

**Plug Fest Interoperability Test Cases**

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| --- | --- |
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# Scope

This document provides the test cases expected to be conducted as a part of the Plugfest interoperability that will be held at Danlaw’s facilities in Novi, Michigan in November of 2016. Some test cases may not be applicable if certificates are not available by the time of the Plugfest.

## References

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

[1] SAE J2945/1 D5.0: “On-board System Requirements for V2V Safety Communications”. Latest issue.

[2] SAE J2735, January 2016 issue. DSRC Message Set Dictionary.

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

[4] IEEE Std. 1609.2-2016: "IEEE Draft Standard for Wireless Access in Vehicular Environments - security Services for Applications and Management Messages".

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

[6] P1609.4™/D5 Draft Standard for Wireless Access in Vehicular Environments – Multi-Channel Operation. Latest issue.

[7] Test System Interface. Latest issue available on GitHub at: <https://github.com/certificationoperatingcouncil>

# Abbreviations

**SAE** Society of Automotive Engineers

**IEEE** Institute of Electrical and Electronics Engineers

**MAC** Media Access Control

**PHY** Physical Layer

**WAVE** Wireless Access in Vehicular Environments

**V2V** Vehicle-to-Vehicle

**DSRC** Dedicated Short Range Communications

**LAN** Local Area Network

**IUT** Implementation Under Test

**COC** Certification Operating Council

**RSU** Road Side Unit

**TCI** Test Control Interface

**IOP** Interoperability

**CFG** Configuration

**STD** Standard

**WSM** WAVE Short Message

**TPID** Transport Protocol Identifier

**PSID** Provider Service Identifier

**BSM** Basic Safety Message

**ID** Identifier

**WSA** Wave Service Advertisement

**TX** Transmit

**UDP** User Datagram Protocol

**IP** Internet Protocol

**IPv6** Internet Protocol Version 6

**I/F** Interface

# Prerequisites and Test Configurations

## Test Configurations

**IOP CFG 1**: Two IUTs are placed a short distance away from each other to allow for easy communication. One IUT may be replaced by a system provided by the COC specifically when an RSU functionality is required.

**IOP CFG 2**: One IUT is connected to a test apparatus cable of automatically testing the IUT through the TCI and returning a pass/fail verdict

# WSM Packet Validation

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 1 | | |
| **Summary:** | Transmit WSM with version number and ethertype | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSM |
| 2 | Stimulus | Device A transmits WSM |
| 3 | Verify | Reception of WSM by Device B |
|  | 4 | Verify | Received WSM contains version number and ethertype |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

## Transmit WSM with N Header / T Header

* + Optional (check contents)

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 2 | | |
| **Summary:** | Transmit WSM with N Header | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSM |
| 2 | Stimulus | Device A transmits WSM |
| 3 | Verify | Reception of WSM by Device B |
|  | 4 | Verify | Received WSM contains Subtype, Wave Info Element, and Count |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 3 | | |
| **Summary:** | Transmit WSM with T Header | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSM |
| 2 | Stimulus | Device A transmits WSM |
| 3 | Verify | Reception of WSM by Device B |
|  | 4 | Verify | Received WSM contains TPID, PSID, WSM Length, and WSM Data |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

## WSM Transmission Parameters

* Tested in WSM Packet Validation

## Reception of WSM

* Tested in WSM Packet Validation

## WSM communications with continuous channel

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 4 | | |
| **Summary:** | Transmit WSMs in continuous operation on selected channel | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  |  | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs. Channel and WSM Repeat Rate to be defined between two parties. | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSM |
| 2 | Stimulus | Device A transmits WSM at defined channel and repeat rate |
| 3 | Verify | Reception of WSM by Device B |
|  | 4 | Verify | Device B receives continuous streams of WSMs and verifies channel used. |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

## WSM communication with alternation channel access

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 5 | | |
| **Summary:** | Transmit WSMs in alternating operation on selected channels | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs. Channels and WSM Repeat Rate to be defined between two parties. | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit 2 WSMs, each WSM is transmitted on a different channel. |
| 2 | Stimulus | Device A transmits WSM at defined channels and repeat rate |
| 3 | Verify | Reception of WSMs by Device B |
|  | 4 | Verify | Device B detects WSMs on defined channels and time slots |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

## Transmission of WSMs with payload exceeding WsmMaxLength

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 6 | | |
| **Summary:** | Transmit WSM with payload exceeding WsmMaxLength | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs. Channels and WSM Repeat Rate to be defined between two parties. | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit 2 WSMs, each WSM is transmitted on a different channel. |
| 2 | Stimulus | Device A transmits WSM at defined channels and repeat rate |
| 3 | Verify | Reception of WSMs by Device B |
|  | 4 | Verify | Device B detects WSMs on defined channels and time slots |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

# BSM

## Transmissions of packets

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 7 | | |
| **Summary:** | Generate valid BSM security header | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [4] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive BSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit BSM |
| 2 | Stimulus | Device A transmits BSM |
| 3 | Verify | Reception of BSM by Device B |
|  | 4 | Verify | Received BSM contains protocol version and content in Ieee1609Dot2Data. Contains hashId in signedData. Contains protocol version, content in tbsData. Contains psid, generationTime and does not include expiryTime, generationLocation in headerInfo |
|  | 5 | Procedure | Repeat Step 1-4 for Device B |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 8 | | |
| **Summary:** | Test transmission and reception of “generic” BSMs | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [2] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) are able to be configured to transmit and receive BSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit BSM |
| 2 | Stimulus | Device A transmits BSM |
| 3 | Verify | Reception of BSM by Device B |
|  | 4 | Verify | Received BSM is successfully received and parsed |
|  | 5 | Procedure | Repeat Step 1-4 for Device B |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 9 | | |
| **Summary:** | Test transmission of BSMs with vehicle event flags | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [3] | | |
|  | | | |
| **Pre-test**  **conditions:** | An independent device (Device A) can connect to the test interface | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is placed in the test system |
| 2 | Stimulus | The test system begins the vehicle event flag test |
| 3 | Verify | Device A passes the test |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 10 | | |
| **Summary:** | Test message number rollover and Temporary ID of BSMs | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [4] | | |
|  | | | |
| **Pre-test**  **conditions:** | An independent device (Device A) can connect to the test interface | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is placed in the test system |
| 2 | Stimulus | The test system begins the vehicle event flag test |
| 3 | Verify | Device A passes the test |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 11 | | |
| **Summary:** | Test data randomization of BSMs | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | An independent device (Device A) can connect to the test interface | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is placed in the test system |
| 2 | Stimulus | The test system begins the data randomization test |
| 3 | Verify | Device A passes the test |

## Reception of packets

Tested in Transmission of packets

## Reception of packets – invalid behavior tests

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 12 | | |
| **Summary**: | Detection of invalid BSM | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [4] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSAs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit BSM |
| 2 | Stimulus | Device A transmits BSM |
| 3 | Verify | Reception of BSM by Device B |
|  | 4 | Verify | BSM signature contains ecdsaP256Signature indicating r and s not verifiable using (KEY) |
|  | 5 | Verify | Device B identifies BSM holds invalid security credential |
|  | 6 | Procedure | Repeat Step 1-4 for Device B |

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 13 | | |
| **Summary:** | Test whether IUT continues sending valid BSMs after receiving invalid data frames/elements | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [6] | | |
|  | | | |
| **Pre-test**  **conditions:** | An independent device (Device A) can connect to the test interface | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is placed in the test system |
| 2 | Stimulus | The test system sends a series of improper BSMs through the TCI |
| 3 | Verify | Device A continues sending valid BSMs throughout the test |

# WSA

## Transmission of packets

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 14 | | |
| **Summary:** | Transmit 1609.2 WSA security header | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [4] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSAs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSA |
| 2 | Stimulus | Device A transmits WSA |
| 3 | Verify | Reception of WSA by Device B |
|  | 4 | Verify | Received WSM contains protocolVersion and content in Ieee1609Dot2Data. Contains protocolVersion and content in tbsData. Contains psid, generationTime, expirtyTime and generationLocation in headerInfo |
|  | 5 | Procedure | Repeat Step 1-4 for Device B |

## Reception of packets

Tested in Transmission of packets

## Reception of packets -invalid behavior tests

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 15 | | |
| **Summary:** | Detection of invalid WSA | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [4] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSAs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSA |
| 2 | Stimulus | Device A transmits WSA |
| 3 | Verify | Reception of WSA by Device B |
|  | 4 | Verify | WSA signature contains ecdsaP256Signature indicating r and s not verifiable using (KEY) |
|  | 5 | Verify | Device B identifies WSA holds invalid security credential |
|  | 6 | Procedure | Repeat Step 1-4 for Device B |

## WSA packet validation

* Transmit WSM with valid header for WSA message
  + Optional (contents of N-Header can also be verified)

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 16 | | |
| **Summary:** | Transmit WSM with valid WSM header for WSA message | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs. | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSM |
| 2 | Stimulus | Device A transmits WSM with N-Header containing Subtype, TPID, PSID and WSM Length |
| 3 | Verify | Reception of WSM by Device B |
|  | 4 | Verify | Device B confirms the presence of content of N-Header |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

* Transmit WSA with version and valid WSA Header
  + Optional (Contents of WSA Header can also be verified)

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 17 | | |
| **Summary:** | Transmit WSM with version number and valid WSA header | | |
| **Configuration:** | IOP CFG 1 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 independent devices (Device A and Device B) configured to transmit and receive WSMs | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to transmit WSA with version, option indicator, identifier and content count |
| 2 | Stimulus | Device A transmits WSA |
| 3 | Verify | Reception of WSA by Device B |
|  | 4 | Verify | Device B confirms the presence of WSA header information |
|  | 5 | Verify | Repeat Step 1-4 for Device B |

## WSA reception

* Tested in WSA Packet Validation

## WSA transmission parameters

* Tested in WSA Packet Validation

## WSA changes

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 18 | | |
| **Summary:** | Change WSA Contents | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 devices, Device A running the TCI Message Generator software and Device B (Device under test)) | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to send Start WSA TX Periodic message. |
| 2 | Stimulus | Device A sends a UDP message with the selected WSA parameters. |
| 3 | Verify | Reception of message by Device B |
|  | 4 | Verify | Device B transmits WSA over the air with the proper parameters as contained in the UDP message. |
|  | 5 | Stimulus | Device A sends a modified Start WSA TX Periodic message. |
|  | 6 | Verify | Reception of modified message by Device B |
|  | 7 | Verify | Device B transmits the modified WSA over the air with the proper parameters as contained in the UDP message. |

# IPv6

## IP Configuration

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 19 | | |
| **Summary:** | Change IP address | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 devices, Device A running the TCI Message Generator software and Device B (Device under test)) | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to send Set IPv6 Address message. |
| 2 | Stimulus | Device A sends a UDP message with Set IPv6 Address message. |
| 3 | Verify | Reception of message by Device B |
|  | 4 | Verify | Device B transmits a UDP message indicating an IPv6 configuration changed message to device A. |
|  | 5 | Stimulus | Device A sends a Get IPv6 I/F Info message. |
|  | 6 | Verify | Device B transmits a UDP message with the new IPv6 address. |
|  | 7 | Verify | That the IPv6 address returned in step 6 is the same IPv6 address requested in |

## Communication using IPv6

|  |  |  |  |
| --- | --- | --- | --- |
| **Identifier:** | IOP TC 20 | | |
| **Summary:** | IPv6 communications | | |
| **Configuration:** | IOP CFG 2 | | |
| **References:** | [5] | | |
|  | | | |
| **Pre-test**  **conditions:** | 2 devices, Device A running the TCI Message Generator software and Device B (Device under test)) | | |
|  | | | |
| **Test Sequence:** | **Step** | **Type** | **Description** |
| 1 | Configure | Device A is configured to send Start IPv6 Ping message. |
| 2 | Stimulus | Device A sends a UDP message with Start IPv6 Ping message with no repeat rate. |
| 3 | Verify | Reception of message by Device B |
|  | 4 | Verify | Device B pings the IPv6 address specified in the message once. |

◙ End of Document ◙