ETSI CTI Plugtest Report 1.1.1 (2012-03)

1st CoAP Plugtest;
Paris, France;
24 - 25 March 2012

World Class Standards

ETSI

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1 Executive Summary

The 1st CoAP Plugtest was held from 24 to 25 March 2012 in Paris, France and was co-located with IETF#83.

This event was jointly organized by ETSI, IPSO Alliance and the FP7 Probe-IT project[1].

This event had excellent industry participation with 15 companies providing implementations, 4 companies as part of the organising plugtest team. Altogether there were more than 50 people at this event and more than 3000 interoperability tests were conducted.

Also an important mix of technologies could be observed, such as 6 different embedded wireless platforms; TinyOS, Contiki, Custom OS; Java, C/C++, C#, Ruby, JavaScript.

The conclusions are that

- all implementations have been compatible on a basic level
- more than 90% of the executed tests indicated interoperability, which shows the high level of maturity of the CoAP implementations
- CoAP standards are mature (This applies to the parts of base standards that were covered in the plugtest)

[1] FP7 Probe-IT (Pursuing Roadmap and Benchmark in Internet of things). http://www.probe-it.eu. This is an FP7 project funded by the European Union

2 Introduction

This plugtest aimed to test the interoperability of CoAP client and server implementations.

The implementations were connected via a IPv6 test network.

A plugtest guide was produce containing 27 interoperability tests.

ETSI provide the interoperability tool suite of wiki, scheduling and test reporting tool.

Probe-IT provided an online tool for CoAP trace validation and a lossy gateway for testing lossy contexts.

Each day test sessions for IOP assessment were conducted. At the end of each day a wrap-up meeting was held to discuss main interoperability points of the day.

During the event the IoT Conformance Validation Framework was demonstrated and one live trial against an implementations was conducted.

3 Base Specifications

The following documents were used as basis for the tests:

[1] Constrained Application Protocol (CoAP); draft-ietf-core-coap-08

[2] CoRE Link Format; draft-ietf-core-link-format-11

[3] Observing Resources in CoAP; draft-ietf-core-observe-04

[4] Blockwise transfers in CoAP; draft-ietf-core-block-08

4 Abbreviations

CoAP	Constrained Application Protocol
NO	Test is recorded as NOT successfully passed.
NA	Test is not applicable.
OK	Test is recorded as successfully passed.
OT	Test is recorded as not being executed due to lack of time.
Test Session	A paring of vendors that test together during a given time slot.
TSR	Test Session Report. Report created during a test session.

5 Participants

The companies which attended the plugtest are listed in the table below. Empty entries are placeholders for companies which did not wish to be mentioned.

Table 1: List of implementations that participated in the tests

#	*Implementations*
1	**Actility**
2	**Watteco**
3	**Eth Zurich**
4	**Hitachi**

5	**Huawei**
6	**Intecs**
7	**KoanLogic**
8	**Patavina**
9	**Sensinode**
10	**Uni Bremen**
11	**Uni Rostock**
12	**Rtx**
13	**Ibbt**
14	**Ferrara**
15	

Table 2: List of plugtest team

#	Company	Role
1	**ETSI**	Organization of Plugtest, Test Network, Test Descriptions
2	**IRISA**	Online Trace Validation, Test Descriptions
3	**BUPT**	Lossy Gateway
4	**CATR**	Observer

Note: IRISA, BUPT and CATR are Probe-IT project partners

6 Technical and Project Management

All the information presented in this chapter is an extract of the ETSI event wiki https://services.plugtests.net/wiki/IoT-CoAP/index.php/Main_Page (Access for registered people only).

6.1 Test Plan

The test plan containing 27 interoperability tests was developed by ETSI CTI together with Probe-IT. During the regular conference calls which were held as part of the event preparation, companies could propose additional tests. The tests were grouped in mandatory and optional tests. The features covered by all tests are listed below:

- CORE
    - Get, Post , Put, Delete, Token, Uri Path/Query
    - Lossy context
- LINK
- BLOCK
- OBSERVE

- Resource Observation
- Deregistration Detection

Table 3: Mandatory Tests

1	TD_COAP_CORE_01	Perform GET transaction (CON mode)
2	TD_COAP_CORE_02	Perform POST transaction (CON mode)
3	TD_COAP_CORE_03	Perform PUT transaction (CON mode)
4	TD_COAP_CORE_04	Perform DELETE transaction (CON mode)
5	TD_COAP_CORE_05	Perform GET transaction (NON mode)
6	TD_COAP_CORE_06	Perform POST transaction (NON mode)
7	TD_COAP_CORE_07	Perform PUT transaction (NON mode)
8	TD_COAP_CORE_08	Perform DELETE transaction (NON mode)
9	TD_COAP_CORE_09	Perform GET transaction with delayed response (CON mode, no piggyback)
10	TD_COAP_CORE_10	Handle request containing Token option
11	TD_COAP_CORE_11	Handle request not containing Token option
12	TD_COAP_CORE_12	Handle request containing several Uri-Path options
13	TD_COAP_CORE_13	Handle request containing several Uri-Query options
14	TD_COAP_CORE_14	Interoperate in lossy context (CON mode, piggybacked response)
15	TD_COAP_CORE_15	Interoperate in lossy context (CON mode, delayed response)
16	TD_COAP_CORE_16	Perform GET transaction with delayed response (NON mode)

Table 4: Optional Tests

1	TD_COAP_LINK_01	Access to well-known interface for resource discovery
2	TD_COAP_LINK_02	Use filtered requests for limiting discovery results
3	TD_COAP_BLOCK_01	Handle GET blockwise transfer for large resource (early negotiation)
4	TD_COAP_BLOCK_02	Handle GET blockwise transfer for large resource (late negotiation)
5	TD_COAP_BLOCK_03	Handle PUT blockwise transfer for large resource
6	TD_COAP_BLOCK_04	Handle POST blockwise transfer for large resource
7	TD_COAP_OBS_01	Handle resource observation
8	TD_COAP_OBS_02	Stop resource observation
9	TD_COAP_OBS_03	Client detection of deregistration (Max-Age)
10	TD_COAP_OBS_04	Server detection of deregistration (client OFF)
11	TD_COAP_OBS_05	Server detection of deregistration (explicit RST)

6.2 Test Scheduling

The preliminary test schedule was developed before the plugtest and was circulated to all the participants in advance for comments. The initial test schedule allowed for each company to test against a fair number of other companies. Two companies were assigned one test slot which had a duration of 1 hour. In this test slot the companies could run tests for the configurations :CompA-Client-CompB- Server and CompA-Server-CompB-Client. Up to 7 test sessions in parallel were planned.

During the test event the test schedule was updated according to the progress of the test sessions. This was done during the daily wrap-up meetings at the end of each day and during face-to-face meetings with the participants.

The figure below shows the final version of the test schedule.

SAT V3	Area1	Area2	Area3	Area4	Area5	Area6	Area7
9:00 - 10:00		Act-Watteco	Rostock	Sensinode	Ibbt	Huawei	Intecs
		Zurich	Ferrara	Rtx	Bremen	KoanLogic	Patavina
10:00 - 11:00		Act-Watteco	Patavina	Rtx	Sensinode	KoanLogic	Zurich
		Rostock	Bremen	Huawei	Ferrara	Ibbt	Intecs
11:00 - 12:00		Act-Watteco	Patavina	Rtx	Zurich	KoanLogic	Ferrara
		Huawei	Ibbt	Bremen	Rostock	Sensinode	Intecs
12:00 - 13:00	Act-Watteco	Patavina	Huawei	Zurich	Rostock		Intecs
	Rtx	Ferrara	Ibbt	Sensinode	Bremen		KoanLogic
14:00 - 15:00	Zurich	Ibbt	Patavina	Act-Watteco		Intecs	Huawei
	Rtx	Ferrara	Rostock	Sensinode		KoanLogic	Bremen
15:00 - 16:00	Patavina	Act-Watteco	Zurich		KoanLogic	Huawei	Intecs
	Rtx	Ferrara	Ibbt		Rostock	Sensinode	Bremen
16:00 - 17:00	Zurich	Act-Watteco	Intecs	Bremen	Ferrara	Ibbt	
	Patavina	KoanLogic	Rtx	Sensinode	Huawei	Rostock	
17:00 - 18:00	Rtx	Zurich	Huawei	Sensinode	Act-Watteco		0
	Ibbt	Ferrara	Rostock	Patavina	Intecs		0

Figure 1: Test Schedule Saturday 24th March

SUN V6	Area1	Area2	Area3	Area4	Area5	Area6	Area7
9:00 - 10:00			Rtx	Huawei	KoanLogic		
	Hitachi		Ferrara	Intecs	Patavina		
10:00 - 11:00	Hitachi	Zurich			Sensinode	Act-Watteco	
	Intecs				KoanLogic	Patavina	
11:00 - 12:00	Hitachi			Zurich	Intecs	Act-Watteco	Sensinode
	KoanLogic		Rtx	Huawei	Ferrara	Bremen	Rostock
12:00 - 13:00	Hitachi		Zurich		Sensinode		Rostock
	Huawei	Bremen	KoanLogic		Ibbt		Rtx
14:00 - 15:00	Hitachi			KoanLogic	Intecs	Ferrara	Huawei
	Sensinode	Rostock		Ferrara	Ibbt	Bremen	Patavina
15:00 - 16:00	Hitachi			KoanLogic	Intecs	Ibbt	
	Bremen	Ferrara		Rtx	Rostock	Act-Watteco	
16:00 - 17:00		Hitachi	Zurich	Hitachi		Intecs	
	Act-Watteco	Patavina	Bremen	Ibbt		Sensinode	Intecs

Figure 2: Test Schedule Sunday 25th March

6.3 Interoperability Test Procedure

Each test was executed in the same manner as listed below:

1) Connect client and server over test network

2) Check connectivity between devices

3) Perform tests according to Plugtest Guide

   a. Check if test runs to completion

   b. Check results from an interoperability point of view:
      Is the intended result visible at the application layer?

4) Result determination and reporting

   a. Result OK: run next test

   b. Result not OK: check monitor tools to identify source of error

c. Report results in ETSI Test Reporting Tool

5) Once all tests executed swap client / server roles and run all tests again

6.4 Test Infrastructure

The test infrastructure provided for the plugtest is shown below.

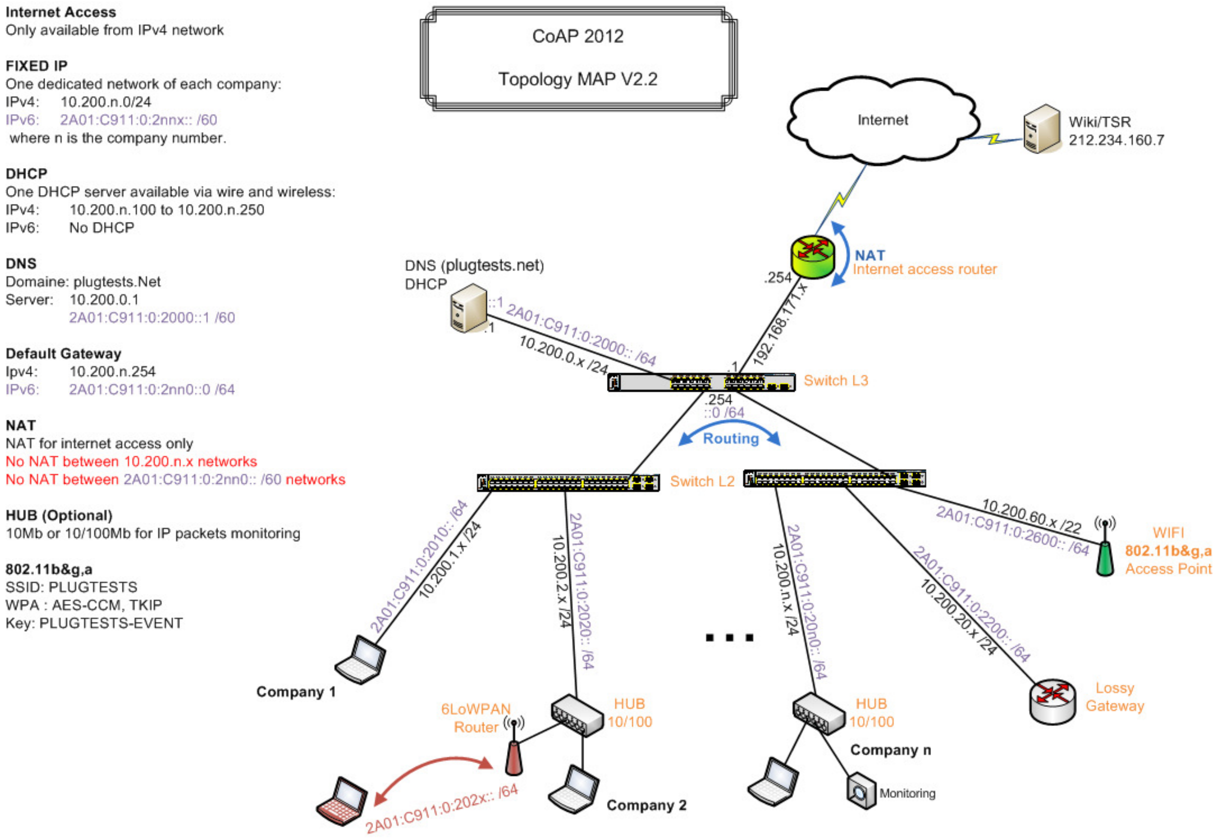

Figure 3: Test Network

6.5 Tooling

6.5.1 ETSI Test Reporting Tool

The purpose of the ETSI Test Reporting Tool is to provide a means to report the test sessions. It provides statistical overviews of the test results. The graphical information in the latter section on results was created with the ETSI Test Reporting Tool. It also provides a means to create a test schedule (see section 6.2).

6.5.2 IRISA Online Trace Validation

The purpose of the passive validation tool for the CoAP protocol is to validate the traces in a capture file (in the pcap format) against the scenarios detailed in the test specification. All details about this tool are located on the web site: http://www.irisa.fr/tipi/wiki/doku.php/Passive_validation_tool_for_CoAP

6.5.3 BUPT UDP Lossy Gateway

The purpose of the UDP lossy gateway is to perform packet loss in CoAP conversations according to the lossy context test descriptions defined in the plugtest guide.

The configuration of the setup is shown below:

CoAP Client ----- UDP Lossy Gateway ----- CoAP Server

Figure 4: UDP Lossy Gateway Configuration

The UDP lossy gateway assigns one listening port for each CoAP server. Thus the UDP lossy gateway provides for each CoAP server a unique lossy address.

A CoAP client that does lossy context test sends the CoAP message to the lossy address of the specified CoAP server. Then the UDP lossy gateway decides the right destination address according to the UDP socket on which the message was received.

Then the UDP lossy gateway starts a new UDP socket to communicate with the appropriate CoAP server. This UDP socket is also used for forwarding back the CoAP server's responses to the right CoAP client. The server-side communication expires after idling 5mn.

Packet loss is performed at 2 places:

- forwarding CoAP client's message to the CoAP server
- forwarding back CoAP server's message to the CoAP client

The program generates random numbers to decide whether to perform packet loss or not. A 30% packet loss rate was used for the plugtest.

7 Achieved Results

The achieved results show that all implementations have been compatible on a basic level, i.e. sent data could be decoded and interpreted properly by receivers and a vast majority of equipment performed well.

However, mature and prototype implementations exist, and the difference between mature and prototype implementations is in the level of coverage of implemented features. It needs to be stated that when features were implemented, then high interoperability was observed.

During the tests sessions capture files were produced, and uploaded to the IRISA tool. This exercise showed that more conformance testing would be beneficial.

7.1 Overall Results

The figure below shows the overall result of mandatory and optional tests. In a total more than 3000 tests were executed.

The execution rate of 89% is a satisfying result, especially as it is a first interoperability event and given the fact that prototype and mature implementations attended.

3% of the tests were not executed due to time limitation (OT – out of time). This small percentage shows that the 1 hour test slots were sufficient.

8 % of the tests were not executed due to non implemented features (NA – not applicable). The non implemented features were mainly BLOCK and OBSERVE.

94% of the test verdicts were PASS which shows the high level of maturity of the implementation.

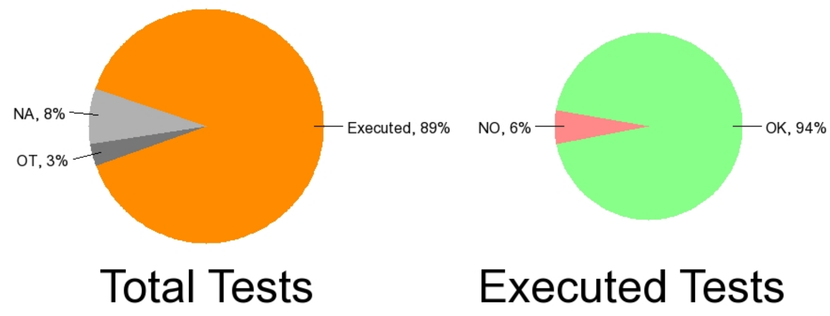

Figure 5: Overall Results

7.2 Results of mandatory tests

There were 16 mandatory tests defined which were to be executed bidirectional, i.e. each test session had to run 32 tests. In a total 2843 tests were executed. The figures below reflect the results as described in section 7.1

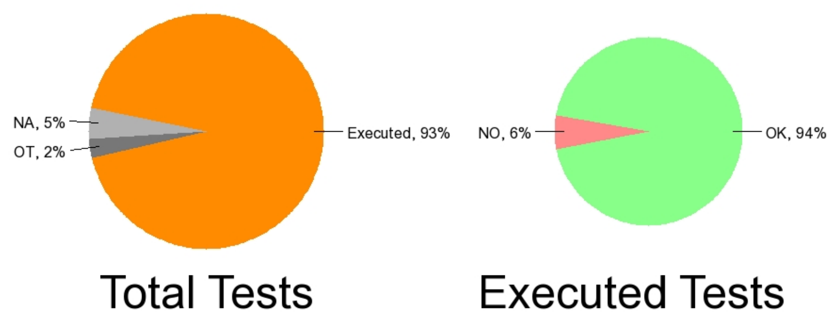

Figure 6: Results of mandatory tests

7.3 Results of optional tests

There were 11 optional tests defined which were to be executed bidirectional, i.e. each test session had to run 22 tests. In a total 298 tests were executed. The figures below reflect the results as described in section 7.1. A high percentage of 30% not implemented features shows that not all implementation have fully covered all features, i.e mainly BLOCK and OBSERVE.

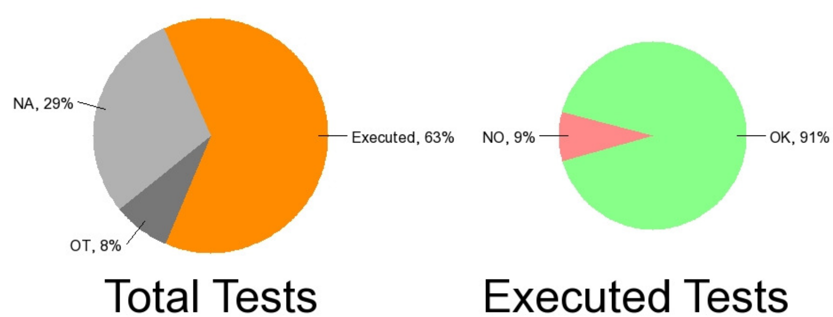

Figure 7: Results of optional tests

8 Summary of Wrap Up Sessions

8.1 IOP Issues

- The setup time of 30 minutes on Saturday morning was not long enough.
  - For a next event it is recommended to have at least a 1 hour setup time
- The conformance monitoring of trace probes showed that conformance testing could be beneficial
- The IOP issues discovered with implementations were mainly
  - Token Options (often implemented only partially)
  - Block1 option (i.e, blockwise PUT/POST)
  - Clients, having received an incoming packet , must use in their response the IP address to which the incoming packet has been addressed; Clients shall not change their source address in a response
- Suggestion: Client should not always use default port (src port == 5683) as source port for requests. Ephemeral port range should be used to make sure that hard coded addresses are not used

8.2 Test Spec Issues

Feedback received during the plugtest is listed here below and needs to be implemented for a next plugtest.

- TD_COAP_CORE_09
  - ACKs in steps 3 and 5 must also have: Code = 0 (empty message)
  - Steps 3 and 4 may occur out-of-order
- TD_COAP_CORE_10, 11, 12, 13 and TD_COAP_LINK_01
  - not necessary to check payload & content type
  - not necessary to check that we have CON messages (we have CON for the request and CON for the response -> this is a separate response)
  - should we care about the result code?
- TD_COAP_CORE_02,03,06,07
  - PUT & POST may result in a 2.01 response
- TD_COAP_CORE_12
  - check that Uri-Path option does not contain '/'
- TD_COAP_LINK_01
  - Check for response code ? --> 2.05
- TD_COAP_BLOCK_01-04
  - More checks to be added
- TD_COAP_OBS_03
  - max-age is the maximum interval (the information can be refreshed before)

Annex A CoAP Interoperability Test Specification

The CoAP Interoperability Test Specification, which forms parts of the present technical report, is contained in the file CoAP_IOT_TestSpecification_v016_20120321.pdf.

History

Document history		
V1.1.1	March 2012	Version for approval