for example retrieval of SUT default settings.
* **Indication**: An event message is sent from the SUT to the Test System indicating the SUT has received a DSRC message or an SUT event occurred.
* **Exception**: This message is sent from the SUT to the Test System. This message is used to report all exception conditions (i.e. INFO/WARNING/ERROR) generated in the SUT to the Test System. Depending on the exception severity, the TS may initiate recovery (i.e. reset to the initial state), or continue its operation.

The TS expects to receive *Response* or *Exception* messages within **50ms** after the SUT received a *Request* message. If no *Response* or *Exception* is received, the TS will attempt to re-initialize the SUT or may require user assistance.

The typical message exchanges are described below:

### TS sends a request to SUT and receives a *Response*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test System | |  | SUT | |
|  |  | Request |  |  |
| ==============================> |
|  |
| Response |
| <=============================== |

The communication exchange is initiated by the TS. The TS sends a *Request*. The SUT responds with a *Response* containing a result code indicating success of an operation or an exception. In the latter case, the *Response* message includes information about the exception.

The response is actually an acknowledgement that the SUT received the test system's request and will be acting on it. It then executes the request. It is the TS that determines if the test passes or fails based on the result of the test.

### SUT sends an unsolicited *Indication* to the TS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test System | |  | SUT | |  |
|  |  |  |  |  | Message received or a specified event occurred |
|  | <================ | |
|  |  |
| Indication |  | |
| <=============================== |  |

This communication exchange is initiated by the SUT. The SUT may send an unsolicited indication to the TS each time a packet is received and processed by the SUT or an event occurred on the SUT. Normally, the SUT will start (or stop) sending *Indications* after it is triggered by the TS. The TS never replies to such messages.

### TS sends a request and receives information from the SUT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test System | |  | SUT | |
|  |  | Request |  |  |
| ==============================> |
|  |
| ResponseInfo |
| <=============================== |

The TS needs to obtain information from the SUT, e.g. the IPv6 address of the DSRC wireless interface. The TS sends a request message. The SUT does not sends a *Response*, but instead replies with a *ResponseInfo* containing the requested information.

### SUT sends an unsolicited Exception to the SUT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test System | |  | SUT | |
|  |  |  |  |  |
|  |
|  |
| Exception |
| <=============================== |

The SUT needs to inform the TS about an exception. The SUT sends an *Exception* message to the TS. TS does not reply to the SUT. This *Exception* message may be generated at any time and does not require a *Request* from the TS.

Message specification is defined using ASN.1. It is provided in the Appendix A. All TCI messages are encoded using OER encoding. Note, that some TCI messages may contain a parameter containing a DSRC message payload. The content of the payload must be encoded to be directly transferrable to the target message payload without re-encoding.

A log of all the message exchanges with the system defined timestamps are maintained in a log file on the Test System; this helps in correlating if the test result is not as expected.

## Transport Protocol

The communication between the TS and SUT uses UDP protocol messages flowing via IPv4-based link.

In order to initiate the connection, the TS sends the initial *Request* message to a pre-defined UDP destination port (*defaultTCIAPort*), which the SUT opens to listen for incoming messages. When the SUT receives *Request.SetInitialState* or *Request.RequestDeviceAvailability* messages from the TS, it saves the UDP source port of this request as *defaultTSPort.* The SUT uses this port to send *Response*, *ResponseInfo* messages as well as unsolicited *Indication* and *Exception* messages. The TS uses the *defaultTSPort* to receive messages from the SUT.

Table 1 TS and SUT default UDP ports configuration

|  |  |  |
| --- | --- | --- |
| Parameter | Description | Value |
| defaultTCIAPort | UDP port used by the TCIA to receive request from TS. | 13001 |
| defaultTSPort | UDP port used by TS to listen for SUT indications and responses. | The source UDP port used by the TS for sending the *SetInitialState* or *RequestDeviceAvailability* request messages. |

# Test Control Interface Messages

## Shared message structure

All messages defined in this specification are grouped under the common root type called *TCIMsg,* which contains the following parameters:

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Definition** | **Description** |
| version | Integer (0..255) | For this revision of specification, version shall be set to 1 |
| timestamp | Time64 | Timestamp provided by the message sender.  Timestamp measures the  the difference in milliseconds, between the current time and midnight, **January 1, 1970 UTC** |
| frame | CHOICE{  TCI16093  TCI16092  TCI16094  TCI80211  TCI29451  TCISutControl  } | Current TCI frames defined in this specification. |

Messages for all frames have the same defined structure. The following example describes TCI16093Event.

TCI16093 ::= CHOICE{

request

response

indication

responseInfo

exception

}

The following sections provide the top level definition of the TCI frame. Appendix A: provides message and type definitions in ASN.1 format.

## Test Control Interface Modules

TCI protocol is defined in the modules listed in the Table 2.

Table 2 TCI protocol modules

|  |  |
| --- | --- |
| **Module (asn extensions omitted)** | **Description** |
| TCIDispatcher | Root module aggregating all other frame specific messages |
| TCI16092 | Frame and message definition used for testing 1609.2 |
| TCI16093 | Frame and message definition used for testing 1609.3 |
| TCI16094 | Frame and message definition used for testing 1609.4 |
| TCI29451 | Frame and message definition used for testing 2945/1 |
| TCI80211 | Frame and message definition used for testing 802.11 |
| TCICommonTypes | Common types shared across TCI modules |
| TCIwsm | Request messages for sending and receiving WSM packets |
| TCIip | Request messages for sending and receiving IPv6 packets |
| TCISutControl | Device-level commands for controlling SUT |
| TCIEventHandling | Common event-handling types shared by other modules |
| TCIindication | Common indication messages shared by other modules |

For example, several TCI frames trigger transmission of WSM. Those requests are defined in TCIwsm and included into corresponding TCI16093, TCI80211, etc by reference. Similarly, requests to transmit IPv6 packets are defined in TCIip and imported into TCI16093, TCI16094, etc. by reference.

# Common TCI modules

This section describes common messages shared by TCI frames.

## TCIwsm module

TCIwsm modules defines request messages from the TS to the SUT to trigger transmission and/or reception of WSMs. It also includes messages for management of the corresponding parameters and service tables on the SUT.

Many WSM parameters including PSID, channelIdentifier, dataRate, transmitPowerLevel, userPriority, etc., are defined by reusing the corresponding types from IEEE 1609.3 [8]. This specification adopts definitions of these parameters from the standard [8]. For the ASN.1, TCI imports these data types from the corresponding definitions of the standard.

Conventions for time and geo-location data representation are adopted from the SAE J2735 [10].

IEEE 1609.3 uses UPER encoding while TCI specification uses OER encoding. Due to encoding difference, the same parameters values may have different representation once encoded for transmission as WSM compared to TCI messages.

### Request messages

#### SetInitialState

This request is used to set the SUT in initial condition. The initial condition defines the initial state in which the SUT has to be to carry out each test case. This message also must clear information from the following MIB tables *ProviderServiceRequestTable, UserServiceRequestTable*, as defined in IEEE1609.3 [8].

#### SetWsmTxInfo

This request is used to configure device parameters before transmitting WSMs.

SetWsmTxInfo ::= SEQUENCE{

psid Psid,

radio RadioInterface,

security SecurityContext,

channelIdentifier ChannelNumber80211,

timeslot TimeSlot,

dataRate DataRate,

transmitPowerLevel TXpower80211,

infoElementsIncluded WaveElementsIncluded DEFAULT '000000000000000000000000'B,

userPriority UserPriority,

destinationMACAddr MACaddress DEFAULT 'FFFFFFFFFFFF'H,

expiryTime INTEGER(0..18446744073709551615) OPTIONAL,

channelLoad Opaque OPTIONAL,

...

}

Table 3 SetWsmTxInfo parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs |
| security | The structure security context including content type of payload (i.e. BSM, WSA) for selecting appropriate security profile; security type (i.e. unsecure, signed, etc); optional reference to a certificate hashID. |
| channelIdentifier | Channel number as defined in 1609.3 [8]. |
| timeslot | Time slot or continuous channel usage as defined in 1609.3 [8]. |
| dataRate | Data rate as defined in 1609.3 [8]. |
| transmitPowerLevel | Transmit power level as defined in 1609.3 [8]. |
| infoElementsIncluded | A bit flag indicating which optional WAVE Info Elements included in the WSM-N-Header |
| userPriority | User priority as defined in 1609.3 [8]. |
| destinationMACAddr | Destination MAC address for the destination as defined in 1609.3 [8].  Default value set for broadcast transmissions. |
| expiryTime | Expiry time as defined in 1609.3 [8].This is an optional parameter. |
| channelLoad | Channel load as defined in 1609.3 [8]. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### StartWsmTx

This request is used to initiate transmission of WSMs by the SUT. Information from this request can be used to invoke *WSM-WaveShortMessage.request* from 1609.3 [8].

StartWsmTx ::= SEQUENCE{

psid Psid,

radio RadioInterface,

repeatRate RepeatRate,

payload Opaque,

...

}

Table 4 StartWsmTx parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |
| repeatRate | Repeat rate for messages as defined in 1609.3 [8]. Additionally, can be set to 0 for transmitting a single message. |
| payload | WSM message payload excluding message length field. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### StopWsmTx

This request is used to stop transmission of WSMs by the SUT. The WSM stream is identified by the RadioInterface and PSID.

StopWsmTx ::= SEQUENCE{

psid Psid,

radio RadioInterface,

...

}

Table 5 StopWsmTx parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### StartWsaTxPerdiodic

This request is used to initiate transmission of WSA by the SUT. Information provided in this request can be used to invoke *WME-ProviderService.request* from 1609.3 [8]. WSAs will be sent as WSMs using the default PSID defined in 1609.3 [8].

StartWsaTxPerdiodic ::= SEQUENCE{

radio RadioInterface,

destinationMACAddr MACaddress DEFAULT 'FFFFFFFFFFFF'H,

wsaChannelIdentifier ChannelNumber80211,

channelAccess TimeSlot,

repeatRate RepeatRate,

ipService BOOLEAN,

security

SecurityContext (WITH COMPONENTS {

contentType (mWSA)

}),

signatureLifetime INTEGER(10..30000),

infoElementIncluded WaveElementsIncluded DEFAULT '000000000000000000000000'B,

advertiserId AdvertiserIdentifier OPTIONAL,

serviceInfos ServiceInfos,

channelinfos ChannelInfos,

wra RoutingAdvertisement OPTIONAL,

...

}

Table 6 StartWsaTxPerdiodic parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSAs. |
| destinationMACAddr | Destination MAC address for the destination as defined in 1609.3 [8].  Default value set for broadcast transmissions. |
| wsaChannelIdentifier | Channel number to transmit WSAs as defined in 1609.3 [8]. |
| channelAccess | Time slot or continuous channel usage as defined in 1609.3 [8]. |
| repeatRate | Repeat rate for messages as defined in 1609.3 [8]. Additionally, can be set to 0 for transmitting a single message. |
| ipService | Indicates if the WSA contains WRA for configuration of IP-based services |
| security | The structure security context including content type of payload (i.e. BSM, WSA, etc) for selecting appropriate security profile; security type (i.e. unsecure, signed, etc); optional reference to a certificate hashID. |
| signatureLifetime | Signature Lifetime as defined in 1609.3 [8]. |
| infoElementsIncluded | A bit flag indicating which optional WAVE Info Elements included in the WSM-N-Header and into WSA message structure. |
| advertiserId | Advertiser Identifier as defined in 1609.3 [8]. |
| serviceInfos | The structure containing sequence of service information elements as defined in 1609.3 [8]. |
| channelinfos | The structure containing sequence of Channel Information elements as defined in 1609.3 [8]. |
| wra | A structure containing WRA information. This field is required if ipService is set TRUE. Otherwise, it’s omitted. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### StopWsaTxPeriodic

This request is used to stop the current WSA transmissions by the SUT and delete associated provider services from the *ProviderServiceRequestTable*.

StopWsaTxPeriodic ::= SEQUENCE{

radio RadioInterface,

...

}

Table 7 StopWsaTxPeriodic parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSAs. |

Specific details for each type definition are listed in the ASN.1 specification referenced in the Appendix A.

#### StartWsmRx

This request is used to configure the SUT to receive messages and forward corresponding event indications to the TS. Information provided in this request can be used to invoke *WME-WSMService.request* and *WME-ChannelService* from 1609.3[8].

StartWsmRx ::= SEQUENCE{

psid Psid,

radio RadioInterface,

channelIdentifier ChannelNumber80211,

timeSlot TimeSlot,

eventHandling EventHandling,

...

}

Table 8 StartWsmRx parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |
| channelIdentifier | Channel number as defined in 1609.3 [8]. |
| timeslot | Time slot or continuous channel usage as defined in 1609.3 [8]. |
| eventHandling | Types of events which TS request to receive indications about. The types of events supported includes reception of a message, completion of message security verification, and etc. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

The SUT will send an *indication* message when it receives a WSM. Using *eventHandling* parameter, the TS can request to receive all WSMs or only those with matching PSID parameters. In the latter case, the PSID parameter is omitted.

The TS will expect to receive the *Indication* message within **50ms** after the corresponding WSM is received by the SUT.

#### StopWsmRx

This request is used to stop SUT reception of messages and generation of *indication* messages.

StopWsmRx ::= SEQUENCE{

psid Psid OPTIONAL,

radio RadioInterface,

...

}

Table 9 StopWsmRx parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service Identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for receiving of WSMs. |

If the preceding *StartWsmRx* omitted *psid* parameter, *psid* is omitted for the *StopWsmRx*.

Specific details for each type definition are listed in the ASN.1 specification referenced in the Appendix A.

#### AddWsaProviderService

This request is used to add a provider service and update WSA. The WSA must be started prior to this request using *StartWsaTxPerdiodic*.

AddWsaProviderService ::=SEQUENCE{

radio RadioInterface,

serviceInfos ServiceInfos,

...

}

Table 10 AddWsaProviderService

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |
| serviceInfos | The structure containing sequence of service information elements as defined in 1609.3 [8]. |

This request can add one or more service entries into an existing WSA. The new services must refer to already existing information in WSA such as Channel Info elements and WRA (if included).

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### DelWsaProviderService

This request is used to remove a provider service and updates WSA. This request must only remove provider services previously added using *AddWsaProviderService*.

DelWsaProviderService ::=SEQUENCE{

radio RadioInterface,

serviceInfos ServiceInfos,

...

}

Table 11 DelWsaProviderService

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |
| serviceInfos | The structure containing sequence of service information elements as defined in 1609.3 [8]. |

The *serviceInfo* structure must contain at least psid information for each service that will be removed.

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### AddUserService

This request is used to add a user service to the SUT. Information provided in this request can be used to invoke *WME-UserService.request* and *WME-ChannelService* from 1609.3 [8].

AddUserService ::= SEQUENCE{ -- register user service via

psid Psid,

radio RadioInterface,

userRequestType UserRequestType,

wsaType WsaType,

providerServiceContext ProviderServiceContext OPTIONAL,

channelIdentifier ChannelNumber80211 OPTIONAL,

sourceMACAddr MACaddress OPTIONAL,

advertiserId AdvertiserIdentifier OPTIONAL,

linkQuality INTEGER OPTIONAL,

immediateAccess INTEGER(0..255) OPTIONAL,

...

}

Table 12 AddUserService parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |
| userRequestType | User Request Type as defined in 1609.3 [8]. (options include autojoin on match, no service channel). |
| wsaType | WSA Type as defined in 1609.3 [8] (options includes secure, unsecure). |
| providerServiceContext | Provider Service Context as defined in 1609.3 [8]. |
| channelIdentifier | Channel number as defined in 1609.3 [8]. |
| sourceMACAddr | Source MAC address as defined in 1609.3 [8]. |
| advertiserId | Advertiser ID as defined in 1609.3 [8]. |
| linkQuality | Link Quality as defined in 1609.3 [8]. |
| channelLoad | Channel Load as defined in 1609.3 [8]. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

#### DelUserService

This request is used to delete a user service on the SUT previously requested by the *AddUserService* request.

DelUserService ::= SEQUENCE{

psid Psid,

radio RadioInterface,

...

}

Table 13 DelUserRequestService parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| psid | Provider Service identifier as defined in 1609.3 [8]. |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSMs. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

## TCIip module

*TCIip* modules defines request messages from the TS to the SUT to trigger transmission and/or reception of messages using IPv6-based protocols. It also includes messages for retrieving IPv6 address information from the SUT.

### Request messages

#### GetIpv6InterfaceInfo

This request is used to retrieve IPv6 configuration from the SUT. This message uses a service provided by the IP domain.

GetIPv6InterfaceInfo ::= SEQUENCE{

radio RadioInterface ( WITH COMPONENTS { ..., antenna ABSENT }),

...

}

Table 14 getIPv6InterfaceInfo Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of IPv6 packets. |

The requested IPv6 configuration is returned in the *ResponseInfo* message and contains:

Ipv6InterfaceInfo ::= SEQUENCE OF SEQUENCE {

interfaceName UTF8String(SIZE(1..255)), -- e.g. “eth0”,

ipAddress SEQUENCE OF IPv6Address, -- linked local, global, etc

macAddress MACaddress, -- MAC address for the network interface

defaultGateway IPv6Address, -- default gateway IPv6 address (assigned via WSA/WRA)

primaryDns IPv6Address, -- primary DNS IPv6 address (assigned via WSA/WRA)

gatewayMacAddress MACaddress, -- gateway Mac address (assigned via WSA/WRA)

...

}

#### SetIpv6Address

This request is used to change SUT IPv6 configuration.

SetIPv6Address ::= SEQUENCE{

radio RadioInterface ( WITH COMPONENTS { ..., antenna ABSENT }),

interfaceName UTF8String(SIZE(1..255)),

ipAddress IpAddress OPTIONAL,

-- optional if the new IPv6 address value must be selected at random

...

}

Table 15 setIPv6Address Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of IPv6 packets. |
| interfaceName | Interface Name is an identifier of the interface provided by the SUT in response to the *GetIpv6InterfaceInfo.* |
| ipAddresses | IPv6 address specified in canonical format (e.g. 2001:ff::1) to be assigned to the interface. If omitted, the SUT must assign a randomly chosen IPv6 address. |

#### StartIPv6Tx

This request is used to initiate transmission of IPv6 packets by the SUT.

StartIPv6Tx ::= SEQUENCE{

radio RadioInterface,

interfaceName UTF8String(SIZE(1..255)),

destIpAddress IpAddress,

destPort IpPort OPTIONAL,

protocol ENUMERATED { tcp, udp, icmp },

repeatRate RepeatRate OPTIONAL,

eventHandling EventHandling (WITH COMPONENTS {..., eventFlag ('000000000'B) }) OPTIONAL,

payload Opaque OPTIONAL,

...

}

Table 16 startIPv6Tx Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of IPv6 packets. |
| interfaceName | Interface Name is an identifier of the interface provided by the SUT in response to the *GetIpv6InterfaceInfo.* |
| destipAddresses | Destination host IPv6 address specified in canonical format (e.g. 2001:ff::1). |
| destPort | Destination host port used for the reception of IPv6 packets. |
| Protocol | IP protocol : tcp, udp or icmp. |
| repeatRate | Repeat rate for messages as defined in 1609.3. Additionally, can be set to 0 for transmitting a single message. |
| eventHandling | This parameter is omitted any protocol except icmp – see SendIpv6Ping. |
| payload | The message content. |

#### StopIPv6Tx

This request is used to cease transmission of IPv6 packets by the SUT.

StopIPv6Tx ::= StartIPv6Tx (WITH COMPONENTS {

radio ( WITH COMPONENTS { ..., antenna ABSENT }),

interfaceName,

destIpAddress,

destPort,

protocol,

repeatRate ABSENT,

eventHandling ABSENT,

payload ABSENT

})

See Table 16 for an explanation.

#### SendIpv6Ping

This request is used to transmit a single ping message, or a multiple ping messages from the SUT over IPv6 and receive ping echo from the remote host.

SendIPv6Ping ::= StartIPv6Tx ( WITH COMPONENTS {

radio,

interfaceName,

destIpAddress,

destPort ABSENT,

protocol (icmp),

repeatRate OPTIONAL,

eventHandling (WITH COMPONENTS {..., eventFlag ({eIcmp6PktRx}) }),

payload ABSENT

})

Table 17 sendIPv6Ping Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of ping v6 messages. |
| interfaceName | Interface Name is an identifier of the interface provided by the SUT in response to the *GetIpv6InterfaceInfo.* |
| destipAddresses | Destination host IPv6 address specified in canonical format (e.g. 2001:ff::1). |
| destPort | Omitted |
| protocol (icmp), | The protocol used for the ping (ICMP in this case). |
| repeatRate | Repeat rate for messages as defined in 1609.3. Additionally, can be set to 0 for transmitting a single message. |
| eventHandling | A parameter is used to request SUT to send an *indication* to the TS when ping echo is received. |
| payload | No payload is required for this message. |

#### StartIPv6Rx

This request is used to initiate reception of IPv6 packets by the SUT.

StartIPv6Rx ::= SEQUENCE{

radio RadioInterface,

interfaceName UTF8String(SIZE(1..255)),

listenPort IpPort,

protocol ENUMERATED { tcp (0), udp (1) },

eventHandling EventHandling

(WITH COMPONENTS {..., eventFlag ({eIpv6PktRx}) }) OPTIONAL,

...

}

Table 18 startIPv6Rx Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for reception of IPv6 packets. |
| interfaceName | Interface Name is an identifier of the interface provided by the SUT in response to the *GetIpv6InterfaceInfo.* |
| listenPort | The port number the SUT should use to listen to IPv6 packets. |
| protocol | The protocol used for the reception (TCP or UDP). |
| eventHandling | A parameter is used to request SUT to send an *indication* to the TS when an IPv6 packet is received. |

#### StopIPv6Rx

This request is used to cease reception of IPv6 packets by the SUT.

StopIPv6Rx ::= StartIPv6Rx ( WITH COMPONENTS {

radio ( WITH COMPONENTS { ..., antenna ABSENT }),

interfaceName,

listenPort,

protocol,

eventHandling ABSENT

})

Table 19 stopIPv6Rx Message Parameters

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for reception of IPv6 packets. |
| interfaceName | Interface Name is an identifier of the interface provided by the SUT in response to the *GetIpv6InterfaceInfo.* |
| listenPort | The port number the SUT should use to listen to IPv6 packets. |
| protocol | The protocol used for the reception (TCP or UDP). |
| eventHandling | Not required. |

## Response, ResponseInfo, Indication and Exception messages

### Response messages

The *Response* message is sent in response to the *Request*. It is defined in the *TCICommonType.asn* module. A *Response* message must be triggered within **50ms** after an SUT received a *Request* message. If no *Response* is received, the TS will attempt to re-initialize the SUT or may request user assistance.

Response ::= SEQUENCE {

msgID MsgID,

resultCode ResultCode,

exception Exception OPTIONAL,

...

}

Table 20 Response message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| msgID | Use the same MsgID from the corresponding *Request* message. msgIDs are listed in the Table 31. |
| resultCode | Success or Failure enumerated as 0 or 1 respectively. |
| exception | This parameter contains additional information if exception must be reported to the TS (i.e. failure, warning, etc). See details in 7.3.4. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

### Indication messages

The *Indication* message is sent from the SUT to TS. It is defined in the *TCIindication.asn* module.

Indication ::= SEQUENCE{

radio RadioInterface,

event Event,

eventParams EventParams OPTIONAL,

pdu Pdu OPTIONAL,

exception Exception OPTIONAL,

...

}

Table 21 Indication message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSAs. |
| event | Enumerated list of events that when occur, will generate an Indication messages. |
| eventParams | Event parameters contain some data related to message reception but not included in the message payload (e.g. message RCPI). |
| pdu | Optional element containing payload of the message identified by the event. |
| exception | Optional element which is used to report exception. It is omitted if no exception is reported. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

Table 22 lists event types that may trigger transmission of an *Indication* message. Those event types are defined in the *TCIIndication.asn* module.

Table 22 Events which can trigger Indication messages

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| e80211PktRx | SUT received an inbound 802.11 frame |
| e16093PktRx | SUT received an inbound 1609.3 packet |
| eWsmPktRx | SUT received an inbound WSM (with matching PSID) |
| eIpv6PktRx | SUT received an inbound IPv6 frame over DSRC |
| eIcmp6PktRx | SUT received an inbound ping (ICMP) IPv6 echo message |
| eIpv6ConfigChanged | SUT IPv6 address change on one of the DSRC radio interfaces |
| eDot3ChannelAssigned | SUT assigned a channel as per WME-Notification.indication |
| eDot3RequestMatchedAvailAppService | request matched with available application-service as per WME-Notification.indication |
| eDot2VerificationCompleteWithResult | Inbound WSM or WSA message signature verification is complete |
| exception | SUT generated an exception. |

### ResponseInfo messages

This message is used to retrieve configuration information from the SUT. It is defined in the *TCIresponseInfo.asn* module. A *ResponseInfo* message must be triggered within **50ms** after an SUT received a *Request* message. If no *ResponseInfo* is received, the TS will attempt to re-initialize the SUT or may request user assistance.

ResponseInfo ::= SEQUENCE {

msgID MsgID,

resultCode ResultCode,

info InfoContent OPTIONAL,

exception Exception OPTIONAL,

...

}

Table 23 ResponseInfo message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| MsgID | Use the same MsgID from the corresponding *Request* message. |
| resultCode | Success or Failure enumerated as 0 or 1 respectively. |
| info | This parameter contains information requested from the SUT.  If SUT detects an error which prevents it to report the requested information, then info parameter is omitted and instead exception parameter is included. |
| exception | This optional parameter is included SUT must report exception explaining the possible details of the failure result code. See details in 7.3.4. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

### Exception messages

*Exception* is a message sent from the SUT to the TS. It is used to report certain conditions to the TS. There is no exception messages from the TS to the SUT. Upon reception of an Exception message, the TS does not need to send a response back to the SUT.

The SUT sends each exception only once and does not need to repeat it. The SUT does not send an exception cancellation if the condition causing exception stops. If repeated exceptions occur due to repeatable events, e.g. reception of invalid message from the TS, then one Exception message is sent for every event which generates an exception.

An Exception message must be triggered within **50ms** after the corresponding event occurred on the SUT.

Exception information can also be reported in the *Response*, *Indication* and *ResponseInfo.* Then, the TS does not need to send a standalone exception message.

Exception ::= SEQUENCE{

type ExceptionType,

id ExceptionId OPTIONAL,

module Module OPTIONAL,

text ExceptionText OPTIONAL,

...

}

Table 24 Exception message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| type | Can be info, warning or error. |
| id | Integer identifier assigned for the exception. |
| module | A text string providing the name of a module where exception is detected. |
| description | This parameter contains a text string describing the exception. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

Table 25 Defined exceptions

|  |  |  |
| --- | --- | --- |
| **id** | **Type** | **Description** |
| 1 | error | Critical error |
| 2 | error | Incorrect parameter value |
| 3 | error | Missing parameter |
| 4 | error | Radio interface is unavailable |

# TCI frames

## TCI80211 frame

### Supported use cases

Use cases (UC) supported by TCI802.11 are listed in the Table 26.

Note, in the Message Sequence column, the common prefix *TCIMsg.frame* is omitted. For example, the full name for *request.SetInitialState* is *TCIMsg.frame.request.SetInitialState*.

Table 26 Use cases supported by TCI802.11

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Use case objective** | **Flow Direction** | **Message Sequence** |
| 1 | Reset the SUT to the Initial state | TS -> SUT  SUT -> TS | request.SetInitialState  response |
| 2 | The SUT transmits a single or periodic WSMs | TS -> SUT  SUT -> TS | request. StartWsmTx  response |
| 3 | The SUT stops transmitting periodic WSMs | TS -> SUT  SUT -> TS | request. StopWsmTx  response |
| 4 | The SUT receives WSMs and sends event indications to the TS | TS -> SUT  SUT -> TS | request. StartWsmRx  response |
| 5 | The SUT stops receiving WSMs | TS -> SUT  SUT -> TS | request. StopWsmRx  response |

### *Request* Messages

Table 27 lists all supported *Request* messages supported in the *TCI16093* frame. When SUT sends a *Response* message, it must include the *MsgID* corresponding to the *Request* message.

Most of these messages are imported from the common *TCIwsm* module.

Table 27 Listing of *Request* messages

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| SetInitialState | 1 | Request to configure SUT to the Initial state |
| StartWsmTx | 2 | Request to start transmission of WSMs |
| StopWsmTx | 3 | Request to stop transmission of WSMs |
| StartWsmRx | 4 | Request to start reception of WSMs |
| StopWsmRx | 5 | Request to stop reception of WSMs |

#### SetInitialState

This request is used to set the SUT in initial condition. This request is defined in *TCIwsm*.

#### StartWsmTX

This request is used to initiate transmission of WSMs by the SUT. This request is defined in *TCIwsm*.

#### StopWsmTx

This request is used to cease transmission of WSMs by the SUT. This request is defined in *TCIwsm*.

#### StartWsmRX

This request is used to configure the SUT to receive messages and forward corresponding event indications to the TS. This request is defined in *TCIwsm*.

#### StopWsmRX

This request is used to stop the SUT reception of messages and generation of *Indication* messages. This request is defined in *TCIwsm*.

### *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCICommonTypes* module.

### *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. TCI80211 defines *Dot11Indication* as follows:

Dot11Indication ::= Indication (WITH COMPONENTS {

radio,

event (e80211PktRx),

eventParams (WITH COMPONENTS {d80211frame} ) OPTIONAL,

pdu OPTIONAL,

exception OPTIONAL

})

where *Indication* is defined in the *TCIindication* module.

### *Exception* messages

*Exception* is a message sent from the SUT to the TS. It is used to report exception conditions to the TS. *Exception* is defined in the *TCICommonTypes* module.

## TCI16094 frame

### Supported use cases

Use cases supported by TCI16094 are listed in Table 28.

Table 28 Use cases supported by TCI16094

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Use case objective** | **Flow Direction** | **Message Sequence** |
| 1 | Reset the SUT to the Initial state | TS -> SUT  SUT -> TS | request.SetInitialState  response |
| 2 | To configure the SUT WSM transmit parameters such as psid, radio, channel, timeslot, data rate … etc. | TS -> SUT  SUT -> TS | request. SetWsmTxInfo  response |
| 3 | The SUT transmits a single or periodic WSMs | TS -> SUT  SUT -> TS | request. StartWsmTx  response |
| 4 | The SUT stops transmitting periodic WSMs | TS -> SUT  SUT -> TS | request. StopWsmTx  response |
| 5 | The SUT receives WSMs and sends event indications to the TS | TS -> SUT  SUT -> TS | request. StartWsmRx  response |
| 6 | The SUT stops receiving WSMs | TS -> SUT  SUT -> TS | request. StopWsmRx  response |
| 7 | Reserved |  |  |
| 8 | The TS requests information from the SUT about the radio (0..3) used for IPv6 Communication | TS -> SUT  SUT -> TS | request.GetIpv6InterfaceInfo  response |
| 9 | The SUT to configure its radio, interface name and IPv6 address used to transmit and receive IPv6 packets | TS -> SUT  SUT -> TS | request.SetIpv6 Ipv6Address  response |
| 10 | The SUT to ping another IPv6 device specifying the radio, the interface, destination IPv6 address and port to use for the transmission and reception. Received ping echo is forwarded to the TS | TS -> SUT  SUT -> TS | request. SendIpv6Ping  response |
| 11 | The SUT transmits single or periodic IPv6 packets | TS -> SUT  SUT -> TS | request. StartIPv6Tx  response |
| 12 | The SUT stops transmitting periodic IPv6 packets | TS -> SUT  SUT -> TS | request. StopIPv6Tx  response |
| 13 | The SUT receives IPv6 packets and sends event indications to the TS | TS -> SUT  SUT -> TS | request. StartIPv6Rx  response |
| 14 | The SUT stops receiving IPv6 packets | TS -> SUT  SUT -> TS | request. StopIPv6Rx  response |

### *Request* Messages

Table 29 lists all supported R*equest* messages supported in the *TCI16094* frame. When the SUT sends a *Response* message, it must include the *MsgID* corresponding to the *Request* message.

Table 29 Listing of *Request* messages

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| SetInitialState | 1 | Request to configure SUT to the Initial state |
| SetWsmTxInfo | 3 | Request to configure WSM transmit parameters |
| StartWsmTx | 3 | Request to start transmission of WSMs |
| StopWsmTx | 4 | Request to stop transmission of WSMs |
| StartWsmRx | 5 | Request to start reception of WSMs |
| StopWsmTx | 6 | Request to stop reception of WSMs |
| GetIpv6InterfaceInfo | 7 | The TS requests IPv6 configuration from the SUT |
| SetIpv6Address | 8 | The TS requests the SUT to change its IPv6 configuration |
| SendIpv6Ping | 9 | Transmit a single ping message over IPv6 and receive ping echo from the remote host |
| StartIPv6Tx | 10 | Request to start transmission of IPv6 packets |
| StopIPv6Tx | 11 | Request to stop transmission of IPv6 packets |
| StartIPv6Rx | 12 | Request to start reception of IPv6 packets |
| StopIPv6Rx | 13 | Request to stop reception of IPv6 packets |

#### SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCIwsm* module.

#### SetWsmTxInfo

This request is used to configure the SUT’s WSM transmission parameters. This request is defined in the *TCIwsm* module.

#### StartWsmTX

This request is used to initiate transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StopWsmTx

This request is used to cease transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StartWsmRX

This request is used to configure the SUT to receive messages and forward corresponding event indications to the TS. This request is defined in the *TCIwsm* module.

#### StopWsmRX

This request is used to stop SUT reception of messages and generation of *indication* messages. This request is defined in the *TCIwsm* module.

#### GetIpv6InterfaceInfo

This request is used to requests IPv6 configuration from the SUT. This request is defined in the *TCIip* module.

#### SetIpv6Address

This request is used to change SUT IPv6 configuration. This request is defined in the *TCIip* module.

#### SendIpv6Ping

This request is used to transmit a single ping message from the SUT over IPv6 and receive a ping echo from the remote host. This request is defined in the *TCIip* module.

#### StartIPv6Tx

This request is used to initiate transmission of IPv6 packets by the SUT. This message uses a service provided by the IP domain. Please refer to section 7.2.1.3 for additional information.

#### StopIPv6Tx

This request is used to cease transmission of IPv6 packets by the SUT. This request is defined in the *TCIip* module.

#### StartIPv6Rx

This request is used to initiate reception of IPv6 packets by the SUT. This request is defined in the *TCIip* module.

#### StopIPv6Rx

This request is used to cease reception of IPv6 packets by the SUT. This request is defined in the *TCIip* module.

### *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCICommonTypes* module.

### *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. TCI16094 defines *Dot4Indication* as follows:

Dot4Indication ::= Indication (WITH COMPONENTS {

radio,

event ( e16093PktRx |

eWsmPktRx |

eIpv6PktRx |

eIcmp6PktRx |

eIpv6ConfigChanged |

eDot3ChannelAssigned |

eDot3RequestMatchedAvailAppService |

exception),

eventParams (WITH COMPONENTS {service} |

WITH COMPONENTS {wsm} |

WITH COMPONENTS {ip}

) OPTIONAL, pdu OPTIONAL,

exception OPTIONAL

})

where *Indication* is defined in *TCIindication* module.

### *ResponseInfo* messages

This message is used to retrieve configuration information from SUT.

Dot4ResponseInfo ::= ResponseInfo (WITH COMPONENTS {

msgID,

resultCode,

info (WITH COMPONENTS {

ipv6InterfaceInfo} ) OPTIONAL, -- if exception reported, no InfoContent provided

exception OPTIONAL

})

### *Exception* messages

*Exception* is a message sent from the SUT to the TS. It is used to report exception conditions to the TS. *Exception* is defined in the *TCICommonTypes* module.

## TCI16093 frame

### Supported use cases

Use cases (UC) supported by TCI16093 are listed in Table 30.

Note, in the Message Sequence column, the common prefix *TCIMsg.frame* is omitted. For example, the full name for *request.SetInitialState* is *TCIMsg.frame.request.SetInitialState*.

Table 30 Use cases supported by TCI16093

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Use case objective** | **Flow Direction** | **Message Sequence** |
| 1 | Reset the SUT to the Initial state | TS -> SUT  SUT -> TS | request.SetInitialState  response |
| 2 | The SUT transmits a single or periodic WSMs | TS -> SUT  SUT -> TS  TS -> SUT  SUT -> TS | request.SetWsmTxInfo  response  request.StartWsmTx  response |
| 3 | The SUT stops transmitting periodic WSMs | TS -> SUT  SUT -> TS | request.StopWsmTx  response |
| 4 | The SUT receives WSMs and sends event indications to the TS | TS -> SUT  SUT -> TS  SUT -> TS | request.StartRx  response  indication |
| 5 | The SUT stops receiving WSMs | TS -> SUT  SUT -> TS | request.StopRx  response |
| 6 | The SUT starts transmitting WSAs | TS -> SUT  SUT -> TS | request.StartWsaTxPeriodic  response |
| 7 | The SUT stops transmitting WSAs | TS -> SUT  SUT -> TS | request.StopWsaTxPeriodic  response |
| 8 | The SUT adds a provider service to WSA | TS -> SUT  SUT -> TS | request.AddWsaProviderService  response |
| 9 | The SUT deletes a provider service from WSA | TS -> SUT  SUT -> TS | request.DelWsaProviderService  response |
| 10 | The SUT registers a user service and notifies the TS when it is activated | TS -> SUT  SUT -> TS  SUT -> TS | request.AddUserService  response  indication |
| 11 | The SUT removes a registered user service | TS -> SUT  SUT -> TS | request.DelUserService  response |
| 12 | The TS requests IPv6 configuration from the SUT | TS -> SUT  SUT -> TS | request. GetIpv6InterfaceInfo  responseInfo |
| 13 | The TS requests the SUT to change its IPv6 configuration | TS -> SUT  SUT -> TS | request.SetIpv6Address  response |
| 14 | Transmit a single ping message over IPv6 and receive ping echo from the remote host | …  TS -> SUT  SUT -> TS  SUT -> TS | Start with Use Case 10, then…  request.SendIpv6Ping  response  indication |
| 16 | SUT joins a WSA and transmits WSMs on a Service channel | … | Run Use Case 10  Wait for the indication message and do Use Case 2 |
| 17 | SUT joins a WSA and receives WSMs on a Service channel |  | Run Use Case 10  Wait for the indication message and do Use Case 4 |
| 15 | An exception occurred on SUT and reported to the TS | SUT -> TS | exception |

The following dependencies are established among use cases:

* UC1 must precede UC 2, UC4, UC6, UC10, UC12, UC13, UC14
* UC3 must follow UC2
* UC5 must follow UC4
* UC7 must follow UC6
* UC8 must follow UC6
* UC9 must follow UC8
* UC11 must follow UC10
* UC12, UC13, UC14 may follow in any order
* UC15 may occur at any time, including during execution of any other UC.

### *Request* messages

Table 31 lists all supported R*equest* messages supported in the *TCI16093* frame. When the SUT sends a *Response* message, it must include the MsgID corresponding to the *Request* message.

Table 31 Listing of *Request* messages

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| setInitialState | 1 | Request to configure SUT to the Initial state |
| setWsmTxInfo | 2 | Request to set parameters used for transmissions of WSMs |
| startWsmTx | 3 | Request to start transmission of WSMs |
| stopWsmTx | 4 | Request to stop transmission of WSMs |
| startWsaTxPerdiodic | 5 | Request to start transmission of WSAs |
| stopWsaTxPeriodic | 6 | Request to stop transmission of WSAs |
| startWsmRx | 7 | Request to start receiving WSMs |
| stopWsmRx | 8 | Request to stop receiving WSMs |
| addWsaProviderService | 9 | Request to add a service provider to an existing WSA broadcast |
| delWsaProviderService | 10 | Request to delete a service provider from an existing WSA broadcast |
| addUserService | 11 | Request to add a user service |
| delUserService | 12 | Request to delete a user service |
| getIpv6InterfaceInfo | 13 | Request to SUT to report its IPv6 configuration |
| setIpv6Address | 14 | Request to SUT to set its IPv6 address |
| sendIpv6Ping | 15 | Request to SUT to send a ping (ICMP over IPv6) |

#### SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCIwsm* module.

#### SetWsmTxInfo

This request is used to configure the SUT’s WSM transmission parameters. This request is defined in the *TCIwsm* module.

#### StartWsmTX

This request is used to initiate transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StopWsmTx

This request is used to cease transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StartWsaTxPerdiodic

This request is used to initiate transmission of WSA by the SUT. This request is defined in the *TCIwsm* module.

#### StopWsaTxPeriodic

This request is used to stop the current WSA transmissions by the SUT and delete associated provider services from the *ProviderServiceRequestTable*. This request is defined in the *TCIwsm* module.

#### StartWsmRX

This request is used to configure the SUT to receive messages and forward corresponding event indications to the TS. This request is defined in the *TCIwsm* module.

#### StopWsmRX

This request is used to stop the SUT’s reception of messages and generation of *indication* messages. This request is defined in the *TCIwsm* module.

#### AddWsaProviderService

This request is used to add a provider service and update WSA. This request is defined in the *TCIwsm* module.

#### DelWsaProviderService

This request is used to removes a provider service and updates WSA. This request is defined in the *TCIwsm* module.

#### AddUserService

This request is used to add a user service to the SUT. This request is defined in the *TCIwsm* module.

#### DelUserService

This request is used to delete a user service on the SUT previously requested by the *AddUserService* request.

#### GetIpv6InterfaceInfo

This request is used to retrieve IPv6 configuration from the SUT. This request is defined in the *TCIip* module.

#### SetIpv6Address

This request is used to set IPv6 address on the SUT. This request is defined in the *TCIip* module.

#### SendIpv6Ping

This request is used to request the SUT to transmit a single ping message over IPv6 and receive a ping echo from the remote host. This request is defined in the *TCIip* module.

### *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCICommonTypes* module.

### *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. TCI16093 defines *Dot3Indication* as follows:

Dot3Indication ::= Indication (WITH COMPONENTS {

radio,

event ( e16093PktRx |

eWsmPktRx |

eIpv6PktRx |

eIcmp6PktRx |

eIpv6ConfigChanged |

eDot3ChannelAssigned |

eDot3RequestMatchedAvailAppService |

exception),

eventParams (WITH COMPONENTS {service} |

WITH COMPONENTS {wsm} |

WITH COMPONENTS {ip}

) OPTIONAL,

pdu OPTIONAL,

exception OPTIONAL

})

where *Indication* is defined in the *TCIindication* module.

Table 32 Indication message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSAs. |
| event | Enumerated list of events that when occur, will generate an Indication messages. See 7.3.2 for the list of pre-defined events. |
| eventParams | Event parameters contain some data related to message reception but not included in the message payload. |
| pdu | Optional element containing payload of the message identified by the event. |
| exception | Optional element which is used to report exception. It is included if an exception is reported. |

The SUT does not need to send both an *Indication* messagewithan *exception* parameter and a separate *Exception* message. If the SUT detects an exception, which doesn’t not prevent it to receive and process subsequent messages, the SUT must report the exception in the *Indication* message. The SUT must use the *Exception* message if the exception condition causes the SUT to abort generation of *Indication* messages.

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

### *ResponseInfo* messages

This message is used to retrieve configuration information from the SUT. TCI16093 defines *Dot3ResponseInfo* as follows:

Dot3ResponseInfo ::= ResponseInfo (WITH COMPONENTS {

msgID,

resultCode,

info (WITH COMPONENTS {

ipv6InterfaceInfo} ) OPTIONAL, -- if exception reported, no InfoContent provided

exception OPTIONAL

})

Table 33 ResponseInfo message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| msgID | Use the same MsgID from the corresponding *Request* message. MsgIDs are listed in the Table 31. |
| resultCode | Success or Failure enumerated as 0 or 1 respectively. |
| info | This parameter contains information requested from the SUT.  If SUT detects an error which prevents it to report the requested information, then info parameter is omitted and instead exception parameter is included. |
| exception | This optional parameter is included if SUT must report exception explaining the possible details of the Failure result code. See details in 8.3.6.. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

### *Exception* messages

*Exception* is a message sent from the SUT to the TS. It is used to report exception conditions to the TS. *Exception* and defined in the *TCICommonTypes* module.

## TCI16092 frame

### Supported use cases

Use cases (UC) supported by TCI16092 are listed in Table 34.

Note, in the Message Sequence column, the common prefix *TCIMsg.frame* is omitted. For example, the full name for *request.SetInitialState* is *TCIMsg.frame.request.SetInitialState*.

Table 34 Use cases supported by TCI16092

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Use case objective** | **Flow Direction** | **Message Sequence** |
| 1 | Reset the SUT to the Initial state | TS -> SUT  SUT -> TS | request.SetInitialState  response |
| 2 | The SUT transmits a single or periodic WSMs | TS -> SUT  SUT -> TS  TS -> SUT  SUT -> TS | request.SetWsmTxInfo  response  request.StartWsmTx  response |
| 3 | The SUT stops transmitting periodic WSMs | TS -> SUT  SUT -> TS | request.StopWsmTx  response |
| 4 | The SUT receives WSMs and sends event indications to the TS | TS -> SUT  SUT -> TS  SUT -> TS | request.StartRx  response  indication |
| 5 | The SUT stops receiving WSMs | TS -> SUT  SUT -> TS | request.StopRx  response |
| 6 | The SUT starts transmitting WSAs | TS -> SUT  SUT -> TS | request.StartWsaTxPeriodic  response |
| 7 | The SUT stops transmitting WSAs | TS -> SUT  SUT -> TS | request.StopWsaTxPeriodic  response |
| 8 | The SUT adds a provider service to WSA | TS -> SUT  SUT -> TS | request.AddWsaProviderService  response |
| 9 | The SUT deletes a provider service from WSA | TS -> SUT  SUT -> TS | request.DelWsaProviderService  response |
| 10 | An exception occurred on SUT and reported to the TS | SUT -> TS | exception |

The following dependencies are assumed among use cases:

* UC1 must precede UC 2, UC4, UC6
* UC3 must follow UC2
* UC5 must follow UC4
* UC7 must follow UC6
* UC8 must follow UC6
* UC9 must follow UC8
* UC10 may occur at any time, including during execution of any other UC.

### *Request* messages

Table 35 lists all supported R*equest* messages supported in the *TCI16092* frame. When the SUT sends a *Response* message, it must include the MsgID corresponding to the *Request* message.

Table 35 Listing of *Request* messages

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| setInitialState | 1 | Request to configure SUT to the Initial state |
| setWsmTxInfo | 2 | Request to set parameters used for transmissions of WSMs |
| startWsmTx | 3 | Request to start transmission of WSMs |
| stopWsmTx | 4 | Request to stop transmission of WSMs |
| startWsaTxPerdiodic | 5 | Request to start transmission of WSAs |
| stopWsaTxPeriodic | 6 | Request to stop transmission of WSAs |
| startWsmRx | 7 | Request to start receiving WSMs |
| stopWsmRx | 8 | Request to stop receiving WSMs |

#### SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCIwsm* module.

#### SetWsmTxInfo

This request is used to configure the SUT’s WSM transmission parameters. This request is defined in the *TCIwsm* module.

#### StartWsmTX

This request is used to initiate transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StopWsmTx

This request is used to cease transmission of WSMs by the SUT. This request is defined in the *TCIwsm* module.

#### StartWsaTxPerdiodic

This request is used to initiate transmission of WSA by the SUT. This request is defined in the *TCIwsm* module.

#### StopWsaTxPeriodic

This request is used to stop the current WSA transmissions by the SUT and delete associated provider services from the *ProviderServiceRequestTable*. This request is defined in the *TCIwsm* module.

#### StartWsmRX

This request is used to configure the SUT to receive messages and forward corresponding event indications to the TS. This request is defined in the *TCIwsm* module.

#### StopWsmRX

This request is used to stop SUT reception of messages and generation of *indication* messages. This request is defined in *TCIwsm* module.

### *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCICommonTypes* module.

### *Indication* messages

The *Indication* message is sent from the SUT to TS indicating an occurrence of a predefined event. TCI16092 defines *Dot2Indication* as follows:

Dot2Indication ::= Indication (WITH COMPONENTS {

radio,

event ( eDot2VerificationCompleteWithResult |

exception),

eventParams ( WITH COMPONENTS {wsm}

) OPTIONAL,

pdu OPTIONAL,

exception OPTIONAL

})

where *Indication* is defined in *TCIindication* module.

Table 36 Indication message

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| radio | The structure contains radio device (radio0, radio1, etc) and antenna port for transmission of WSAs. |
| event | Enumerated list of events that when occur, will generate an Indication messages. See 7.3.2 for the list of pre-defined events. |
| eventParams | Event parameters contain some data related to message reception but not included in the message payload. |
| pdu | Optional element containing payload of the message identified by the event. |
| exception | Optional element which is used to report exception. It is omitted if an exception is reported. |

Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

### *ResponseInfo* messages

TCI16092 does not use ResponseInfo messages.

### *Exception* messages

*Exception* is a message sent from the SUT to TS. It is used to report exception conditions to the TS. *Exception* is defined in the *TCICommonTypes* module.

## TCI2945 frame

Use cases supported by TCI2945 are listed in Table 40.

Table 40 Use cases supported by TCI29451

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Request/Response Messages** | **Flow Direction** | **Message Sequence** |
| 1 | Set the SUT to the Initial state | TS -> SUT  SUT -> TS | request.SetInitialState  response |
| 2 | The SUT transmits periodic BSMs | TS -> SUT  SUT -> TS  TS -> SUT  SUT -> TS | request.ConfigureBsm  response  request.StartBsmTx  response |
| 3 | The SUT stops transmitting periodic BSMs | TS -> SUT  SUT -> TS | request.StopBsmTx  response |
| 4 | The SUT starts receiving BSMs | TS -> SUT  SUT -> TS | request.StartBsmRx  response |
| 5 | The SUT stops receiving BSMs | TS -> SUT  SUT -> TS | request.StopBsmRX  response |
| 6 | Set a position for the SUT | TS -> SUT  SUT -> TS | request.SetPosition  response |
| 7 | Change the position of the SUT | TS -> SUT  SUT -> TS | request.ChangePosition  response |
| 8 | Change the speed of the SUT | TS -> SUT  SUT -> TS | request.ChangeSpeed  response |
| 9 | Change the heading of the SUT | TS -> SUT  SUT -> TS | request.ChangeHeading  response |
| 10 | Turn the brake pedal status of the SUT on or off | TS -> SUT  SUT -> TS | request.EnableBrakePedalStatus  response |
| 11 | Change the yaw rate of the SUT | TS -> SUT  SUT -> TS | request.ChangeYawRate  response |
| 12 | Set the exterior lights status of the SUT | TS -> SUT  SUT -> TS | request.SetExteriorLightsStatus  response |
| 13 | Turn the positional data of the SUT on or off | TS -> SUT  SUT -> TS | request.EnablePositionalData  response |
| 14 | Turn the brake availability of the SUT on or off | TS -> SUT  SUT -> TS | request.EnableBrakeAvailability  response |
| 15 | Turn congestion mitigation of the SUT on or off | TS -> SUT  SUT -> TS | request.EnableCongestionMitigation  response |
| 16 | Set the Temporary ID of the SUT | TS -> SUT  SUT -> TS | request.SetTemporaryId  response |
| 17 | Set the Message Count of the SUT | TS -> SUT  SUT -> TS | request.SetMsgCount  response |
| 18 | Set the vehicle event flags of the SUT | TS -> SUT  SUT -> TS | Request.SetVehicleEventFlags  response |
| 19 | Set the transmission of the SUT | TS -> SUT  SUT -> TS | request.SetTransmission  response |

### Request messages

Table 41 lists all supported *request* messages. When the SUT sends a *response* message, it must include the *MsgID* corresponding to the *request* message.

Table 41 Request supported in TCI16093 frame

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| setInitialState | 1 | Set the SUT to the Initial state |
| setPosition | 2 | Set a position for the SUT |
| changePosition | 3 | Change the position of the SUT |
| changeSpeed | 4 | Change the speed of the SUT |
| changeHeading | 5 | Change the heading of the SUT |
| changeYawRate | 6 | Change the yaw rate of the SUT |
| enablePositionalData | 7 | Enable positional data to the SUT |
| setVehicleTransmission | 8 | Set the transmission state of the SUT |
| setExteriorLightsStatus | 9 | Set the exterior lights status of the SUT |
| setVehicleEventFlags | 10 | Set the vehicle flags of the SUT |
| enableBrakePedalStatus | 11 | Enable or disable the brake pedal status of the SUT |
| enableBrakeAvailability | 12 | Enable or disable the brake availability of the SUT |
| enableCongestionMitigation | 13 | Enable or disable the congestion mitigation on the SUT |
| setTemporaryId | 14 | Set the temporary ID of the SUT |
| setMsgCount | 15 | Set the message count of the SUT |
| configureBsm | 16 | Configure the transmission parameter of BSMs from the SUT |
| startBsmTx | 17 | Begin transmission of BSMs |
| stopBsmTx | 18 | Stop transmission of BSMs |
| startBsmRx | 19 | Begin reception of BSMs |
| stopBsmRx | 20 | Stop reception of BSMs |

#### SetInitialState

This request is used to set the SUT in initial condition. The initial condition defines the initial state in which the SUT has to be to carry out each test case.

#### SetPosition

This request is used to set the position of the SUT. The definition of data units is adopted from [10].

SetPosition ::= SEQUENCE{

latitude Latitude,

longitude Longitude,

elevation Elevation

}

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| latitude | Parameter specifying the desired latitude of the SUT |
| longitude | Parameter specifying the desired longitude of the SUT |
| elevation | Parameter specifying the desired elevation of the SUT |

#### ChangePosition

This request is used to change the position of the SUT relative to its initial position at the time of the request. The definition of data units is adopted from [10].

ChangePosition ::= SEQUENCE{

deltaLatitude Latitude,

deltaLongitude Longitude,

deltaElevation Elevation

}

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| deltaLatitude | Parameter specifying the desired change in latitude of the SUT |
| deltaLongitude | Parameter specifying the desired change in longitude of the SUT |
| deltaElevation | Parameter specifying the desired change in elevation of the SUT |

#### ChangeSpeed

This request is used to change the speed of the SUT. The definition of data units is adopted from [10].

ChangeSpeed ::= INTEGER(0..8191)

#### ChangeHeading

This request is used to change the heading of the SUT. The definition of data units is adopted from [10].

ChangeHeading ::= INTEGER(0..28800)

#### ChangeYawRate

This request is used to change the yaw rate of the SUT. The definition of data units is adopted from [10].

ChangeYawRate ::= INTEGER(-32767..32767)

#### EnablePositionalData

This request is used to enable or disable positional data within the SUT.

EnablePositionalData ::= BOOLEAN

#### SetVehicleTransmission

This request is used to set the vehicle transmission state of the SUT.

SetVehicleTransmission ::= ENUMERATED {

neutral (0),

park (1),

forwardGears (2),

reverseGears (3),

reserved1 (4),

reserved2 (5),

reserved3 (6),

unavailable (7)

}

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| neutral | The vehicle is set to neutral gear |
| park | The vehicle is set to park |
| forwardGears | The vehicle is set to forward gear |
| reverseGears | The vehicle is set to reverse gear |
| reserved1 | Reserved for additional gears |
| reserved2 | Reserved for additional gears |
| reserved3 | Reserved for additional gears |
| unavailable | Vehicle transmission is set to unavailable |

#### SetExteriorLightsStatus

This request is used to set the exterior lights of the SUT.

SetExteriorLightsStatus ::= BIT STRING

{

lowBeamHeadlightsOn (0),

highBeamHeadlightsOn (1),

leftTurnSignalOn (2),

rightTurnSignalOn (3),

hazardSignalOn (4),

automaticLightControlOn (5),

daytimeRunningLightsOn (6),

fogLightOn (7),

parkingLightsOn (8)

}

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| lowBeamHeadlightsOn | Low beam headlights are turned on |
| highBeamHeadlightsOn | High beam headlights are turned on |
| leftTurnSignalOn | Left turn signal is turned on |
| rightTurnSignalOn | Right turn signal is turned on |
| hazardSignalOn | Hazard signal is turned on |
| automaticLightControlOn | Automatic light control is turned on |
| daytimeRunningLightsOn | Daytime running lights are turned on |
| fogLightOn | Fog light is turned on |
| parkingLightsOn | Parameter specifying the desired state of the external lights |

#### SetVehicleEventFlags

This request configures the vehicle event flags of the SUT.

SetVehicleEventFlags ::= BIT STRING {

eventHazardLights (0),

eventStopLineViolation (1), -- Intersection Violation

eventABSactivated (2),

eventTractionControlLoss (3),

eventStabilityControlActivated (4),

eventHazardousMaterials (5),

eventReserved1 (6),

eventHardBraking (7),

eventLightsChanged (8),

eventWipersChanged (9),

eventFlatTire (10),

eventDisabledVehicle (11), -- DisabledVehicle DF may also be sent

eventAirBagDeployment (12)

}

|  |  |
| --- | --- |
| **Parameters** | **Explanation** |
| eventHazardLights | Parameter specifying whether a Hazard Light Event is occurring |
| eventStopLineViolation | Parameter specifying whether a Stop Line Violation Event is occurring |
| eventABSactivated | Parameter specifying whether an ABS Activated event is occurring |
| eventTractionControlLoss | Parameter specifying whether a Traction Control Loss event is occurring |
| eventStabilityControlActivated | Parameter specifying whether a Stability Control Activated event is occurring |
| eventHazardousMaterials | Parameter specifying whether a Hazardous Materials Event is occurring |
| eventReserved1 | Parameter reserved for an event not explicitly included in the J2945.1 standard |
| eventHardBraking | Parameter specifying whether a Hard Braking event is occurring |
| eventLightsChanged | Parameter specifying whether a Lights Changes event is occurring |
| eventWipersChanged | Parameter specifying whether a Wipers Changed event is occurring |
| eventFlatTire | Parameter specifying whether a Flat Tire event is occurring |
| eventDisabledVehicle | Parameter specifying whether a Disabled Vehicle event is occurring |
| eventAirBagDeployment | Parameter specifying whether an Air Bag Deployment event is occurring |

#### EnableBrakePedalStatus

Sets the brake pedal status of the SUT.

EnableBrakePedalStatus ::= BOOLEAN

#### EnableBrakeAvailability

This request sets the brake availability of the SUT.

EnableBrakeAvailability ::= BOOLEAN

#### EnableCongestionMitigation

This request sets the congestion mitigation of the SUT.

EnableCongestionMitigation ::= BOOLEAN

#### SetTemporaryId

This request sets the temporary ID of the SUT. The definition of data units is adopted from [10].

SetTemporaryId ::= OCTET STRING (SIZE(4))

#### SetMsgCount

This request sets the message count of the SUT. The definition of data units is adopted from [10].

SetMsgCount ::= INTEGER (0..127)

#### ConfigureBsm

This request configures the BSM transmission of the SUT. Refer to SetWsmTxInfo for more information on parameter settings.

ConfigureBsm ::= SetWsmTxInfo (WITH COMPONENTS {

psid (32),

radio,

security (WITH COMPONENTS { contentType (mBSM) }),

channelIdentifier (172),

timeslot (continuous),

dataRate (r6Mbps-12BPSK),

transmitPowerLevel (20),

infoElementsIncluded ('000000000000000000000000'B),

userPriority (7),

destinationMACAddr ('FFFFFFFFFFFF'H),

repeatRate ABSENT,

payload ABSENT -- Assumes BSM payload is generated by the SUT

})

#### StartBsmTx

This request starts BSM transmission from the SUT. Refer to StartWsmTx for more information on parameter settings.

StartBsmTx ::= StartWsmTx (WITH COMPONENTS {

psid (32),

radio,

repeatRate,

payload ABSENT -- Assumes BSM payload is generated by the SUT

})

#### StopBsmTx

This request stops BSM transmission from the SUT. Refer to StopWsmTx for more information on parameter settings.

StopBsmTx ::= StopWsmTx (WITH COMPONENTS {

psid (32)

})

#### StartBsmRx

This request starts BSM reception from the SUT. Refer to StartWsmRx for more information on parameter settings.

StartBsmRx ::= StartWsmRx (WITH COMPONENTS {

psid (32),

-- PSID is optional if eventHandling.rxFlag is set to receive any WSM with PSID

radio ( WITH COMPONENTS { ..., antenna ABSENT }),

channelIdentifier,

timeSlot,

eventHandling

})

#### StopBsmRx

This request stops BSM reception from the SUT. Refer to StopWsmRx for more information on parameter settings.

StopBsmRx ::= StopWsmRx (WITH COMPONENTS {

psid (32)

})

### *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCICommonTypes* module.

### *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. TCI29451 defines *D2945Indication* as follows:

D2945Indication ::= Indication (WITH COMPONENTS {

radio,

event ( eWsmPktRx |

exception),

eventParams (WITH COMPONENTS {wsm} ) OPTIONAL,

pdu OPTIONAL,

exception OPTIONAL

})

where *Indication* is defined in the *TCIindication* module.

### *ResponseInfo* messages

TCI29451 does not use *ResponseInfo* messages.

### *Exception* messages

*Exception* is a message sent from the SUT to TS. It is used to report exception conditions to the TS. *Exception* is defined in the *TCICommonTypes* module.

## TCISutControl

### Supported use cases

Use cases (UC) supported by TCISutControl are listed in Table 37.

Table 37 Use cases supported by TCI16093

|  |  |  |  |
| --- | --- | --- | --- |
| **UC #** | **Use case objective** | **Flow Direction** | **Message Sequence** |
| 1 | Request the SUT to shut down. | TS -> SUT  SUT -> TS | request.Shutdown  response |
| 2 | Request the SUT to restart. | TS -> SUT  SUT -> TS | request.Restart  response |
| 3 | Request SUT status to accept new commands. | TS -> SUT  SUT -> TS | request.RequestDeviceAvailability  response |

### *Request* messages

Table 38 lists all supported R*equest* messages in the *TCISutControl.*

Table 38 Listing of *Request* messages

| **Request Messages** | **MsgID** | **Explanation** |
| --- | --- | --- |
| Shutdown | 1 | Request to shut the SUT down. |
| Restart | 2 | Request to restart the SUT. |
| RequestDeviceAvailability | 3 | Request device availability status. |

#### Shutdown

This request is used to command the SUT to shut down and power off. If complete power off is not supported, the device must enter into a state where the CPU is halted and power draw is minimized.

#### Restart

This request is used to command the SUT to restart. The “restart” is meant to be interpreted as it is used in defining certain requirements in SAE J2945/1 [9]. Therefore, this request must trigger the device to perform certain activities which must occur upon the device restart, i.e. change security certificates, change MAC address to a new random value, etc.

#### RequestDeviceAvailability

The TS sends to the SUT this message after restart or power up to determine the SUT status. If the SUT is ready to receive commands from the TS, it responds back to the TS with a Response message and ResultCode = rcSuccess. The TS is not ready if it doesn’t respond within the response timeout of **50ms** or includes the ResultCode = rcFailure.

1. TCI protocol ASN.1 definition

This appendix contains listing of all data types defined in the ASN.1 for the TCI protocol. Data types are listed under the corresponding module name where they are defined.

The current TCI protocol ASN.1 definition files are posted in github at the following location:

<https://github.com/certificationoperatingcouncil/TCI_ASN1>

**TCIdispatcher.asn**

TCIMessage

Frame

**TCI16093.asn**

TCI16093

Request

MESSAGE-ID-AND-TYPE

MessageTypes

Dot3Indication

Dot3ResponseInfo

**TCI16092.asn**

TCI16092

Request

MESSAGE-ID-AND-TYPE

MessageTypes

Dot2Indication

**TCI16094.asn**

TCI16094

Request

MESSAGE-ID-AND-TYPE

MessageTypes

Dot4Indication

Dot4ResponseInfo

**TCI29451.asn**

TCI29451

Request

MESSAGE-ID-AND-TYPE

MessageTypes

SetPosition

ChangePosition

ChangeSpeed

ChangeHeading

ChangeYawRate

ConfigureBsm

StartBsmTx

StopBsmTx

StartBsmRx

StopBsmRx

EnablePositionalData

EnableBrakeAvailability

EnableBrakePedalStatus

EnableCongestionMitigation

SetTemporaryId

SetMsgCount

SetVehicleEventFlags

SetVehicleTransmission

SetExteriorLightsStatus

D2945Indication

**TCI80211.asn**

TCI80211

Request

MESSAGE-ID-AND-TYPE

MessageTypes

Dot11Indication

**TCIEventHandling.asn**

EventHandling

RxFlag

EventFlag

SecurityFlag

**TCIindication.asn**

Indication

Event

EventParams

Pdu

ServiceParameters

WsmParameters

IpParameters

D80211Parameters

SecResultParams

SecurityResultCode

**TCIip.asn**

GetIPv6InterfaceInfo

SetIPv6Address

StartIPv6Tx

StopIPv6Tx

SendIPv6Ping

StartIPv6Rx

StopIPv6Rx

**TCIresponseInfo.asn**

ResponseInfo

InfoContent

Dot11PhyType

Dot4StationConfigEntry

Dot3StationConfigEntry

Ipv6InterfaceInfo

**TCISutControl.asn**

TCISutControl

Request

MESSAGE-ID-AND-TYPE

Request

MessageTypes

Shutdown

Restart

RequestDeviceAvailability

**TCIwsm.asn**

SetInitialState

SetWsmTxInfo

StartWsmTx

StopWsmTx

AddUserService

DelUserService

StartWsmRx

StopWsmRx

StartWsaTxPerdiodic

StopWsaTxPeriodic

AddWsaProviderService

DelWsaProviderService

AddUserService

DelUserService

ContentType

SignerIdentifierType

SecurityContext

WaveElementsIncluded

UserRequestType

WsaType

ServiceInfos

ServiceInfo

ChannelOptions

RepeatRate

IPAddress

PduData

**TCICommonTypes.asn**

Antenna

DataRate

Exception

ExceptionId

ExceptionText

ExceptionType

HashedId8

IpAddress

IpPort

Module

MsgID

Opaque

PduData

PduType

Psid

Radio

RadioInterface

RCPI

RepeatRate

Response

ResultCode

Time64

TimeSlot

UdpPort

UserPriority

VarLengthNumber

**WEE.ASN and WSA.ASN are imported from ASN.1 for IEEE 1609.3V3D6**

**wee.asn**

EXT-TYPE

Extension

IPv6Address

MACaddress

TXpower80211

ChannelNumber80211

**WSA.asn is modified to import VarLengthNumber from TCI-CommonTypes**

**wsa.asn**

AdvertiserIdentifier

ProviderServiceContext

ServiceInfoExts

ChannelInfos

RoutingAdvertisement

## Revision History

|  |  |  |
| --- | --- | --- |
| V0.1.0 | March 21, 2016 | Initial Draft |
| V0.2.0 | June 1, 2016 | \* Some editorial revisions to address industry feedback.  \* Link to github is added. |
| V0.3.0 | July 19, 2016 | \* Editorial changes based on comments from Noblis |

## Open Issues

None

◙ End of Document ◙