ASN.1 Requirements
Wireless Environments (WAVE) --
Test Control Interface ASN1 Specification

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1 Revision History

V2.0.0	February 24, 2020	Initial Draft of Version 2 – Aaron Moore

2 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.

3 References

3.1 Normative References

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

[1] WAVE802.11-TSS&TP (V1.2.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — 802.11 Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 10/09/2017

[2] WAVEMCO-TSS&TP (V1.3.0): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — Multi-channel Operation Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 10/08/2017

[3] WAVENS-TSS&TP (V1.3.3): “Conformance test specifications for Wireless Access in Vehicular Environments (WAVE) — Networking Services Test Suite Structure and Test Purposes (TSS & TP)”. Revision date: 10/08/2017

[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: 10/08/2017

[5] J2945/1-TSS&TP (V0.5.5): “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: 10/08/2017

[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”.

3.2 Informative References

The following referenced documents are not necessary for the application of the present document, but they assist the user regarding 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".

4 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

5 Test System

5.1 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.

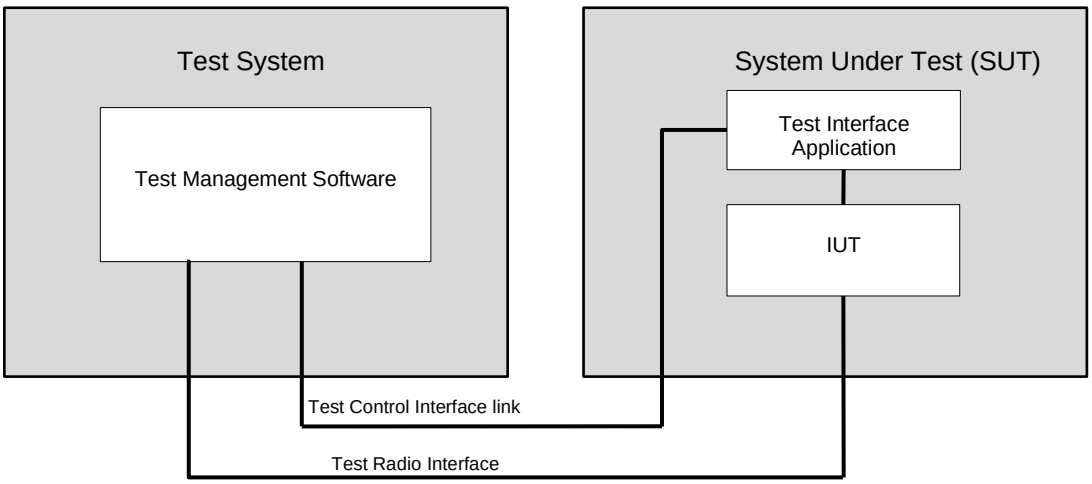


Figure 1: General Architecture

5.2 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 IPbased 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.

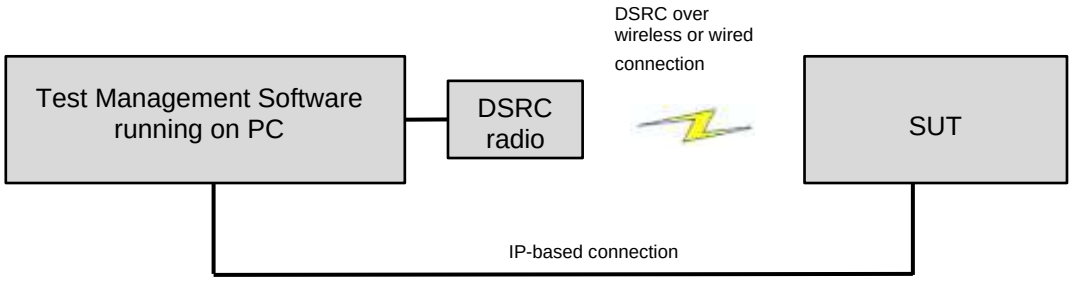


Figure 2: Test System Implementation

5.2.1 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 must 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 regarding the DSRC wireless exchanges since the IPv4 protocol is not supported for DSRC over-the-air transmissions.

5.3 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].

5.4 Interface Requirements

5.4.1 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.

5.4.2 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].

5.4.3 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.

6 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

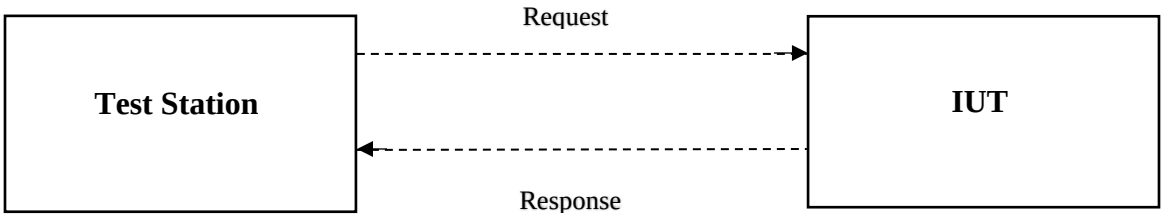
- **Request**: This message is initiated from the Test System to the SUT in order to stimulate the SUT to trigger requested functionality.
- **Response**: This message is sent from the SUT to the Test System indicating an acceptance of the *Request* by the SUT. Acceptance means ability of the SUT to 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:

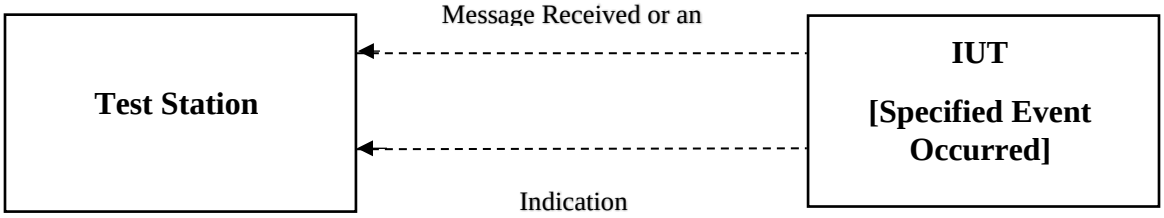
6.1.1 TS sends a request to SUT and receives a *Response*



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.

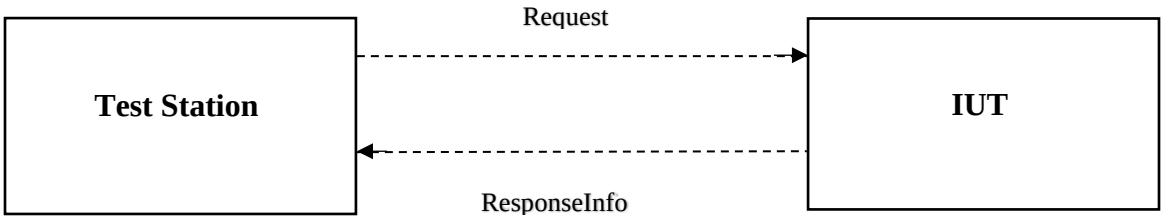
The response is an acknowledgement that the SUT received the test system's request and will be acting on it. It then executes the request. It is the TS that determines if the test passes or fails based on the result of the test.

6.1.2 SUT sends an unsolicited *Indication* to the TS



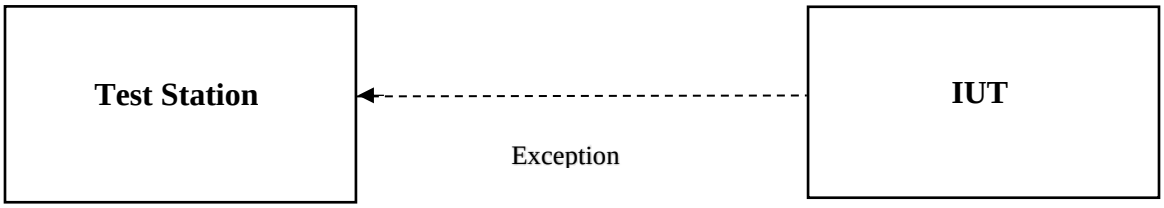
This communication exchange is initiated by the SUT. The SUT may send an unsolicited indication to the TS each time a packet is received and processed by the SUT or an event occurred on the SUT. Normally, the SUT will start (or stop) sending *Indications* after it is triggered by the TS. The TS never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

6.1.3 TS sends a request and receives information from the SUT



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.

6.1.4 SUT sends an unsolicited Exception to the SUT



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. The default encoding for all TCI messages is using **OER** encoding. Additional TCI message encodings, e.g. UPER, may also be supported. 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.

6.2 Transport Protocol

The communication between the TS and SUT uses UDP protocol messages flowing via IPv4-based link. The IP addresses for TS and SUT can be selected from the following ranges:

Testing System: 192.168.23.1 … 192.168.23.127, subnet 255.255.255.0

SUT: 192.168.23.128 … 192.168.23.254, subnet 255.255.255.0

In order to initiate the connection, the TS sends the initial *Request* message to a pre-defined UDP destination port (*defaultTCIAPort = 13001*), which the SUT opens to listen for incoming messages. When the SUT receives the first *Request* message from the TS, it saves the UDP source port of this request as *defaultTSPort.* The SUT uses the *defaultTSPort* UDP port to send *Response*, *ResponseInfo* messages as well as unsolicited *Indication* and *Exception* messages.

The TS must keep the *defaultTSPort* unchanged during continuous testing sequence until the TS and/or the SUT is reset, test sequence is interrupted, or another similar event takes place. When the testing is resumed, the previously described process is repeated: the SUT waits for the initial *Request* message on the *defaultTCIAPort*, stores the source port as the *defaultTSPort* and sends the response back to the *defaultTCIAPort*.

The SUT can receive the initial *Request* message of type *SetInitialState*, or *RequestSutAvailability*. The latter case will apply when the SUT is recovering from the previously received requests for *Shutdown* or *Restart*. The TS may also start the test execution with the *SetTestId*. Regardless which message is SUT receives first from the TS, the SUT will use the UDP source port from the first *Request* message from the TS and use it as the destination UDP port when the SUT sends messages to the TS.

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 *RequestSutAvailability* request messages.

7 Test Control Interface Messages

7.1 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 2.
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
	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.

7.2 Test Control Interface Modules

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

Table 2 TCI protocol modules

ASN.1 Module	Description
TCI-16093	Frame and message definition used for testing 1609.3
TCI-16094	Frame and message definition used for testing 1609.4
TCI-29451	Frame and message definition used for testing 2945/1
TCI-80211	Frame and message definition used for testing 802.11
TCI-CommonTypes	Common types shared across TCI modules
TCI-Dispatcher	Root module aggregating all other frame specific messages
TCI-EventHandling	Common event-handling types shared by other modules
TCI-SutControl	Device-level commands for controlling SUT
TCI-indication	Common indication messages shared by other modules
TCI-ip	Request messages for sending and receiving IPv6 packets
TCI-responseInfo	Returns Version Information from IUT
TCI-wsm	Request messages for sending and receiving WSM packets

For example, several TCI frames trigger transmission of WSM. Those requests are defined in the *TCI-wsm* module and included into the corresponding modules *TCI-16093*, *TCI-80211*, etc. by reference. Similarly, requests to transmit IPv6 packets are defined in the *TCI-ip* module and imported into the modules *TCI-16093*, *TCI-16094*, etc. by reference.

8 Common TCI modules

This section describes common messages shared by TCI frames.

8.1 TCI-wsm module

The *TCI-wsm* module 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, by default, OER encoding. Due to encoding difference, the same parameters values may have different representation once encoded for transmission as WSM compared to TCI messages.

8.1.1 Request messages

8.1.1.1 SetInitialState

This request is used to set the SUT in initial condition. The initial condition defines the initial state in which the SUT must 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].

8.1.1.2 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              Time64 OPTIONAL,
    channelLoad             Opaque OPTIONAL,
    repeatRate              RepeatRate OPTIONAL,
    Payload                 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].
repeatRate	Repeat rate for messages as defined in 1609.3 [8] as number of messages per 5 sec intervals. Additionally, it 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.

8.1.1.3 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] and must be preceded by StartWsmTxInfo to set up the transmitter parameters.

```
StartWsmTx ::= SEQUENCE {
 psid                 Psid,
 radio                RadioInterface,
 repeatRate           RepeatRate,
 payload              Opaque OPTIONAL,
 ...
}
```

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] as number of messages per 5 sec intervals. Additionally, it 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.

8.1.1.4 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.

8.1.1.5 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 *WMEChannelService* from 1609.3[8].

```
StartWsmRx ::= SEQUENCE{

    psid                    Psid OPTIONAL,
    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.

8.1.1.6 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.

8.1.1.7 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 '00000000000000000000000'B,
 advertiserId               AdvertiserIdentifier OPTIONAL,
 serviceInfos               ServiceInfos,
 channelinfos               ChannelInfos,
```

```
 wra                          RoutingAdvertisement OPTIONAL,
 dataRate                     DataRate80211 OPTIONAL,
userPriority            UserPriority OPTIONAL,
transmitPowerLevel      TXpower80211 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] as number of messages per 5 sec interval. Additionally, it 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.
dataRate	Data Rate used for transmission of WSMs containing WSA. If omitted, use default value from the MIB
userPriority	User Priority used for transmission of WSMs containing WSA. If omitted, use default value from the MIB
transmitPowerLevel	Transmit Power setting used for transmission of WSMs containing WSA. If omitted, use default value from the MIB

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

8.1.1.6 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.

8.1.1.7 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.

8.1.1.8 ChangeWsaProviderService

This request is used to change a provider service and updates WSA.

```
ChangeWsaProviderService ::= SEQUENCE{

     radio                RadioInterface

     serviceInfos         ServiceInfos

     …

}
```

7.1.1.9 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.

8.1.1.10 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,
 wsaChannelIdentifier        ChannelNumber80211 OPTIONAL,
 channelAccess               TimeSlot OPTIONAL,
 evenHandling                EventHandling,
...
}
```

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 include 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].
immediateAccess	Channel Load as defined in 1609.3 [8].
wsaChannelIdentifier	Channel number to transmit WSAs as defined in 1609.3 [8].
channelAccess	Channel to listen for WSA
eventHandling	Event Handling when service is joined

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

8.1.1.12 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.

8.1.2 Content Type

The *TCI-wsm* module specifies content types. There are 7 content types in the TCI-wsm

```
ContentType ::= ENUMERATED {
mOther         (0),
mIeee16092Data (1),
mWSA           (2),
mBSM           (3),
mMAP           (4),
mSPAT          (5),
mTIM           (6)
}
```

8.2 TCI-ip module

The *TCI-ip* module 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.

8.2.1 Base Classes

8.2.1.1 IPv6TxRecord

This base class specifies ……

```
Ipv6TxRecord ::= SEQUENCE{
   Radio              radioInterface
   interfaceName      UTF8STRING(SIZE(1..255)),
   destIpAddress      IPv6Address,
   destPort           ServicePort OPTIONAL
   Protocol           ENUMERATED {tcp, udp, icmp},
   repeatRate         RepeatRate OPTIONAL,
   eventHandling      EventHandling (WITH COMPONENTS {…, eventFlag}) OPTIONAL
   Payload            Opaque OPTIONAL,
   …
}
```

8.2.1.2 IPv6RxRecord

This base class specifies ……

```
IPv6RxRecord ::= SEQUENCE{
   radio              RadioInterface,
   interfaceName      UTF8String(SIZE(1...255))
   listenPort         ServicePort
   Protocol           ENUMERATED {tcp (0), udp (1)},
   eventHandling      EventHandling (WITH COMPONENTS {…, eventFlag({eIpv6PktRx})})
OPTIONAL
   …
}
```

8.2.2 Request messages

8.2.2.1 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 found in the *TCI-responseInfo* module and contains:

```
Ipv6InterfaceInfo ::= SEQUENCE OF SEQUENCE {
       interfaceName  UTF8String(SIZE(1..255)), ,
        ipAddress     SEQUENCE OF IPv6Address,
        macAddress    MACaddress,
        defaultGateway       IPv6Address OPTIONAL,
        primaryDns           IPv6Address OPTIONAL,
        gatewayMacAddress    MACaddress OPTIONAL,
 ...
}
```

8.2.2.2 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,

         ...
}
```

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.

8.2.2.3 StartIPv6Tx

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

```
StartIPv6Tx ::= IPv6TxRecord(WITHCOMPONENTS{
 radio                RadioInterface,
 interfaceName        UTF8String(SIZE(1...255)),
 destIpAddress        IpAddress,
 destPort             IpPort OPTIONAL,
 protocol             ENUMERATED { tcp, udp, icmp },
 repeatRate       RepeatRate OPTIONAL, -- number of msg per 5 sec interval
 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 contents of the message.

8.2.2.4 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.

8.2.2.5 StartIpv6Ping

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.

```
StartIPv6Ping ::= IPv6TxRecord (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 as number of messages per 5 sec intervals. Additionally, it 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.

8.2.2.6 StopIPv6Ping

```
StopIPv6Ping ::= IPv6TxRecord (WITH COMPONENTS{
   Radio (WITH COMPONENTS {…, antenna ABSENT}),
   interfaceName,
   destIpAddress,
   destPort ABSENT
   Protocol (icmp),
   repeatRate ABSENT,
   eventHandling ABSENT
   Payload ABSENT
})
```

See Table 17 for an explanation.

8.2.2.7 StartIPv6Rx

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

```
StartIPv6Rx ::= IPv6RxRecord (WITH COMPONENTS{
       radio
       interfaceName
       listenPort
       protocol
       eventHandling  PRESENT
})
```

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.

8.2.2.8 StopIPv6Rx

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

```
StopIPv6Rx ::= IPv6RxRecord (
 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.

8.3 Response, ResponseInfo, Indication and Exception messages

8.3.1 Response messages

The *Response* message is sent in response to the *Request*. It is defined in the *TCI-CommonType* 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.

8.3.2 Indication messages

The *Indication* message is sent from the SUT to TS. It is defined in the *TCI-indication* module.

```
Indication ::= SEQUENCE{
 radio             RadioInterface (WITH COMPONENTS {…, antenna ABSENT}),
 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 *TCI-Indication* module.

Table 22 Events which can trigger Indication messages

Parameters	Enumerated	Explanation
e80211PktRx	1	SUT received an inbound 802.11 frame
e16093PktRx	2	SUT received an inbound 1609.3 packet
eWsmPktRx	3	SUT received an inbound WSM (with matching PSID)
eIpv6PktRx	4	SUT received an inbound IPv6 frame over DSRC
eIcmp6PktRx	5	SUT received an inbound ping (ICMP) IPv6 echo message
eIpv6ConfigChanged	6	SUT IPv6 address change on one of the DSRC radio interfaces
eDot3ChannelAssigned	7	SUT assigned a channel as per WME-Notification.indication
eDot3RequestMatchedAvailAppService	8	request matched with available application-service as per WMENotification.indication
eDot2VerificationCompleteWithResult	9	Inbound WSM or WSA message signature verification is complete
exception	15	SUT generated an exception.

8.3.3 ResponseInfo messages

This message is used to retrieve configuration information from the SUT. It is defined in the *TCI-responseInfo* 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.

8.3.4 Exception messages

Exception is a message sent from the SUT to the TS. It is used to report certain conditions to the TS. There are 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. It is defined in the *TCI-CommonTypes* module.

```
Exception ::= SEQUENCE{
   type        ExceptionType,
   id          ExceptionId OPTIONAL,
   module      Module OPTIONAL,
   text        Exception 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

9 TCI frames

9.1 TCI80211 frame

9.1.1 Supported use cases

Use cases (UC) supported by **TCI80211** 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	Set the WSM Transmission Info	TS → SUT SUT → TS	request.setWsmTxInfo
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

9.1.2 *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* and Type corresponding to the *Request* message.

Most of these messages are imported from the common *TCI-wsm* module.

Table 27 Listing of *Request* messages

Request Messages Type	MsgID	Explanation
SetInitialState	1	Request to configure SUT to the Initial state
Dot11SetWsmTxInfo	2	Request to configure the WSM transmission information
Dot11StartWsmTx	3	Request to start transmission of WSMs
StopWsmTx	4	Request to stop transmission of WSMs
StartWsmRx	5	Request to start reception of WSMs
StopWsmRx	6	Request to stop reception of WSMs

9.1.2.1 SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCI-wsm* module.

9.1.2.2 Dot11SetWsmTxInfo

This request is used to configure device parameters before transmitting WSMs per 80211. This request correlates to the pre-defined *setWsmTxInfo* request in the *TCI-wsm* module.

```
Dot11SetWsmTxInfo ::= SetWsmTxInfo (WITH COMPONENTS {
                psid,
                radio,
                security,
                channelIdentifier,
                timeslot,
                dataRate,
                transmitPowerLevel,
                infoElementsIncluded,
                userPriority,
                destinationMACAddr ('FFFFFFFFFFFF'H),
                expiryTime            ABSENT,
                channelLoad           ABSENT,
                repeatRate            ABSENT,
                payload               ABSENT
})
```

9.1.2.3 Dot11StartWsmTx

This request is used to initiate transmission of WSMs by the SUT. This request correlates to the pre-defined *StartWsmTx* request in the *TCI-wsm module*.

```
Dot11StartWsmTx ::= StartWsmTx (WITH COMPONENTS {
                psid,
                radio,
                repeatRate            ABSENT,
                payload                ABSENT
})
```

9.1.2.4 StopWsmTx

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

9.1.2.5 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 *TCI-wsm* module.

9.1.2.6 StopWsmRx

This request is used to stop the SUT reception of messages and generation of *Indication* messages. This request is defined in the *TCI-wsm* module.

9.1.3 *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCI-CommonTypes*

module.

9.1.4 *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. *TCI-80211* 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 *TCI-indication* module.

9.1.5 *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 *TCI-CommonTypes* module.

9.2 TCI16094 frame

9.2.1 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	Add Transmit Profile of SUT	TS → SUT SUT → TS	request.AddTxProfile response
8	Delete Transmit Profile of SUT	TS → SUT SUT → TS	request.DelTxProfile response
9	The TS requests information from the SUT about the radio (0..3) used for IPv6 Communication	TS → SUT SUT → TS	request.GetIpv6InterfaceInfo response
10	The SUT transmits single or periodic IPv6 packets	TS → SUT SUT → TS	request. StartIPv6Tx response

11	The SUT stops transmitting periodic IPv6 packets	TS → SUT SUT → TS	request. StopIPv6Tx response
12	The SUT receives IPv6 packets and sends event indications to the TS	TS → SUT SUT → TS	request. StartIPv6Rx response
13	The SUT stops receiving IPv6 packets	TS → SUT SUT → TS	request. StopIPv6Rx response
14	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
15	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. StartIpv6Pingresponse
16	The SUT stops transmission of ping to another IPv6 device	TS → SUT SUT → TS	Request StopIPv6Ping response

9.2.2 *Request* Messages

Table 29 lists all supported R*equest* messages supported in the *TCI-16094* 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	2	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
StartIPv6Tx	9	Request to start transmission of IPv6 packets
StopIPv6Tx	10	Request to stop transmission of IPv6 packets
StartIPv6Rx	11	Request to start reception of IPv6 packets
StopIPv6Rx	12	Request to stop reception of IPv6 packets
StartIpv6Ping	13	Transmit ping messages over IPv6 and receive ping echo from the remote host
StopIpv6Ping	14	Stop transmission of ping messages over IPv6

AddTxProfile	15	Add transmission profile for IPv6 testing without WSA
DelTxProfile	16	Delete transmission profile for Ipv6 testing without WSA

9.2.2.1 SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCI-wsm* module.

9.2.2.2 Dot4SetWsmTxInfo

This request is used to configure the SUT's WSM transmission parameters. This request correlates to the pre-defined *setWsmTxInfo* request in the *TCI-wsm* module.

9.2.2.3 Dot4StartWsmTX

This request is used to initiate transmission of WSMs by the SUT. This request correlates to the pre-defined *startWsmTx* request in the *TCI-wsm* module.

9.2.2.4 StopWsmTx

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

9.2.2.5 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 *TCI-wsm* module.

9.2.2.6 StopWsmRX

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

9.2.2.7 GetIpv6InterfaceInfo

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

9.2.2.8 SetIpv6Address

This request is used to change SUT IPv6 configuration. This request is defined in the *TCI-ip* module.

9.2.2.9 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.

9.2.2.10 StopIPv6Tx

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

9.2.2.11 StartIPv6Rx

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

9.2.2.12 StopIPv6Rx

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

9.2.2.13 StartIpv6Ping

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 *TCI-ip* module.

9.2.2.14 StopIpv6Ping

This request stops transmission of ping messages from the SUT over IPv6. This request is defined in the *TCI-ip* module.

9.2.2.15 AddTxProfile

This request adds transmissions profile of the SUT for IPV6 Testing without WSAs. This request is defined in the *TCI-ip* module.

9.2.2.16 DelTxProfile

This request deletes the transmission profile of the SUT for IPV6 Testing without WSAs. This request is defined in the *TCI-ip* module.

9.2.3 *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCI-CommonTypes*

module.

9.2.4 *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. *TCI-16094* 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 *TCI-indication* module.

9.2.5 *ResponseInfo* messages

This message is used to retrieve configuration information from SUT.

```
Dot4ResponseInfo ::= ResponseInfo (WITH COMPONENTS{

msgId,

resultsCode

info (WITH COMPONENTS {ipv6InterfaceInfo} ) OPTIONAL
```

```
exception OPTIONAL
})
```

9.2.6 *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 *TCI-CommonTypes* module.

9.3 TCI16093 frame

9.3.1 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.

9.3.2 *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
ChangeWsaProviderService	10	Request to change a service provider to an existing WSA broadcast

DelWsaProviderService	11	Request to delete a service provider from an existing WSA broadcast
AddUserService	12	Request to add a user service
DelUserService	13	Request to delete a user service
GetIpv6InterfaceInfo	14	Request to SUT to report its IPv6 configuration
SetIpv6Address	15	Request to SUT to set its IPv6 address
StartIpv6Ping	16	Request to SUT to send a ping (ICMP over IPv6)
StopIpv6Ping	17	Request to SUT to stop sending ping (ICMP over IPv6)

9.3.2.1 SetInitialState

This request is used to set the SUT in initial condition. This request is defined in the *TCI-wsm* module.

9.3.2.2 Dot3SetWsmTxInfo

This request is used to configure the SUT's WSM transmission parameters. This request correlates to the pre-defined *SetWsmTxInfo* request in the *TCI-wsm* module.

9.3.2.3 Dot3StartWsmTx

This request is used to initiate transmission of WSMs by the SUT. Information about the expected content of the WSM needs to be set via the 8.3.2.2 Dot3SetWsmTxInfo request before. This request correlates to the pre-defined *StartWsmTx* request in the *TCI-wsm* module.

9.3.2.4 StopWsmTx

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

9.3.2.5 StartWsaTxPerdiodic

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

9.3.2.6 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 *TCI-wsm* module.

9.3.2.7 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 *TCI-wsm* module.

9.3.2.8 StopWsmRx

This request is used to stop the SUT's reception of messages and generation of *indication* messages. This request is defined in the *TCI-wsm* module.

9.3.2.9 AddWsaProviderService

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

9.3.2.10 changeWsaProviderService

This request is used to change a provider service and update WSA. This request is defined in the TCI-wsm module.

9.3.2.10 DelWsaProviderService

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

9.3.2.11 AddUserService

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

9.3.2.12 DelUserService

This request is used to delete a user service on the SUT previously requested by the *AddUserService* request. This request is defined in the *TCI-wsm* module.

9.3.2.13 GetIpv6InterfaceInfo

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

9.3.2.14 SetIpv6Address

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

9.3.2.15 StartIpv6Ping

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 *TCI-ip* module.

9.3.2.16 StopIpv6Ping

This request is used to stop requesting the SUT to transmit ping messages. This request is defined in the TCI-ip module.

9.3.3 *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCI-CommonTypes*

module.

9.3.4 *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. *TCI-16093* defines *Dot3Indication* as follows:

```
Dot3Indication ::= Indication (WITH COMPONENTS {
radio,
       event ( e16093PktRx |
                     eWsmPktRx |
                     eIpv6PktRx |
                     eIcmp6PktRx |
                     eIpv6ConfigChanged |
                     eDot3ChannelAssigned |

eDot3RequestMatchedAvailAppServiceexception),
      eventParams      (WITH COMPONENTS {wsm} |
                        WITH COMPONENTS {ip} |
                    WITH COMPONENTS {security}
                       ) OPTIONAL,
 pdu OPTIONAL,
 exception OPTIONAL
 })
```

where *Indication* is defined in the *TCI-indication* 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* message with an *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.

9.3.5 *ResponseInfo* messages

This message is used to retrieve configuration information from the SUT.
TCI-16093 defines *Dot3ResponseInfo* as follows:

```
Dot3ResponseInfo ::= ResponseInfo (WITH COMPONENTS {
       msgID,
       resultCode,
       info (WITH
       COMPONENTS {
       ipv6InterfaceInfo}  ) OPTIONAL, 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.

9.3.6 *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 *TCI-CommonTypes* module.

9.4 TCI29451 frame

Use cases supported by TCI29451 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.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 after turning off GPS input	TS → SUT SUT → TS TS → SUT SUT → TS	request.EnableGpsInput = false response request.SetLatitude response request.SetLongitude response request.SetElevation response etc.
7	Change the position of the SUT after turning off GPS input	TS → SUT SUT → TS TS → SUT SUT → TS	request.EnableGpsInput = false response request.SetLatitude response request.SetLongitude response
8	Change the speed of the SUT after turning off GPS input	TS → SUT SUT → TS TS → SUT SUT → TS	request.EnableGpsInput = false response request.SetSpeed response
9	Change the heading of the SUT after turning off GPS input	TS → SUT SUT → TS TS → SUT SUT → TS	request.EnableGpsInput = false response request.SetHeading 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 after turning off GPS input	TS → SUT SUT → TS TS → SUT SUT → TS	request.EnableGpsInput = false response request.SetAccelerationSet4Way response
12	Set the exterior lights status of the SUT	TS → SUT SUT → TS	request.SetExteriorLightsStatus response

13	Turn the GPS input of the SUT on or off	TS → SUT SUT → TS	request.EnableGpsInput 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
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.SetTransmissionState response
20	Set the availability of individual brake pedal status of the SUT	TS → SUT SUT → TS	request.SetBrakeSystemStatus response

9.4.1 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 TCI29451 frame

Request Messages	MsgID	Explanation
SetInitialState	1	Set the SUT to the Initial state
EnableGpsInput (deprecated)	2	Set a position for the SUT, overwriting its current position
StartBsmTx	3	Begin transmission of BSMs
StopBsmTx	4	Stop transmission of BSMs
EnableCongestionMitigation	5	Enable or disable the congestion mitigation on the SUT
SetTemporaryId	6	Set the temporary ID of the SUT, overwriting the current ID
SetLatitude (deprecated)	7	Set the Latitude of the SUT, overwriting the current Latitude
SetLongitude (deprecated)	8	Set the Longitude of the SUT, overwriting the current Longitude
SetElevation (deprecated)	9	Set the Elevation of the SUT, overwriting the current Elevation
SetPositionalAccuracy (deprecated)	10	Change the position of the SUT relative to its current position
SetTransmissionState	11	Set the transmission state of the SUT, overwriting its current transmission
SetSpeed (deprecated)	12	Change the speed of the SUT relative to its current speed
SetHeading (deprecated)	13	Change the heading of the SUT relative to its current heading
SetSteeringWheelAngle	14	Set the steering wheel angle of the SUT, overwriting the current steering wheel angle
SetAccelerationSet4Way (deprecated)	15	Set the 4Way acceleration of the SUT, overwriting the current 4Way acceleration
SetBrakeSystemStatus	16	Enable or disable the brake pedal status of the SUT
SetVehicleSize	17	Set the Vehicle Size in the SUT
SetExteriorLights	18	Set the exterior lights status of the SUT, overwriting its current light status
SetVehicleEventFlags	19	Set the vehicle flags of the SUT, overwriting its current flags
StartBsmRx	20	Begin reception of BSMs
StopBsmRx	21	Stop reception of BSMs
SetGpsTime (deprecated)	22	Set the Gps time of the SUT.

9.4.1.1 SetInitialState

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

9.4.1.2 EnableGpsInput (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.6 enableGpsInputEnableGpsInput.

9.4.1.3 StartBsmTx

This request is used to start BSM transmission on the SUT. The *StartWSMTx* request is predefined in *TCI-wsm* module.

```
StartBsmTx ::= StartWsmTx (WITH COMPONENTS {

    psid  (WITH COMPONENTS {content (32)}),

    radio,

    repeatRate,

    payload ABSENT

})
```

9.4.1.4 StopBsmTx

This request is used to stop BSM transmission on the SUT. The *StopWSMTx* request is predefined in *TCI-wsm* module.

```
StopBsmTx ::= StopWsmTx (WITH COMPONENTS {

    psid (WITH COMPONENTS {content  (32)})

})
```

9.4.1.5 EnableCongestionMitigation

This request sets the congestion mitigation of the SUT.

```
EnableCongestionMitigation ::= BOOLEAN
```

9.4.1.6 SetTemporaryId

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

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

9.4.1.7 SetLatitude (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.7 setLatitudeSetLatitude.

9.4.1.8 SetLongitude (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.8 setLongitudeSetLongitude.

9.4.1.9 SetElevation (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.9 setElevationSetElevation.

9.4.1.10 SetPositionalAccuracy (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.10 setPositionalAccuracySetPositionalAccuracy

9.4.1.11 SetTransmissionState

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

```
SetTransmissionState ::= 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

9.4.1.12 SetSpeed (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.11 setSpeedSetSpeed.

9.4.1.13 SetHeading (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.12 setHeadingSetHeading.

9.4.1.14 SetSteeringWheelAngle

The request is used to set the steering wheel angle of the SUT.

```
SetSteeringWheelAngle ::= INTEGER (-126... 127)
```

9.4.1.15 SetAccelerationSet4Way (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.13 setAccelerationset4WaySetAccelerationSet4Way.

9.4.1.16 SetBrakeSystemStatus

The request is used to set the status of the brake system of the SUT.

```
SetBrakeSystemStatus ::= SEQUENCE {
    brakeAppliedStatus      BIT STRING {
        unavailable (0),
        leftFront   (1),
        leftRear    (2),
        rightFront  (3),
        rightRear   (4)
    },
    tractionControlStatus    ENUMERATED {
        unavailable (0),
        off         (1),
        on          (2),
        engaged     (3)
    },
```

```
    antiLockBrakeStatus      ENUMERATED {
        unavailable (0),
        off         (1),
        on          (2),
        engaged     (3)
    },
    stabilityControlStatus   ENUMERATED {
        unavailable (0),
        off         (1),
        on          (2),
        engaged     (3)
    },
    brakeBoostApplied        ENUMERATED {
        unavailable (0),
        off         (1),
        on          (2)
    },
    auxiliaryBrakeStatus     ENUMERATED {
        unavailable (0),
        off         (1),
        on          (2),
        reserved    (3)
    }
}
```

9.4.1.17 SetVehicleSize

The request sets the vehicle size in the SUT.

```
SetVehicleSize ::= SEQUENCE{
    vehicleWidth     INTEGER(0 .. 1023),
    vehicleLength    INTEGER(0 .. 4095)
}
```

9.4.1.18 SetExteriorLights

The request sets the exterior lights in the SUT.

```
SetExteriorLights ::= BIT STRING
{
   lowBeamHeadlightsOn       (0),
   highBeamHeadlightsOn      (1),
```

```
    leftTurnSignalOn          (2),
    rightTurnSignalOn         (3),
    hazardSignalOn            (4),
    automaticLightControlOn   (5),
    daytimeRunningLightsOn    (6),
    fogLightOn                (7),
    parkingLightsOn           (8)
}
```

9.4.1.19 SetVehicleEventFlags

```
SetVehicleEventFlags ::= BIT STRING {
    eventHazardLights               (0),
    eventStopLineViolation          (1),
    eventABSactivated               (2),
    eventTractionControlLoss        (3),
    eventStabilityControlActivated  (4),
    eventHazardousMaterials         (5),
    eventReserved1                  (6),
    eventHardBraking                (7),
    eventLightsChanged              (8),
    eventWipersChanged              (9),
    eventFlatTire                   (10),
    eventDisabledVehicle            (11),
    eventAirBagDeployment           (12)
}
```

9.4.1.20 StartBsmRx

This request starts BSM reception on the SUT. The *StartWsmRx* request is predefined in *TCI-wsm* module

```
StartBsmRx ::= StartWsmRx (WITH COMPONENTS {
    psid   (WITH COMPONENTS {content    (32)}), -- PSID is optional if
eventHandling.rxFlag is set to receive any WSM with PSID
    radio ( WITH COMPONENTS { ..., antenna ABSENT }),
    channelIdentifier (172),        -- default value for BSM
    timeSlot (continuous),          -- default value for BSM
    eventHandling
    })
```

9.4.1.21 StopBsmRx

This request starts BSM reception on the SUT. The *StopWsmRx* request is predefined in *TCI-wsm* module

```
StopBsmRx ::= StopWsmRx (WITH COMPONENTS {
```

```
        psid (WITH COMPONENTS {content  (32)})
    })
```

9.4.1.22 setGpsTime (Deprecated)

This request was moved to the *TCI-SutControl* module. Refer to 8.5.2.14 setGpsTimeSetGpsTime.

9.4.2 *Response* messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCI-CommonTypes* module.

9.4.3 *Indication* messages

The *Indication* message is sent from the SUT to the TS indicating an occurrence of a predefined event. *TCI-29451* 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 *TCI-indication* module.

9.4.4 *ResponseInfo* messages

TCI-29451 does not use *ResponseInfo* messages.

9.4.5 *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 *TCI-CommonTypes* module.

9.5 TCISutControl frame

9.5.1 Supported use cases

Use cases (UC) supported by *TCI-SutControl* are listed in Table 34.

Table 34 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.RequestSutAvailability response
4	Request SUT version information	TS → SUT SUT → TS	request.RequestSutInfo responseInfo
5	Provide information about Test ID to the SUT	TS → SUT SUT → TS	request.SetTestId response
6	Request enable/disable GPS input of the SUT	TS → SUT SUT → TS	request.enableGpsInput response
7	Set the latitude of the SUT	TS → SUT SUT → TS	request.setLatitude response
8	Set the longitude of the SUT	TS → SUT SUT → TS	request.setLongitude response
9	Set the elevation of the SUT	TS → SUT SUT → TS	request.setElevation response
10	Set the positional accuracy of the SUT	TS → SUT SUT → TS	request.setPositionalAccuracy response
11	Set the speed of the SUT	TS → SUT SUT → TS	request.setSpeed response
12	Set the heading of the SUT	TS → SUT SUT → TS	request.setHeading response
13	Set the 4-way acceleration of the SUT	TS → SUT SUT → TS	request.setAccelerationSet4Way response
14	Set the GPS time of the SUT	TS → SUT SUT → TS	request.setGpsTime response

9.5.2 *Request* messages

Table 35 lists all supported R*equest* messages in the *TCI-SutControl* module.

Table 35 Listing of *Request* messages

Request Messages	MsgID	Explanation
Shutdown	1	Request to shut the SUT down.
Restart	2	Request to restart the SUT.
RequestSutAvailability	3	Request SUT availability status.
RequestSutInfo	4	Request information about SUT version
SetTestId	5	Send Test ID information to the SUT
EnableGpsInput	6	Enable/Disable GPS on the SUT
SetLatitude	7	Set the latitude of the SUT
SetLongitude	8	Set the longitude of the SUT
SetElevation	9	Set the elevation of the SUT
SetPositionalAccuracy	10	Set the positional accuracy of the SUT

SetSpeed	11	Set the speed of the SUT
SetHeading	12	Set the heading of the SUT
SetAccelerationSet4Way	13	Set the 4-way acceleration of the SUT
SetGpsTime	14	Set the GPS time of the SUT

9.5.2.1 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.

9.5.2.2 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.

9.5.2.3 RequestSutAvailability

This request is used to poll the availability of the SUT after a preceding restart. 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 SUT is not ready if it doesn't respond within the response timeout of **50ms** or includes the ResultCode = rcFailure.

9.5.2.4 RequestSutInfo

This request is used to obtain version information from the SUT. This request must be answered with the *SutResponseInfo* message. The version information can be referenced in test reports and other test documentation.

9.5.2.5 SetTestId

This request is used to send a Test identifier to the SUT. The Test ID is a text string e.g. "TP-16093-WSMMST-BV-01" which the SUT can reference in its own log file. This message could be used for identifying tests in all TCI frames, i.e. TCI16093, TCI80211, TCI16094, etc.

There is no time restriction when the TS can send this message. Though, it is recommended that the *SetTestId* message is sent at the beginning of each individual test, after the *request.SetInitialState --> response* sequence is completed.

9.5.2.6 EnableGpsInput

This request sets GPS Input to true or false. If it is set to *True*, the SUT will use its own GPS data input to retrieve positioning data. If it is set to *False*, the SUT will retrieve all positioning related data via TCI messages SetLatitude, SetLongitude, SetElevation, SetPositionalAccuracy, SetSpeed, SetHeading, SetAccelerationSet4Way, and SetGpsTime.

Note that in case not all data were provided via TCI, the SUT should use previously stored values or initial values.

```
EnableGpsInput ::= BOOLEAN
```

9.5.2.7 SetLatitude

This request sets the latitude of the position of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetLatitude ::= Latitude
```

9.5.2.8 SetLongitude

This request sets the longitude of the position of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetLongitude ::= Longitude
```

9.5.2.9 SetElevation

This request sets the elevation of the position of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
 SetElevation ::= Elevation
```

9.5.2.10 SetPositionalAccuracy

This request sets the positional accuracy of the position of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
  SetPositionalAccuracy ::= SEQUENCE{

    semiMajorAxisAccuracy   INTEGER (0 .. 255),

    semiMinorAxisAccuracy   INTEGER (0 .. 255),

    semiMajorAxisOrientation   INTEGER (0 .. 65535)

}
```

9.5.2.11 SetSpeed

This request sets the current speed of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetSpeed ::= INTEGER (0 .. 8191)
```

9.5.2.12 SetHeading

This request sets the heading of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetHeading ::= INTEGER (0 .. 28800)
```

9.5.2.13 SetAccelerationSet4Way

This request sets the 4-way acceleration of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetAccelerationSet4Way ::= SEQUENCE {

    longAcceleration INTEGER (-2000 .. 2001),
```

```
    latAcceleration INTEGER (-2000 .. 2001),
    verticalAcceleration INTEGER (-127 .. 127),
    yawRate INTEGER (-32767 .. 32767)
}
```

9.5.2.14 SetGpsTime

This request sets the GPS time of the SUT.

Note that this command can only be processed if the GPS data input was set to *False* via the *EnableGpsInput* request.

```
SetGpsTime ::= Time64
```

9.5.3 Response messages

The *Response* message is sent in response to the *Request*. *Response* is defined in the *TCI-CommonTypes* module.

9.5.4 *ResponseInfo* messages

This message is used to retrieve version information from the SUT.
TCI-SutControl defines *SutResponseInfo* as follows:

```
SutResponseInfo ::= ResponseInfo (WITH COMPONENTS {
   msgID,
   resultCode,
   info (WITH COMPONENTS {sutInfo}) OPTIONAL, -- if exception reported, no InfoContent
provided
   exception OPTIONAL
   })
```

Table 36 ResponseInfo message

Parameters	Explanation
msgID	Use the same MsgID from the corresponding *Request* message. MsgIDs are listed in the Table 35Table 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 the 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 8.5.5

The *SutResponseInfo* is derived from the *ResponseInfo* definition in the *TCI-responseInfo* module. Specific details for each type definition are listed in the ASN.1 specification referenced in Appendix A.

9.5.5 *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 *TCI-CommonTypes* module.

Appendix A: 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 file is posted in github at the following location:

https://github.com/certificationoperatingcouncil/TCI_ASN1

TCIdispatch.asn
TCIMsg
Frame

TCI1609.3.asn
TCI16093
 Request
 MESSAGE-ID-AND-TYPE
 MessageTypes
 Dot3SetWsmTxInfo
 Dot3StartWsmTx
 Dot3Indication
 Dot3ResponseInfo

TCI16094.asn
 TCI16094
 Request
 MESSAGE-ID-AND-TYPE
 MessageTypes
 Dot4SetWsmTxInfo
 Dot4StartWsmTx
 Dot4Indication
 Dot4ResponseInfo

TCI29451.asn
 TCI29451
 Request
 MESSAGE-ID-AND-TYPE
 MessageTypes StartBsmTx
 StopBsmTx
 EnableCongestionMitigation
SetTemporaryID
SetTransmissionState
SetSteeringWheelAngle
SetBrakeSystemStatus
SetVehicleSize
SetVehcileEventFlags
SetExteriorLights
D2945Indication

TCI80211.asn
TCI80211
Request
MESSAGE-ID-AND-TYPE
MessageTypes
Dot11SetWsmTxInfo
Dot11StartWsmTx
Dot11Indication

TCIEventHandling.asn
EventHandling
RxFlag
EventFlag
SecurityFlag
EventParamsChoice

TCIindication.asn
Indication
Event
EventParams
Pdu
ServiceParameters
WsmParameters
IpParameters
D80211Parameters
SecResultParams
SecurityResultCode

TCIip.asn
AddTxProfile
DelTxProfile
GetIPv6InterfaceInfo
SetIPv6Address
IPv6TxRecord
StartIPv6Tx
StopIPv6Tx
StartIPv6Ping
StopIPv6Ping
IPv6RxRecord
StartIPv6Rx
StopIPv6Rx

TCIresponseInfo.asn
ResponseInfo
InfoContent
Ipv6InterfaceInfo
SutInfo
VersionInfoBlock

TCISutControl.asn
TCISutControl
MESSAGE-ID-AND-TYPE
Request
MessageTypes
SetTestId
Shutdown
Restart
RequestSutInfo

SutResponseInfo
EnableGpsInput
SetGpsTime
SetLatitude
SetLongitude
SetElevation
SetPositionalAccuracy
SetSpeed
SetHeading
SetAccelrationSet4Way

TCIwsm.asn
setInitialState
SetWsmTxInfo
StartWsmTx
StopWsmTx
StartWsmRx
StopWsmRx
StartWsmTxPerdiodic
StopWsaTxPeriodic
AddWsaProviderService
ChangeWsaProviderService
delWsaProviderService
AddUserService
DelUserService
ContentType
SignerIdentifierType
SecurityContext
WaveElementsIncluded
UserRequestType
WsaType
ServiceInfos
ServiceInfo
ChannelOptions

TCICommonTypes.asn
PduData
PduType
Opaque
HashedId8
Response
ResultCode
Exception
ExceptionType
ExceptionText
RadioInterface
Radio
Antenna
Timeslot
RCPI
UserPriority
Time64
Psid
RepeatRate
MsgID

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

Open Issues

None ◙ End of Document ◙