6TiSCH Interoperability Test Description

1. Scope

This document forms the guidelines to lead the technical organization of the 3rd ETSI 6TiSCH Plugtests event, held in Berlin, Germany, on 15th -16th July 2016. This document is intended to be updated for future interoperability events.

This document describes:

- The testbed architecture, showing which IETF 6TiSCH systems and components are involved, and how they inter-work in the interoperation focus.
- The configurations used during test sessions, including the relevant parameter values of the different layers (IEEE802.15.4e TSCH, 6TiSCH, 6LoWPAN, RPL).
- The interoperability test descriptions, describing the scenarios the participants follow to perform the tests.
- Guidelines on how to use the tools provided:
    - the *golden device*, a pre-programmed physical device to test an implementation against
    - a modified version of Wireshark, a packet analyzer, which includes the necessary dissectors

2. References

Referenced documents, which are not publicly available at the expected location can be found at **http://docbox.etsi.org/Reference**.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

2.1 Normative references

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

[1] IEEE standard for Information Technology, "*IEEE std. 802.15.4e, Part. 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs) Amendment 1: MAC sublayer*", April 2012.

[2] X. Vilajosana, K. Pister. "*Minimal 6TiSCH Configuration*", IETF 6TiSCH Working Group, draft-ietf-6tisch-minimal-16, June 2016.

[3] T. Winter, P. Thubert, A. Brandt, J. Hui, R. Kelsey, P. Levis, K. Pister, R. Struik, JP. Vasseur, and R. Alexander, "*RPL: IPv6 Routing Protocol for Low-Power and Lossy Networks*", RFC 6550, March 2012.

[4] P. Thubert, "*Objective Function Zero for the Routing Protocol for Low-Power and Lossy Networks (RPL)*", RFC6552, March 2012.

[5] J. Hui, and JP Vasseur, "*The Routing Protocol for Low-Power and Lossy Networks (RPL) Option for Carrying RPL Information in Data-Plane Datagrams*", RFC6553, March 2012.

[6] J. Hui, JP. Vasseur, D. Culler, and V. Manral, "*An IPv6 Routing Header for Source Routes with the Routing Protocol for Low-Power and Lossy Networks (RPL)*", RFC6554, March 2012.

[7] N. Kushalnagar, G. Montenegro, and C. Schumacher, "*IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs): Overview, Assumptions, Problem Statement, and Goals*", RFC4919, August 2007.

[8] Qin Wang, Xavier Vilajosana. "6TiSCH 6top Protocol ", draft-ietf-6tisch-6top-protocol-01, June 2016.

[9] P. Thubert, C. Bormann, L. Toutain , "*6LoWPAN Routing Header And Paging Dispatches*", draft-ietf-6lo-routing-dispatch-02, Jan 2016.

[10] D. Dujovne, M.R. Palatella, A. Grieco. N. Accettura. "6TiSCH 6top Scheduling Function Zero (SF0)", draft-ietf-6tisch-6top-sf0-00, May 2016.

[11] P. Thubert, "IPv6 Backbone Router", draft-ietf-6lo-backbone-router-01, March 2016.

2.1 Informative references

[12] P. Thubert, "*An Architecture for IPv6 over Time Slotted Channel Hopping*", IETF 6TiSCH Working Group, draft-ietf-6tisch-architecture-09, Nov. 2015.

[13] T. Watteyne, M. R. Palattella, L. A. Grieco, "*Using IEEE802.15.4e Time-Slotted Channel Hopping (TSCH) in the Internet of Things (IoT): Problem Statement*", RFC7554, May 2015.

[14] M. R. Palattella, P. Thubert, T. Watteyne, Q. Wang, "*Terminology in IPv6 over Time Slotted Channel Hopping*", IETF 6TiSCH Working Group, draft-ietf-6tisch-terminology-06, Nov. 2015.

[15] ETSI EG 202 237 V1.1.2 (2007-04). *ETSI Guide. Methods for Testing and Specification (MTS), Internet Protocol Testing (IPT), Generic approach to interoperability testing.*

[16] ETSI EG 202 568 V1.1.3 (2007-04). *ETSI Guide. Methods for Testing and Specification (MTS);. Internet Protocol Testing (IPT); Testing: Methodology and Framework.*

3. Abbreviations

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

6BBR:	IPv6 Backbone Router
6LBR:	6LoWPAN Border Router
6LR:	6LoWPAN Router
6N:	6TiSCH node
6P:	6top Protocol
6LoRH:	6lo Routing Header
ACK:	Acknowledgement packet
ARO:	Address Registration Option
DAO:	RPL Destination Advertisement Object
DIO:	RPL DAG Information Object
DAG:	Directed Acyclic Graph
DAR:	Duplicate Address Request
DAC:	Duplicate Address Confirmation
DODAG:	Destination Oriented DAG
EARO:	Enhanced Address Registration Option
EB:	Enhanced Beacon packet
GD:	Golden Device
GD/root:	Golden Device acting as DAGroot
GD/sniffer:	Golden Device acting as PS
GPIO:	General-Purpose Input/Output
KA:	Keep-Alive message
LA:	Logic Analyzer
NUT:	Node Under Test
NA:	Neighbor Advertisement
ND:	Neighbor Discovery
NS:	Neighbor Solicitation
OSC:	Oscilloscope
OUID:	Owner Unique ID
PS:	Packet Sniffer
RPI:	RPL Information Option
SF0:	Scheduling Function zero
SUT:	System Under Test
SYN:	Synchronization

TD: Test Description

TID: Transaction ID

Equipment Type:

DAGroot (DR): A DAGroot is a 6TiSCH Node acting as root of the DAG in the 6TiSCH network topology.

6TiSCH Node (6N): A 6TiSCH Node is any node within a 6TiSCH network other than the DAGroot. It can act as parent and/or child node within the DAG. It can communicate with its children and its parent using the 6TiSCH minimal schedule, or any other TSCH schedule. In the test description, the term is used to refer to a non-DAGroot node.

6LoWPAN Router (6LR): An intermediate router in the 6TiSCH network. It is present only in route-over topologies.

6LoWPAN Border Router (6LBR): A border router located at the junction of separate 6TiSCH networks or between a 6TiSCH network and another IP network. There may be one or more 6LBRs at the 6TiSCH network boundary.

IPv6 Backbone Router (6BBR): An IPv6 router that federates the 6TiSCH network, using a Backbone link as a backbone.

4. Conventions

4.1 *Interoperability test process*

4.1.1 Introduction

According to well-established test methodology, such as ETSI EG 202 237 [15] and ETSI EG 202 568 [16], it is possible to distinguish two different and complementary ways for testing devices which implement a given standard: Conformance and Interoperability testing.

Conformance Testing aims at checking whether a product correctly implements a particular standardized protocol. Thus, it **establishes whether or not the protocol Implementation Under Test (IUT) meets the requirements specified for the protocol itself**. For example, it will test protocol *message contents and format* as well as the *permitted sequences of messages*.

Interoperability Testing aims at checking whether a product works with other similar products. Thus, it proves that end-to-end functionality between (at least) two devices (from different vendors) is, as required by the standard(s) on which those devices are based.

Conformance testing in conjunction with interoperability testing provides both the proof of conformance and the guarantee of interoperation. ETSI EG 202 237 [15] and ETSI EG 202 568 [16
] describe several approaches on how to combine these two methods. The most common approach consists in **Interoperability Testing with Conformance Checks**, where reference points between the devices under test are monitored to verify the appropriate sequence and contents of protocol messages, API calls, interface operations, etc. This will be the approach used by the 6TiSCH Plugtests.

The test session will be mainly executed between two devices from different vendors. For some test descriptions, it may be necessary to have more than two devices involved. The information about the test configuration, like the number of devices or the roles required are indicated in Section 6.

4.1.2 The test description proforma

The test descriptions are provided in proforma tables, which include the different steps of the Test Sequence. The steps can be of different types, depending on their purpose:

- A **stimulus** corresponds to an event that triggers a specific protocol action on a NUT, such as sending a message.
- A **configure** corresponds to an action to modify the NUT or SUT configuration.
- An **IOP check** (IOP stands for “Interoperation”) consists of observing that one NUT behaves as described in the standard: i.e. resource creation, update, deletion, etc. For each IOP check in the Test Sequence, a result can be recorded.
- The overall IOP Verdict will be considered “PASS” if and only if all the IOP checks in the sequence are “PASS”.

In the context of **Interoperability Testing with Conformance Checks**, an additional step type, **CON checks** (CON stands for “Conformance”) can be used to verify the appropriate sequence and contents of protocol messages, API calls, interface operations, etc.

In this case, the **IOP Verdict will be PASS if <u>all</u> the IOP checks are PASS**, and **CON Verdict will**

be PASS if all the CON checks are PASS. The **IOP/CON Verdict will be FAIL if at least one of the IOP/CON checks is FAIL.**

Every IOP check and CON check of a test description should be performed using a trace created by a monitor tool, as described in Section 4.2.

4.2 Tooling

Participant shall use their own tools for logging and analyzing messages for the "check" purpose. The monitor tools include some mandatory, and other optional.

The following tools are REQUIRED for executing the tests.

Packet Sniffer: An IEEE802.15.4 compliant Packet Sniffer (PS) and the relevant tools to be able to analyze packets exchanges over the air.

Note: The Plugtests organizers provide the participants with a "Golden Device" which can act as a packet sniffer device. Participant are free, however, to use their own PS.

Dissector: A computer program capable of interpreting the frames captured by the packet sniffer, and verify the correct formatting of the different headers inside that frame.

Note: The Plugtests organizers provide the participants with a custom-built version of Wireshark, a popular packet analysis software, which contains the necessary dissectors. Participant are free, however, to use their own dissector(s).

The following tools are OPTIONAL to execute the tests.

Logic Analyzer or Oscilloscope: A Logic Analyzer (LA) to display the state of a GPIO (a pin on a board). It must offer tools to convert the captured data into timing diagrams.

Debug Pins (GPIOs): To the scope of the tests, at least 2 programmable Digital I/O pins are recommended. One of the Debug pins should be used to track the slotted activity, and thus, be toggled at the beginning of each timeslot. The other debug pin should be toggled every time an action as defined by the timeslot template happens, i.e., the debug pin will toggle at tsTxOffset, tsRxAckDelay, etc.

Antenna Attenuators: The attenuators (which can be of different type: SMA, MMCX, u.FL) will be used to simulate distance between nodes. By doing so, multi-hop topologies can be constructed without the need of physically separating nodes. An attenuator can connect two motes using a *pigtail* (little wire) with the corresponding antenna connector (e.g, SMA, MMCX, u.FL, etc). Several attenuators (10 dB, 20 dB, 30 dB, etc.) will be used. It is also preferable that they can be connected in a *daisy chain*.

4.3 Test Description naming convention

All the tests described in this document, which will be performed during the PlugTests, can be classified in different groups, based on the type of features they verify. There are 5 different groups of tests: Synchronization (SYN), Security (SEC), 6top protocol (6P), Scheduling Function Zero (SF0), Backbone Router Neighbor Discovery (BBR-ND) and 6LoWPAN dispatch for routing headers (6LoRH).

For each group, several tests are performed.

To identify each test, this TD uses a Test ID following the following naming convention: **TD_6TiSCH_<test group>_<test number within the group>**

4.4 6TiSCH Tests Summary

Test Number	Test ID	Test Summary	Test Group
1	TD_6TiSCH_SYN_01	Check that a 6N can synchronize to the EB sent by the DR and join the network.	SYN
2	TD_6TiSCH_SEC_01	Check the 6N is correctly authenticated with K1, when it synchronizes to DR with EB.	SEC
3	TD_6TiSCH_SEC_02	Check the data packet sent by 6N is correctly encrypted with K2.	SEC
4	TD_6TiSCH_6P_01	Check that a 6N can COUNT the cells allocated in the schedule to a given neighbor, according to draft-ietf-6tisch-6top-protocol-01.	6P
5	TD_6TiSCH_6P_02	Check that a 6N can obtain the LIST of cells in the schedule, according to draft-ietf-6tisch-6top-protocol-01	6P
6	TD_6TiSCH_6P_03	Check that a 6N can CLEAR the schedule of a node, according to draft-ietf-6tisch-6top-protocol-01	6P
7	TD_6TiSCH_6P_04	Check that concurrent transaction cannot request for the same cells in the schedule according to draft-ietf-6tisch-6top-protocol-01	6P
8	TD_6TiSCH_6P_05	Check the correct implementation of the 6P timeout (after a 6P request is received), according to draft-ietf-6tisch-6top-protocol-01.	6P
9	TD_6TiSCH_SF0_01	Check SF0 initial overprovision of cells at bootstrap, according to draft-ietf-6tisch-6top-sf0-00	SF0
10	TD_6TiSCH_SF0_02	Check SF0 progressive allocation of cells as traffic demand increases, according to draft-ietf-6tisch-6top-sf0-00	SF0
11	TD_6TiSCH_SF0_03	Check SF0 progressive de-allocation of slots as traffic demand decreases, according to draft-ietf-6tisch-6top-sf0-00	SF0
12	TD_6TiSCH_BBR-ND_01	Check registration of nodes to Backbone router based on ND	BBR-ND
13	TD_6TiSCH_BBR-ND_02	Check registration of nodes to	BBR-ND

		Backbone router based on RPL	
14	TD_6TiSCH_BBR-ND_03	Check de-registration of nodes to the Backbone router	BBR-ND
15	TD_6TiSCH_BBR-ND_04	Check that a node can move to another backbone router while still keeping the registration.	BBR-ND
16	TD_6TISCH_BBR-ND_05	Check that a collision is detected when a node registers to the backbone with an already registerd EUI64	BBR-ND
17	TD_6TiSCH_6LoRH_01	Check that the source routing header is correctly encoded as a 6LoRH Critical RH3, according to draft-ietf-6lo-routing-dispatch-02	6LoRH
18	TD_6TiSCH_6LoRH_02	Check that, when the packet's sent towards the DR, the RPL Information Option is correctly encoded as a 6LoRH RPI, according to draft-ietf-6lo-routing-dispatch-02	6LoRH
19	TD_6TiSCH_6LoRH_03	Check that, when the packet's travel inside the RPL domain, the IP in IP 6LoRH will not be presented in the packet.	6LoRH
20	TD_6TiSCH_6LoRH_04	Check that, when the packet travel outside a RPL domain, IP in IP 6LoRH is present in the packet.	6LoRH

Table 1. 6TiSCH tests

5. 6TiSCH Test Configurations

5.1 Node Under Test (NUT)

In the context of 6TiSCH, and according to draft-ietf-6tisch-minimal [2], a Node Under Test is a low-power wireless node equipped with a IEEE802.15.4-compliant radio, and implementing at least:

- the IEEE802.15.4e TSCH MAC protocol [1]
- the RPL routing protocol [3]
- the 6LoWPAN adaptation layer [7].

In the scope of this Test Description, a NUT also implements:

- draft-ietf-6tisch-6top-protocol-01 [8]
- draft-ietf-6lo-routing-dispatch-02 [9]
- draft-ietf-6tisch-6top-sf0-00 [10]
- draft-ietf-6lo-backbone-router-01 [11]
- the UDP protocol

When executing this Test Description, the relevant parameter values of the protocols adopted at different layers (IEEE802.15.4e TSCH and RPL) are set according to [2],[8] – [11]. Those not defined in [2], [8] - [11] are specified in this TD.

Additionally, the NUT also required to implement specific functions not being defined in the draft or standard but necessary for conducting the tests. In the scope of this Test Description, a NUT also implements

- a way to increase and decrease traffic load .
- a way to disable and enable 6P Response.

The traffic load of each 6N can be modified either with a button pressing event or a serial command input. There is no specific requirement for how to implement this function as long as the node support that. The disabling and enabling 6P Response functions are required when conducting the timeout test (TD_6TiSCH_6P_06). “Disable the 6P Response” means the node do not send response even it is available to send. This makes node stuck at the current 6P transaction. Then “Enable the 6P Response”s operation makes the node back to normal. However, the node only able to send the response after TIMEOUT.

5.2 System Under Test (SUT)

The System Under Test (SUT) is composed of a number of Nodes Under Test (NUTs), possibly implemented by different vendors. To address different functional areas and groups of tests, the following SUT scenario have been defined.

5.2.1 Single-hop scenario

For most tests, the SUT is a 6TiSCH single-hop topology, including a DAGroot and a 6TiSCH Node. For conformance tests, the DR is the golden device (GD/root). For interoperability tests, the DR is implemented by the vendor.

In some tests, in order to verify the correct formatting of the frames exchanged between the DR and the 6N, a packet sniffer is also needed.

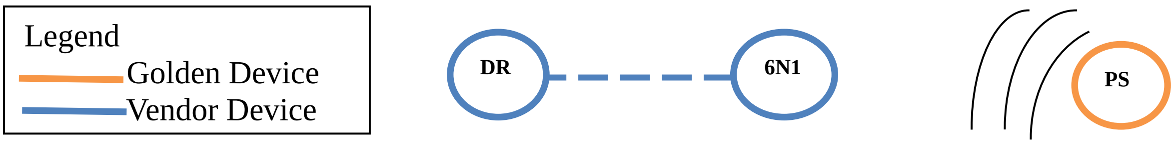

Figure 1 Single-hop scenario

5.2.2 Multi-hop scenario

The multi-hop scenario includes 1 DR and 3 6Ns, forming a linear topology as displayed in Fig. 2. This topology is used for testing 6LoRH features. The DR is either a GD/root or a vendor node. For some tests, another GD/sniffer or a vendor PS is used for capturing the frames exchanged.

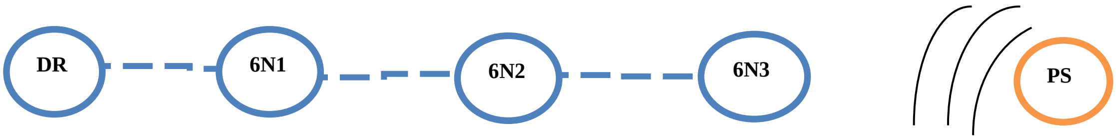

Figure 2 Multi-hop scenario

5.2.3 Star scenario

The star scenario includes 1 DR and 2 6Ns, both directly connected to the DR, as displayed in Fig. 3. For some tests, another GD/sniffer or a vendor PS is used for capturing the frames exchanged. This start topology is mainly used for testing 6P and SF0 features.

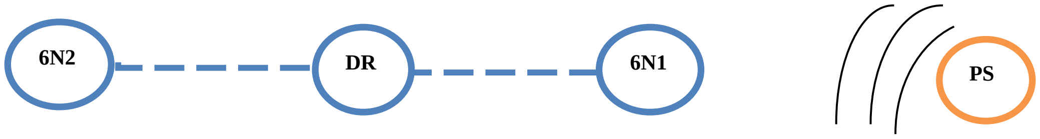

Figure 3 Star scenario

5.2.4 BBR_1 scenario

The BBR_1 scenario includes 1 6BBR, 1 6LBR, 1 6LR, and 1 6N (as shown in Fig. 4). The 6BBR acts as a backbone router proxying different 6LBRs. The 6LBR is the dagroot of the network and the RPL root. The 6LR and the 6LBR can be the same or different nodes. The 6N1 is the wireless node connecting to the RPL network. For some tests, a GD/sniffer or a vendor PS is used for capturing the frames exchanged. In the backbone a network analyzer is used.

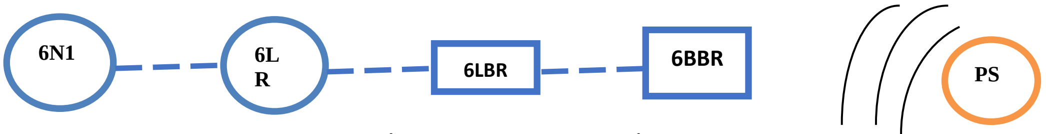

Figure 4 BBR_1 scenario

5.2.5 BBR_2 scenario

The BBR scenario includes 2 BBRs, 2 6LBRs, 2 6LRs, and 1 6Ns (as shown in Fig. 5). The two backbone structures are identical and are used to evaluate the movement of one node from one 6BBR subnetwork to another. The 6BBR acts as a backbone router proxying different 6LBRs. The 6LBR is the dagroot of the network and the RPL root. The 6LR and the 6LBR can be the same or different nodes. The 6N1 is the wireless node connecting to the RPL network. For some tests, a GD/sniffer or a vendor PS is used for capturing the frames exchanged.

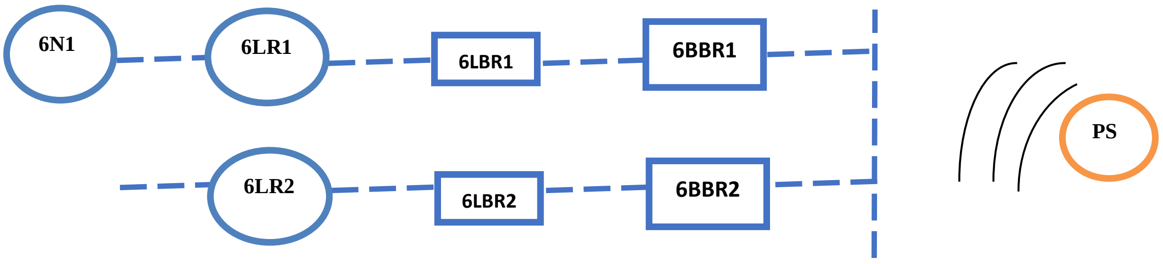

Figure 5 BBR_2 scenario

5.3 *Golden Device*

This section describes the two images which run on the Golden Device to perform the different tests listed in Section 6. With the first image, the GD acts as DAGroot (GD/root). With the second image, the GD acts as packet sniffer (GD/sniffer). All images can be configured using a script (described in Section 5.3.4), which allows setting the value of several parameters (e.g., frequency, slotframe size, etc.), or triggering the transmission of a given type of packet (EB, DATA, ACK, etc.). The commands which allow configuring the images are presented in Section 5.3.3; the specific set of parameters to be used for each test are specified in Section 6.

5.3.1 GD/root

With this first image, the golden device is a DAGroot. By using the script, it is possible to configure:

- the number of frequencies (Single frequency or Multiple Frequencies/Channel Hopping)
- the slotframe size
- the type of packet to send/receive (EB, KA, DATA, ACK, DIO, DAO)
- the value of the DAGrank.

The script displays information about the frames the GD/root received from the vendor node. For example, following the reception of a KA message, the GD/root prints out the information about the ASN the KA was received in, and the Time Offset of the vendor node.

The script can also cause GD/root to issue 6P packets (6P_ADD, 6P_DELETE, 6P_COUNT, 6P_LIST, 6P_CLEAR). The GD/root also returns information about the 6P response (e.g. the number of reserved cells in a 6P_COUNT response, the reserved cell list in 6P_LIST response). The value of the return code field in the 6P response is always printed. The script also allows the user to specify up to 3 slots to be included in the 6P_ADD or 6P_DELETE packets (random slots are used when the user does not specify any).

Details about when/how to use the GD/root in the tests are provided in Section 6.

5.3.2 GD/sniffer

With this second image, the golden device acts as a packet sniffer. The script allows the user to configure the frequency the GD/sniffer is listening on. The packet sniffer can forward the received frames to the dissector.

The GD/sniffer is mainly used for conformance tests to verify packet formats and the values of specific fields, as detailed in the different tests.

5.3.3 Configuring Script

A Python configuration script allows the user to configure the golden device. The script sends command to the GD over its serial port. Table 2 shows the format of Generic serial packet.

Length (bytes)	1	1	Variable
Script Command Content	Version	ImageID	Command Content

Table 2. Generic serial packet format

Version: the first field of the command (1 byte long) indicates the version of script. The command is valid only when its version matches the one supported by the GD image. Otherwise, the command is discarded by the GD.

ImageID: the second field of the command (1 byte long) indicates the ImageID. When it is set to 1, the GD will run GD/root, when it is set to 2, it will run GD/sniffer. If the value of ImageID in the command sent to the GD is different from the two allowed values (1 and 2), the command is discarded by the GD.

Command Content: this field (variable length) is composed by three different fields, as specified in Table 3

Length (bytes)	1	1	Variable
Command Content	CommandID	length	(value of) Parameter

Table 3. Format of Command Content

CommandID: this field (1 byte long), together with ImageID allows identifying the specific command used for configuring the GD.

Length: this field (1 byte long) specifies the length of the next field, i.e., of the parameter content.

(value of) Parameter: this field contains the value of the specific parameter configured by using that command. Table 4 summarizes the list of parameters which can be configured, using different commands (identified by different CommandID).

Command Scope	Command ID	length	Parameter	Allowed Range of Value	Unit
Send EB	0	2 bytes	Sending period	0~65535	second
Configure Frequency	1	1 byte	Frequency number	(0,11~26, when frequency number is set to 0, channel hopping is enabled)	
Send KA	2	2 bytes	Sending period	0~65535	millisecond
Send DIO	3	2 bytes	Sending period	0~65535	millisecond
Send DAO	4	2 bytes	Sending period	0~65535	millisecond
Set Rank Value	5	2 bytes	Rank	0~65535	
Enable/Disable Security	6	1 byte	Option	True(enable) False(disable)	
Set Slotframe Size	7	2 bytes	Slotframe length	0~65535	
Enable/Disable ACK Transmission	8	1 byte	Option	True(enable) False(disable)	
Issue a 6P ADD Packet	9	Multiple bytes (0 to 3)	Candidate cell List	0~slotframeLength-1 (for each cell in list)	
Issue a 6P DELETE Packet	10	Multiple bytes (0 to 3)	Candidate cell List	0~slotframeLength-1 (for each	

				cell in list)	
Issue a 6P COUNT Packet	11	0	None	None	
Issue a 6P LIST Packet	12	0	None	None	
Issue a 6P CLEAR Packet	13	0	None	None	
Set Slot Duration	14	2bytes	Duration	0~65535	Ticks (30.5us)
Enable/Disable 6p Response	15	1 byte	Option	True(enable) False(disable)	
Set outgoing bandwidth	16	1byte	Number of packet sent per slotframe	0~255	

Table 4. List of commands

Any other value of CommandID not listed in Table 4 is treated as an error, and the command is discarded by the GD.

Beyond setting the set of parameters, listed in Table 4, the script when used with GD/root allows printing out on the screen of the laptop connected to GD/root, the received packet, and all the related information (type of packet, ASN when the packet is received, time offset, 6P return code, number of reserved cell, cell list etc); and when used with GD/sniffer, it allows parsing the captured packet. The format of the packet is printed out on the screen of the laptop connected to GD/sniffer to verify the correctness of the packet format itself.

Vendors are free to bring their own packet sniffer, able to support similar functions to those of GD/sniffer in order to perform both interoperability and conformance tests.

6. Test Descriptions

6.1 Synchronization

Test Number	1			
Test ID	TD_6TiSCH_SYN_01			
Test Objective	Check that a 6N can synchronize to the EB sent by the DR and parse all the IEs with their default values.			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the EB on the air. To this purpose, GD/sniffer or a vendor PS can be used.			
References	IEEE802.15.4e			
Pre-test conditions	The DR sends EBs periodically, with a fast rate (equal to 10 sec, according to [2]), so that the 6N does not need to send KAs for keeping synchronization The 6N needs to listen to one EB only All EBs are sent on a single frequency. Power on 6N and DR			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The DR sends EB periodically	
	2	IOP Check	The 6N receives one EB and get synchronized	
	3	IOP Check	The DR receives an EB sent by 6N	
IOP Verdict				

6.2 Security

Test Number	2			
Test ID	TD_6TiSCH_SEC_01			
Test Objective	Check the 6N is correctly authenticated with K1, when it synchronizes to DR with EB			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the EB on the air. To this purpose, GD/sniffer or a vendor PS can be used.			
References	draft-ietf-6tisch-minimal-15			
Pre-test conditions	The DR sends EBs periodically, with a fast rate (equal to 10 sec, according to [2]), so that the 6N does not need to send KAs for keeping synchronization. The 6N needs to listen to one EB only. All frames are sent on a single frequency. The SEC option is enabled on DR and 6N The key K1 is set according to draft-ietf-6tisch-minimal-15[2] Power on 6N and DR.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The DR sends EB	
	2	IOP Check	The 6N receives the EB and get synchronized	

	3	IOP Check	The 6N sends EB	
	4	IOP Check	The DR receives the EB from 6N	
IOP Verdict				

Test Number	3			
Test ID	TD_6TiSCH_SEC_02			
Test Objective	Check the data packet sent by 6N is correctly encrypted with K2.			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the EB and DATA packet on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6tisch-minimal-15			
Pre-test conditions	All frames are sent on a single frequency. The SEC option is enabled on DR and 6N. The key K1 and the key K2 are set according to draft-ietf-6tisch-minimal-15[2] and Section 7 of the TD. Power on 6N and DR.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	DR sends a ping DATA packet to 6N	
	2	IOP Check	6N sends an Echo Reply message to DR	
	3	IOP Check	Check the DATA is correctly encrypted/decrypted with K2	
IOP Verdict				

6.3 6top Protocol (6P)

Test Number	4			
Test ID	TD_6TiSCH_6P_01			
Test Objective	Check a 6N can COUNT the cells allocated in the schedule to a given neighbor, according to draft-ietf-6tisch-6top-protocol-01.			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	IEEE802.15.4e, draft-ietf-6tisch-6top-protocol-01			
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until the 6N join the DR			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The 6N1 sends a 6P ADD request to the DR for 1 slot. The candidate list is {4,5}.	
	2	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	3	IOP Check	The PS captures the sequence of request and response	
	4	IOC Check	Check the packet header captured by the sniffer has the same format defined in the draft-ietf-6tisch-6top-sublayer-04 for both	

			the request and the response	
	5	IOC Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS. And the counter value received is 2.	
IOP Verdict				
Test Number.	5			
Test ID.	TD_6TiSCH_6P_02.			
Test Objective.	Check a 6N can obtain the LIST of cells in the schedule, according to draft-ietf-6tisch-6top-protocol-01.			
Configuration.	Single-hop			
Applicability.	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References.	IEEE802.15.4e, draft-ietf-6tisch-6top-protocol-01.			
Pre-test conditions.	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until the 6N join the DR			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	2	Stimulus	The 6N1 sends a 6P LIST request to the DR.	
	3	IOP Check	The PS captures the sequence of request and response	
	4	IOC Check	Check the packet header captured by the sniffer has the same format defined in the draft-ietf-6tisch-6top-protocol-01 for both the request and the response	
	5	IOC Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS. And check the cell list is {4,5}	
IOP Verdict				

Test Number	6
Test ID	TD_6TiSCH_6P_03
Test Objective	Check a 6N can CLEAR the schedule of a node, according to draft-ietf-6tisch-6top-protocol-01.
Configuration	Single-hop
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.
References	IEEE802.15.4e, draft-ietf-6tisch-6top-protocol-01
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until the 6N join the DR

Test sequence	Step	Type	Description	Result
	1	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	2	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	3	IOP Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS. And the counter value received is 2.	
	4	Stimulus	The 6N1 sends a 6P CLEAR request to the DR.	
	5	IOP Check	The PS captures the sequence of request and response	
	7	IOC Check	Check the packet header captured by the sniffer has the same format defined in the draft-ietf-6tisch-6top-protocol-01 for both the request and the response	
	8	IOC Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS.	
	9	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	10	IOP Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS. And the counter value received is 0.	
IOP Verdict				

Test Number	7			
Test ID	TD_6TiSCH_6P_04			
Test Objective	Check that concurrent transaction cannot request for the same cells in the schedule according to draft-ietf-6tisch-6top-protocol-01			
Configuration	Star scenario			
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	IEEE802.15.4e, draft-ietf-6tisch-6top-protocol-01			
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until all 6N join the DR			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	2	Stimulus	The 6N2 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	3	IOP Check	Check that the returned code for the	

			operation is IANA_6TOP_RC_BUSY.	
IOP Verdict				

Test Number	8			
Test ID	TD_6TiSCH_6P_05			
Test Objective	Check the timeout after a 6P request, is implemented according to draft-ietf-6tisch-6top-protocol-01.			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	IEEE802.15.4e, draft-ietf-6tisch-6top-protocol-01			
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until the 6N joins the DR Disable the 6P response			
Test sequence	Step	Type	Description	Result
	1	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	2	Stimulus	Enable the 6P response at the DR	
	3	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	4	IOP Check	Check that the returned code for the operation is IANA_6TOP_RC_BUSY.	
	5	Stimulus	The 6N1 waits for the timeout to elapse.	
	7	Stimulus	The 6N1 sends a 6P ADD request to the DR for 2 slots. The candidate list is {4,5}.	
	8	IOP Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS.	
IOP Verdict				

6.4 Scheduling Function Zero (SF0)

Test Number	9
Test ID	TD_6TiSCH_SF0_01
Test Objective	Check SF0 initial overprovision of cells at bootstrap, according to draft-ietf-6tisch-6top-sf0-00
Configuration	Single-hop

Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	IEEE802.15.4e, draft-ietf-6tisch-6top-sf0-00, draft-ietf-6tisch-6top-protocol-01			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. SF0THRESH is set to 3 Power on DR. Wait until 6N join the DR.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	SF0 is enabled on 6N1	
	2	IOP Check	The 6N1 sends a 6P ADD request to the DR for 1 slot. (at initial, schedule cells equals to require cells, add one slot)	
	3	IOP Check	The PS captures the sequence of request and response	
	4	IOC Check	Check the packet header captured by the sniffer has the same format defined in the draft-ietf-6tisch-6top-protocol-01 for both the request and the response	
	5	IOC Check	Check that the returned code for the operation is IANA_6TOP_RC_SUCCESS	
	6	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	7	IOP Check	Check the counter value received is 1.	
IOP Verdict				

Test Number	10
Test ID	TD_6TiSCH_SF0_02
Test Objective	Check SF0 progressive allocation of cells as traffic demand increases, according to draft-ietf-6tisch-6top-sf0-00
Configuration	Single-hop
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.
References	IEEE802.15.4e, draft-ietf-6tisch-6top-sf0-00, draft-ietf-6tisch-6top-protocol-01
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency.

	SF0THRESH is set to 3 Power on DR. Wait until 6N1 join the DR.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	SF0 is enabled on 6N1	
	2	Stimulus	Increase traffic generating by 6N1 to 3 packet per slotframe.	
	3	IOP Check	Check 6N1 sends a 6P ADD request to the DR, asking for a number of cells equal to 3.	
	4	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	5	IOP Check	Check the counter value received is 4 .	
IOP Verdict				

Test Number	11			
Test ID	TD_6TiSCH_SF0_03			
Test Objective	Check SF0 progressive de-allocation of slots as traffic demand decreases, according to draft-ietf-6tisch-6top-sf0-00			
Configuration	Single-hop			
Applicability	SUT includes a PS to see the 6P packets on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	IEEE802.15.4e, draft-ietf-6tisch-6top-sf0-00, draft-ietf-6tisch-6top-protocol-01			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. SF0THRESH is set to 3 Power on DR. Wait until both 6N1 join the DR			
Test sequence	Step	Type	Description	Result
	1	Stimulus	SF0 is enabled on 6N1	
	3	Stimulus	Decrease traffic generating by 6N1 to 2 packet per slotframe.	
	4	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	5	IOP Check	Check the counter value received is still 4.	
	6	Stimulus	Decrease traffic generating by 6N1 to 0	

			packet per slotframe.	
	4	IOP Check	Check 6N1 sends a 6P DELETE request to the DR, asking for deleting a number of cells equal to SF0THRESH.	
	5	Stimulus	The 6N1 sends a 6P COUNT request to the DR.	
	6	IOP Check	Check the counter value received is 1.	
IOP Verdict				

6.5 Backbone Router ND

Test Number	12			
Test ID	TD_6TISCH_BBR-ND_01			
Test Objective	Check registration of nodes to BBR based on ND			
Configuration	BBR_1			
Applicability	SUT includes a PS to see the EARO and DAR/DAC option on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6lo-backbone-router-01, RFC6775			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR/6LBR. Power on 6BBR. Wait until all the 6N1 and 6N2 join the network. Ensure a linear topology. 6N1 acts as joining node. 6N2 acts as 6LR. DR acts as 6LBR. 6BBR is the backbone router where 6LBR is connected.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	6N1 sends NS(EARO) to 6LR(6N2) with T=1 TID=1 OUID=6N1 EUI64 and lifetime >0.	
	2	IOP Check	Check 6LR sends DAR(EARO) to 6LBR. Dest address is 6LBR address. Src address is 6LR address. The Registered address is 6N1 address. EUI64 and Lifetime are copied from EARO. Check status = 0	
	3	IOP Check	6LBR sends NS(EARO) to 6BBR. Target=6N1 address SLLA=6LBR, UID=EUI64 6N1 TID=1	
	4	IOP Check	6BBR sends NS DAD (EARO) to the backbone . After >800m 6BBR timeouts	
	5	IOP Check	6BBR sends NA(EARO) Status = 0 to 6LBR. Target is 6N1	
	6	IOP Check	6LBR sends DAC (EARO) to 6LR. The status is 0.	
	7	IOP Check	6N1 receives an NA(EARO) with status = 0 s	
IOP Verdict				

Test Number	13			
Test ID	TD_6TISCH_BBR-ND_02			
Test Objective	Check registration of nodes to BBR based on RPL			
Configuration	BBR_1			
Applicability	SUT includes a PS to see the EARO and DAR/DAC option on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6lo-backbone-router-01, RFC6775			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR/6LBR. Power on 6BBR. Wait until all the 6N1 and 6N2 join the network. Ensure a linear topology. 6N1 acts as joining node. 6N2 acts as 6LR. DR acts as 6LBR. 6BBR is the backbone router where 6LBR is connected.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	6LR sends DAO to 6LBR. Dest address is Parent or Root address. Src address is 6LR address. Target is 6N1. TID included in transit option	
	2	IOP Check	6LBR sends NS(ARO) to 6BBR. Target=6N1 address SLLA=6LBR, UID=EUI64 6N1 TID=1	
IOP Verdict				

Test Number	14			
Test ID	TD_6TISCH_BBR-ND_03			
Test Objective	Check de-registration of nodes to the Backbone router			
Configuration	BBR_1			
Applicability	SUT includes a PS to see the EARO and DAR/DAC option on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6lo-backbone-router-01, RFC6775			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR/6LBR. Power on 6BBR. Wait until all the 6N1 and 6N2 join the network. Ensure a linear topology. 6N1 acts as joining node. 6N2 acts as 6LR. DR acts as 6LBR. 6BBR is the backbone router where 6LBR is connected.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	6N1 sends NS(EARO) to 6LR(6N2) with T=1 TID=2 OUID=6N1 EUI64 and lifetime = 0.	
	2	IOP Check	Check 6LR sends DAR(EARO) to 6LBR. Dest address is 6LBR address. Src address is 6LR address. The Registered address is 6N1 address. EUI64 and Lifetime are	

			copied from EARO. Check status = 0	
	3	IOP Check	6LBR sends NS(EARO) to 6BBR. Target=6N1 address, OUID=EUI64 6N1 TID=2	
	4	IOP Check	6BBR sends NA(EARO) Status = 4 to 6LBR	
	5	IOP Check	6LBR sends DAC to 6LR1. The status is 4.	
	6	IOP Check	6N1 receives an NA(EARO) with status = 4 after	
IOP Verdict				

Test Number	15			
Test ID	TD_6TISCH_BBR-ND_04			
Test Objective	Check that a node can move to another backbone router while still keeping the registration.			
Configuration	BBR_2			
Applicability	SUT includes a PS to see the EARO and DAR/DAC option on the air. To this purpose, GD/sniffer, or a vendor PS can be used. A packet analyzer is used to see NS/DAD messages in the backbone.			
References	draft-ietf-6lo-backbone-router-01, RFC6775			
Pre-test conditions	The DR1 and DR2 send EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR1/6LBR2 and DR2/6LBR2. Power on 6BBR1. Power on 6BBR2. Wait until all the 6N1, 6N2 join the 6LBR1 network. Ensure a linear topology. 6N1 acts as joining node. 6N2 acts as 6LR (6LR1). DR1 acts as 6LBR (6LBR1). 6BBR1 is the backbone router where 6LBR1 is connected. 6N3 acts as 6LR (6LR2). DR2 acts as 6LBR2. 6LBR2 is connected to 6BBR2. 6N1 joins the 6BBR1. Registers to the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	Connect 6N1 to the 6LR2 (movement)	
	2	Stimulus	6N1 sends NS(EARO) to 6LR2(6N3) with T=1 TID=2 OUID=6N1 EUI64 and lifetime >0.	
	3	IOP Check	Check 6LR2 sends DAR(EARO) to 6LBR2. Dest address is 6LBR2 address. Src address is 6LR2 address. The Registered address is 6N1 address. EUI64 and Lifetime are copied from EARO. Check status = 0	
	4	IOP Check	6LBR2 sends NS(EARO) to 6BBR2. Target=6N1 address SLLA=6LBR, UID=EUI64 6N1 TID=2	
	5	IOP Check	6BBR2 sends NS DAD(EARO) multicast. It is received by 6BBR1 6BBR2 timeouts after 800ms	

	6	IOP Check	6BBR1 sends NA(ARO) status = 0 to 6BBR2	
	7	IOP Check	6BBR2 sends NA(ARO) Status = 0 to 6LBR2	
	8	IOP Check	6LBR2 sends DAC to 6LR2. The status is 0.	
	9	IOP Check	6N1 receives an NA(EARO) with status = 0	
	10	IOP Check	6BBR1 sends NA(EARO) status = 3 to 6LBR1	
	11	IOP Check	6LBR1 sends DAC(EARO) status = 3 to 6LR1	
IOP Verdict				

Test Number	16			
Test ID	TD_6TISCH_BBR-ND_04			
Test Objective	Check that a collision is detected when a node registers to the backbone with an already registered EUI64			
Configuration	BBR_2			
Applicability	SUT includes a PS to see the EARO and DAR/DAC option on the air. To this purpose, GD/sniffer, or a vendor PS can be used. A packet analyzer is used to see NS/DAD messages in the backbone.			
References	draft-ietf-6lo-backbone-router-01, RFC6775			
Pre-test conditions	The DR1 and DR2 send EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR1/6LBR2 and DR2/6LBR2. Power on 6BBR1. Power on 6BBR2. Wait until all the 6N1, 6N2 join the 6LBR1 network. Ensure a linear topology. 6N1 acts as joining node. 6N2 acts as 6LR (6LR1). DR1 acts as 6LBR (6LBR1). 6BBR1 is the backbone router where 6LBR1 is connected. 6N3 acts as 6LR (6LR2). DR2 acts as 6LBR2. 6LBR2 is connected to 6BBR2. 6N1 joins the 6BBR1. Registers to the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	Connect 6N1 to the 6LR2 (duplicate registration)	
	2	Stimulus	6N1 sends NS(EARO) to 6LR2(6N3) with T=1 TID=1 (same TID) OUID=6N1 EUI64 and lifetime >0.	
	3	IOP Check	Check 6LR2 sends DAR(EARO) to 6LBR2. Dest address is 6LBR2 address. Src address is 6LR2 address. The Registered address is 6N1 address. EUI64 and Lifetime are copied from EARO. Check status = 0	
	4	IOP Check	6LBR2 sends NS(EARO) to 6BBR2. Target=6N1 address SLLA=6LBR, UID=EUI64 6N1 TID=1	

	5	IOP Check	6BBR2 sends NS DAD(EARO) multicast. It is received by 6BBR1. Collision is detected.	
	6	IOP Check	6BBR1 sends NA(ARO) Status = 1 to 6BBR2 (collision)	
	7	IOP Check	6BBR2 sends NA(ARO) Status = 1 to 6LBR2	
	8	IOP Check	6LBR2 sends DAC to 6LR2. The status = 1.	
	9	IOP Check	6N1 receives an NA(EARO) with status = 1	
IOP Verdict				

6.6 6LoRH

Test Number	17			
Test ID	TD_6TiSCH_6LoRH_01,			
Test Objective	Check that the source routing header is correctly encoded as a 6LoRH Critical RH3, according to draft-ietf-6lo-routing-dispatch-02			
Configuration	Multi-hop			
Applicability	SUT includes a PS to see the RH3 headers on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6lo-routing-dispatch-02			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until all the 6N join the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	Send an ICMPv6(echo request) packet to 6N3 (with source address inside of RPL domain)	
	2	IOP Check	The ICMPv6 receives the echo request	
	3	IOP Check	The PS captures the sequence of packets forwarded downstream to the 6N3	
	4	IOP Check	Check the 6LoRH RH3 header at each hop is compliant with draft-ietf-6lo-routing-dispatch-02	
IOP Verdict				

Test Number	18
Test ID	TD_6LoRH_02
Test Objective	Check that, when the packet’s sent towards the DR, the RPL Information Option is correctly encoded as a 6LoRH RPI, according to draft-ietf-6lo-routing-dispatch-02
Configuration	Multi-hop
Applicability	SUT includes a PS to see the RPI headers on the air. To this purpose, GD/sniffer, or a vendor PS can be used.

References	draft-ietf-6lo-routing-dispatch-02			
Pre-test conditions	The DR sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. The DR sends DIO periodically, every 10 seconds. Power on DR. Wait until all the 6N join the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	sends The 6N3 sends a DAO packet	
	2	IOP Check	The PS captures the sequence of packet forwarded upstream to the DR	
	3	IOP Check	Check the 6LoRH RPI header at each hop is compressed and compliant with draft-ietf-6lo-routing-dispatch-02	
IOP Verdict				

Test Number	19			
Test ID	TD_6LoRH_03			
Test Objective	Check that, when the packet's travel inside the RPL domain, the IP in IP 6LoRH is not be presented in the packet.			
Configuration	Multi-hop			
Applicability	SUT includes a PS to see the RPI headers on the air. To this purpose, GD/sniffer, or a vendor PS can be used.			
References	draft-ietf-6lo-routing-dispatch-02			
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until all the 6N join the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	Send an echo request with source address inside of RPL domain and destination address of 6N3.	
	2	IOP Check	6N3 received the echo request and send back echo response upstream to the DR.	
	3	IOP Check	The PS captures the sequence of packet forwarded downstream to the 6N 3 and upstream to the DR	
	4	IOP Check	Check the 6LoRH RPI header at each hop is compressed and compliant with draft-ietf-6lo-routing-dispatch-02 and no IP in IP 6LoRH present in the packet.	
IOP Verdict				

Test Number	19
Test ID	TD_6LoRH_04
Test Objective	Check that, when the packet travel outside a RPL domain, Ip in IP 6LoRH is present in the packet.
Configuration	Multi-hop
Applicability	SUT includes a PS to see the RPI headers on the air. To this purpose, GD/sniffer, or a vendor PS can be used.

References	draft-ietf-6lo-routing-dispatch-02			
Pre-test conditions	The DG sends EB periodically, every 10 sec [2]. All EB packets are sent on a single frequency. Power on DR. Wait until all the 6N join the network.			
Test sequence	Step	Type	Description	Result
	1	Stimulus	Send an echo request with source address outside of RPL domain and destination address of 6N3.	
	2	IOP Check	6N3 received the echo request and send back echo response upstream to the DR.	
	3	IOP Check	The PS captures the sequence of packet forwarded downstream to the 6N3 and upstream to the DR	
	4	IOP Check	Check the 6LoRH RPI header at each hop is compressed and compliant with draft-ietf-6lo-routing-dispatch-02 and IP in IP 6LoRH are presented in the packet.	
IOP Verdict				

7. Annex

7.1 IEEE802.15.4 Default Parameters

All the tests are performed using the following setting.

7.1.1 Address length

ALL IEEE802.15.4 addresses will be long (64-bit), because association is not part of [2].

The only exception is the broadcast address, 0xffff.

7.1.2 Frame version

ALL IEEE802.15.4 frames will be of version 2 (b10).

7.1.3 PAN ID compression and sequence number

ALL IEEE802.15.4 frames will contain the following field: a source address, a destination address, a sequence number, a destination PANID (no source PANID).

7.1.4 Payload termination IE

The IE payload list termination will NOT be included in the EB.

7.1.5 IANA for 6P IE related

Since they have not defined yet by AINA, for the Interop event, we use the following values:

IANA_GROUP_ID_SIXTOP_IE: 0x02

IANA_SIXTOP_SUB_IE_ID : 0x00

IANA_SIXTOP_VERSION : 0x01

IANA_SFID_SF0: 0x00

IANA_6TOP_CMD_ADD 0x01

IANA_6TOP_CMD_DELETE 0x02

IANA_6TOP_CMD_COUNT 0x03

IANA_6TOP_CMD_LIST 0x04

IANA_6TOP_CMD_CLEAR 0x05

IANA_6TOP_RC_SUCCESS 0x06

IANA_6TOP_RC_VER_ERR 0x07

IANA_6TOP_RC_SFID_ERR	0x08
IANA_6TOP_RC_BUSY	0x09
IANA_6TOP_RC_RESET	0x0a
IANA_6TOP_RC_ERR	0x0b

7.1.6 Sixtop Timeout

A timeout happens when the node sending the 6P Request has not received the 6P Response. The value of the timeout is set to **4 seconds** during the tests.

7.1.7 RPL Operation Mode

There are two modes for a RPL Instrance to choose for maintaning Downward routes: Storing and Non-Storing modes. We use the Non-Storing mode during the tests.

7.1.8 Default Security Keys

To perform the SEC-related tests, the value of key K1 will be set according to draft-ietf-6tisch-minimal-16[2], while the value of K2 will be set to `deadbeeffacecafe` per default. Moreover, Key Index (advertised in the auxiliary security header of the packet), will be used for K1 and K2, to enable nodes to look up the right key before decrypting.

Change History

Revision	Status	Author	Date
1.0	Preliminary TD	X. Vilajosana	15 June 2016
1.1	Initial BBR tests added	X. Vilajosana	27 June 2016
1.2	More BBR tests and SF tests	M.R. Palattella X. Vilajosana	28 June 2016
1.3	Finalizing tests specs + review	X. Vilajosana	29 June 2016
1.4	SF0 tests, BBR scenarios, review	M.R. Palattella Tengfei Chang	30 June 2016
1.5	BBR tests review	X. Vilajosana	1 Jul 2016
1.6	Update SF0 test	Tengfei Chang	4 Jul 2016

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