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TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	6
1 TRAINING PLATFORM	7
1.1 FIESTA-IoT: WHAT IS IT?.....	8
1.2 GUIDE FOR 3 RD PARTIES	9
1.3 FIESTA-IoT OPEN CALLS	13
2 TRAINING WORKSHOPS	14
2.1 TRAINING WORKSHOPS FOR EXPERIMENTERS	14
2.2 TRAINING WORKSHOPS FOR EXTENSIONS	16
2.3 TRAINING WORKSHOP AT IOT WEEK 2017	18
3 SUPPORT TOOLS STATISTICS.....	18
3.1.1 <i>FIESTA-IoT Support Suite</i>	18
3.1.1.1 Mantis Solved/Unsolved Issues	18
3.1.1.2 Chat Solved/Unsolved Issues	20
3.1.2 <i>GitHub Issue Tracker</i>	21
3.1.2.1 in-house-dynamic-discovery	21
3.1.2.2 testbed.tpi	22
3.1.2.3 ontology	22
3.1.2.4 experiment.data.receiver.....	23
3.1.3 <i>FIESTA-IoT Training Platform</i>	23
4 INTEROPERABILITY TESTING AND VALIDATION	27
4.1 INTRODUCTION	27
4.2 CERTIFICATION OF FIESTA-IoT SPECIFICATION COMPLIANCE	29
4.2.1 <i>Individual Interoperability Compliance Tests</i>	30
4.2.2 <i>TPS Certification and Interoperability Tests</i>	39
4.2.3 <i>FIESTA-IoT Testbed Validation</i>	40
4.3 LOCAL TPS INTEROPERABILITY TESTING.....	41
4.3.1 <i>FIESTA-IoT Stakeholder (Testbed) Performing Interoperability Testing</i>	41
4.3.2 <i>An NGSI-10 to FIESTA-IoT TPS Interoperability Test</i>	43
4.4 CONCLUSIONS AND INTEROPERABILITY TESTING AND VALIDATION PLAN	46
5 CONCLUSION.....	47
6 BIBLIOGRAPHY	48
ANNEX A – AGENDA: 1ST OPEN-CALL TRAINING WORKSHOP FOR EXPERIMENTERS	49
ANNEX B – AGENDA: 1ST OPEN-CALL TRAINING WORKSHOP FOR EXTENSIONS	50
ANNEX C – AGENDA: 2ND OPEN-CALL TRAINING WORKSHOP FOR EXTENSIONS.....	51

LIST OF FIGURES

FIGURE 1 - FIESTA-IOT TRAINING PLATFORM.	7
FIGURE 2 - SECTION WITH AN OVERVIEW ABOUT WHAT IS FIESTA-IOT.	8
FIGURE 3 - RELEVANT INFORMATION SECTION WITH USEFUL LINKS.	9
FIGURE 4 - FIESTA-IOT OVERVIEWSECTION.	10
FIGURE 5 - FIESTA-IOT SECURITY FRAMEWORKSECTION.	10
FIGURE 6 - SECTION WITH THE GUIDE FOR EXPERIMENTERS.	11
FIGURE 7 - SECTION WITH THE GUIDE FOR EXTENSIONS.	12
FIGURE 8 - SECTION WITH THE FIESTA-IOT HANDBOOK.	13
FIGURE 9 - FIESTA-IOT OPEN CALLS COURSE.	13
FIGURE 10 - FOLDER WITH THE RESOURCES USED/PRESENTED IN THE TRAINING WORKSHOP.	14
FIGURE 11 - SECTION WITH THE PRESENTATION VIDEOS FOR EXPERIMENTERS.	15
FIGURE 12 - FOLDER WITH THE RESOURCES PRESENTED IN THE TRAINING WORKSHOP.	16
FIGURE 13 - TRAINING WORKSHOP FOLDER AND THE PRESENTATION VIDEOS FOR EXTENSIONS.	17
FIGURE 14 - SUMMARY OF MANTIS SYSTEM.	19
FIGURE 15 - CHART OF OPENED AND RESOLVED ISSUES.	19
FIGURE 16 - CHART OF RESOLVED ISSUES BY HELPDESK.	20
FIGURE 17 - HISTORY CHATS LIST.	20
FIGURE 18 - CHART OF SOLVED AND UNSOLVED ISSUES.	21
FIGURE 19 - STATISTICS OF “IN-HOUSE-DYNAMIC-DISCOVERY” REPOSITORY.	22
FIGURE 20 - STATISTICS OF “TESTEBED.TPI” REPOSITORY.	22
FIGURE 21 - STATISTICS OF “ONTOLOGY” REPOSITORY.	23
FIGURE 22 - STATISTICS OF “EXPERIMENT.DATA.RECEIVER” REPOSITORY.	23
FIGURE 23 - STATISTICS OF “FIESTA-IOT: WHAT IS IT ?” COURSE.	24
FIGURE 24 - STATISTICS OF “GUIDE FOR 3 RD PARTIES” COURSE.	24
FIGURE 25 - STATISTICS OF “FIESTA-IOT OPEN CALLS” COURSE.	25
FIGURE 26 - STATISTICS OF OPEN CALLS FOR EXPERIMENTS AND EXTENSIONS.	26
FIGURE 27 - STATISTICS OF SUBMISSION OF PROPOSALS FOR EACH OPEN CALL.	26
FIGURE 28 - TESTING FOR CERTIFICATION.	28
FIGURE 29 - THE FIESTA-IOT PLATFORM <-> TESTBED ARCHITECTURE [3].	29
FIGURE 30 - TPS CERTIFICATION.	39
FIGURE 31 - TPS CERTIFICATION TEST IN THE PORTAL.	40
FIGURE 32 - INTEROPERABILITY TESTING OVERVIEW.	41
FIGURE 33 - INTEROPERABILITY TEST IN THE MBT TOOL.	42

LIST OF TABLES

TABLE 1 - FIESTA-IoT TPS VALIDATION RESULTS	40
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TERMS AND ACRONYMS

API	Application Programming Interface
EaaS	Experiment-as-a-Service
EEE	Experiment Execution Engine
FIRE	Future Internet Research and Experimentation
IoT	Internet of Things
REST	Representational State Transfer
TPI	Testbed Provider Interface
TPS	Testbed Provider Services
UI	User Interface
WP	Work Package

EXECUTIVE SUMMARY

This deliverable describes "Training, Consulting, Testing and Validation" as a result of the work done in WP6 along with other work packages in the FIESTA-IoT project. This document aims to address the following topics:

- Training Platform;
- Training Workshops;
- Support Tools Statistics;
- Interoperability Testing and Validation.

In chapter 1 it describes in detail the FIESTA-IoT training platform that provides all the information necessary to properly use the FIESTA-IoT platform. This training platform includes all the information in the "Handbook for Experts and Extensions" in a more dynamic and user-friendly way as it is organized by specific courses that are also explained in detail in this document.

To support the FIESTA-IoT Open Calls, training workshops were organized for experimenters and extensions in order to present the FIESTA-IoT platform to the third parties. In chapter 2 more information about each of the workshops and all the material used in each one is provided.

Chapter 3 presents relevant information about the acquired statistics on solved and unsolved issues through the different support tools as the FIESTA-IoT training platform, Mantis System, Live Chat Support, and the GitHub Issue Tracker.

Chapter 4 describes how the FIESTA-IoT interoperability testing tools (specifically the Certification Portal and Model-based Interoperability Testing Tools) were employed to test and validate that the in-house FIESTA-IoT testbeds interoperated correctly with the FIESTA-IoT platform.

1 TRAINING PLATFORM

The FIESTA-IoT Training platform is implemented using the Moodle learning platform¹, offering some useful courses that provide information and describe how to correctly use of the FIESTA-IoT platform. This training material is accessible in the FIESTA-IoT Moodle platform².

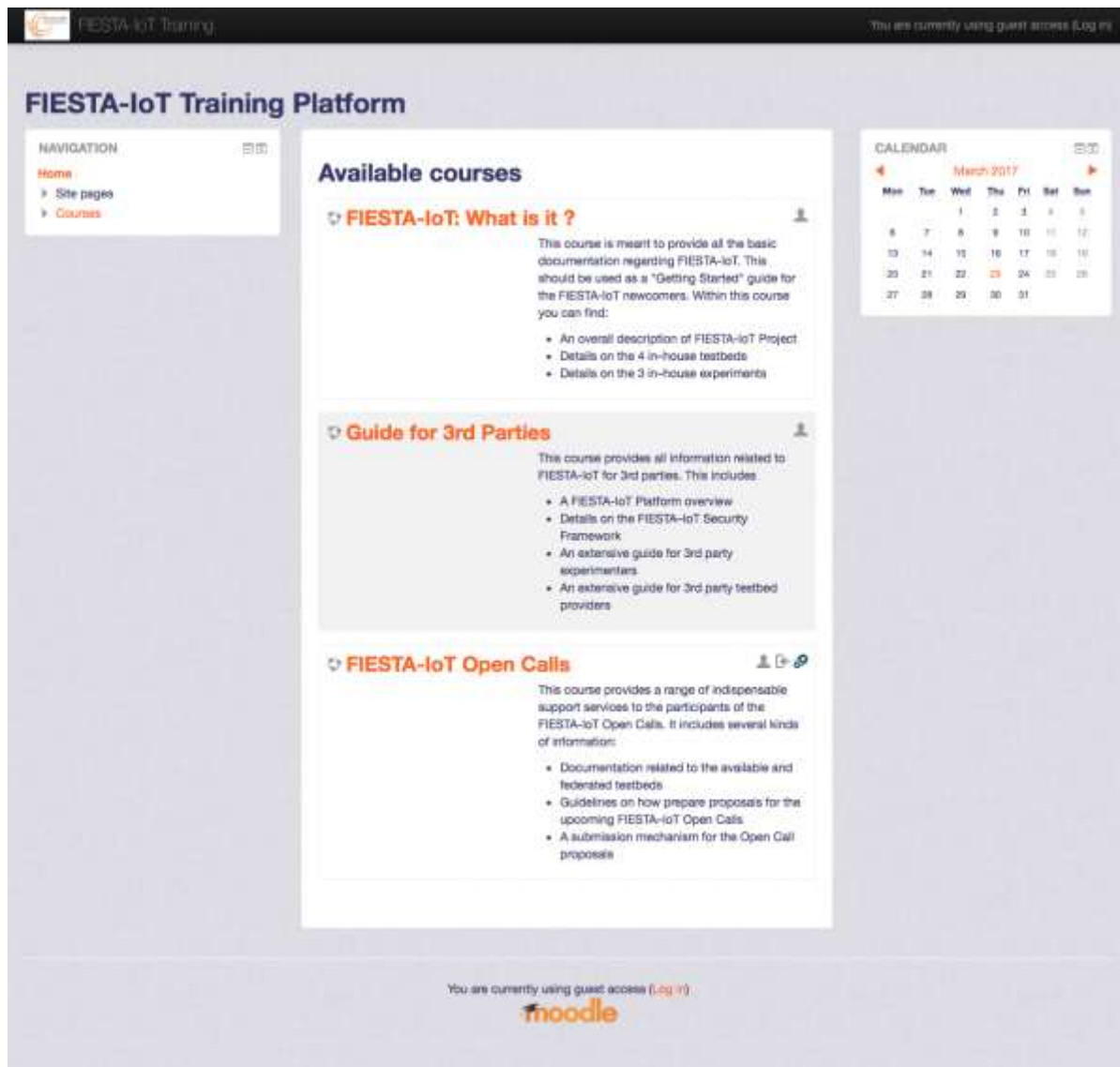


Figure 1 - FIESTA-IoT training platform.

FIESTA-IoT Moodle platform provides many types of resources related to organisation and support of FIESTA-IoT Open Calls. These resources are grouped in three courses:

- FIESTA-IoT: What is it?³ – Is intended to be used as a “Getting Started” guide, providing an overall description of the FIESTA-IoT project. It intends to provide a contextualization to FIESTA-IoT newcomers;

¹ <https://moodle.org>

² <http://moodle.fiesta-iot.eu/>

³ <http://moodle.fiesta-iot.eu/course/view.php?id=3>

- Guide for 3rd Parties⁴ – Intends to provide support to the FIESTA-IoT for 3rd parties, giving an overview of the FIESTA-IoT platform, detailed information on the FIESTA-IoT Security framework and extensive guides for 3rd parties Experimenters and for Testbed providers;
- FIESTA-IoT Open Calls⁵ – This course provides several support services to the participants of the FIESTA-IoT Open Calls.

1.1 FIESTA-IoT: What is it?

This course is intended to provide all the basic documentation regarding FIESTA-IoT. It is explained in detail the Interoperability Challenge of the FIESTA-IoT, the access through a common Experiment as a Service approach and the FIESTA-IoT main architecture.



Figure 2 - Section with an overview about what is FIESTA-IoT.

The FIESTA-IoT project has four in-house Testbeds and three in-house Experiments. In this section, there is also a description of each in-house Testbeds such as the summary of the domains supported by each platform, the main assets associated to each of these domains and the number of resources available in each of the cases.

Some examples of IoT in-house Experiments that can be carried out across the FIESTA-IoT Federation can be consult here.

⁴ <http://moodle.fiesta-iot.eu/course/view.php?id=4>

⁵ <http://moodle.fiesta-iot.eu/course/view.php?id=2>

1.2 Guide for 3rd Parties

This course provides all the information related to FIESTA-IoT for 3rd parties and some useful links to the FIESTA-IoT GitHub page that can be used by the users to understand several aspects of the FIESTA-IoT Platform, the link with relevant information about the FIESTA-IoT Help-Desk Support and the link to the FIESTA-IoT Platform.

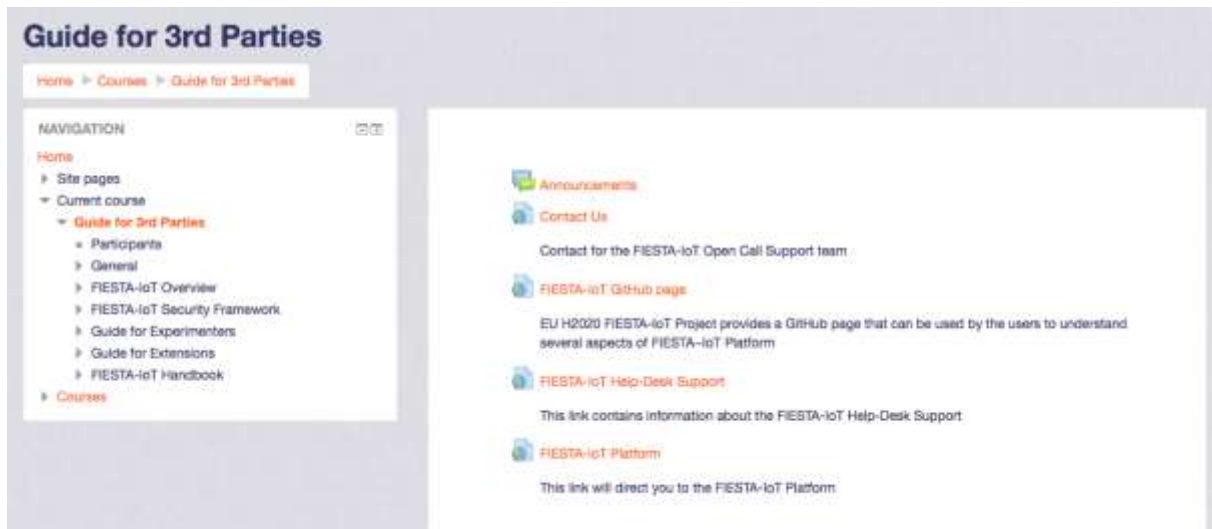


Figure 3 - Relevant information section⁴ with useful links.

The resources present on this course are based on the “Handbook for Experimenters and extensions”, written by FIESTA-IoT consortium to provide guidelines 3rd parties FIESTA-IoT platform users on how this platform works and on to use it.

This course is open to everyone and therefore no account or specific access permissions are required to access the training resources. The topics covered in this course are:

- FIESTA-IoT Overview;
- FIESTA-IoT Security Framework;
- Guide for Experimenters;
- Guide for Extensions;
- FIESTA-IoT Handbook.

FIESTA-IoT Overview

In this section, we provide a short introduction of the FIESTA-IoT platform⁶, as API documentation and the FIESTA-IoT Web Portal. This section also recommends some external references to be read before starting playing around with the framework.

⁶ <http://moodle.fiesta-iot.eu/mod/book/view.php?id=110>

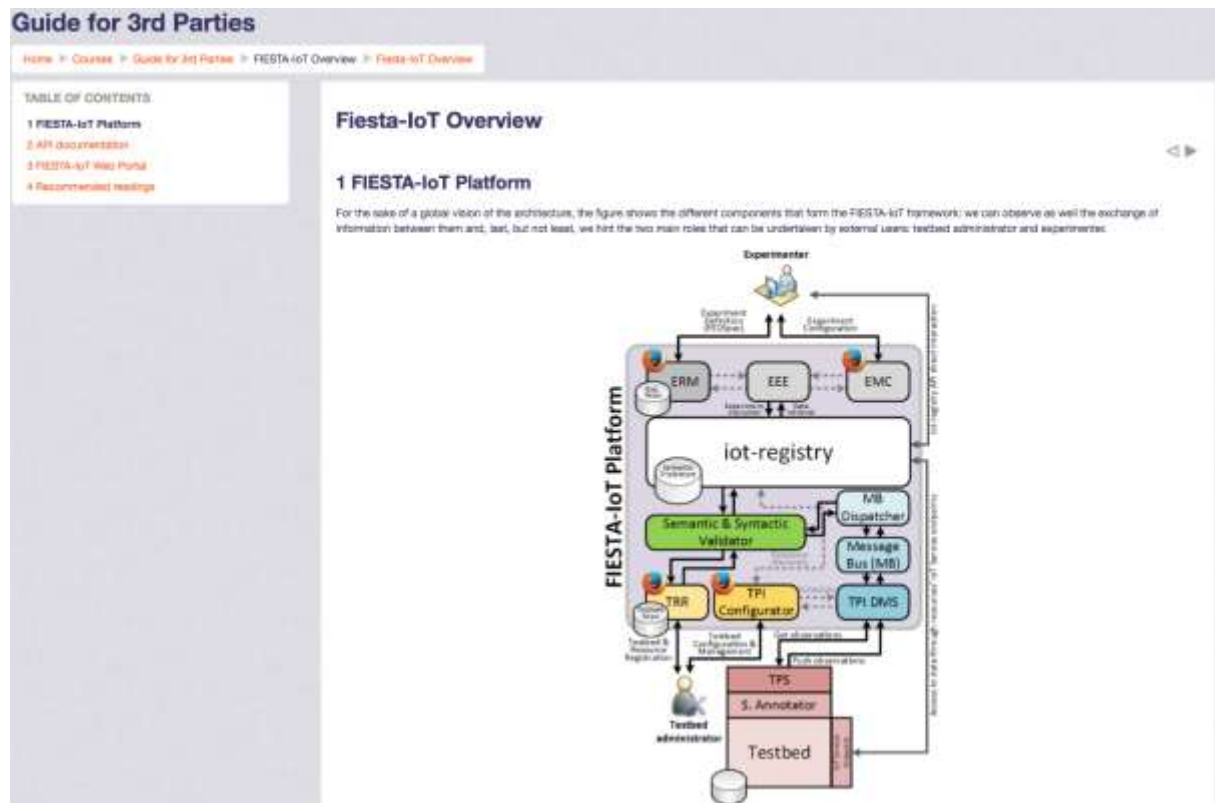


Figure 4 - FIESTA-IoT Overview section.

FIESTA-IoT Security Framework

This section is dedicated to the Security processes of the FIESTA-IoT Framework⁷ that are common to administrators of Testbeds and Experimenters.

Guide for 3rd Parties

Home > Courses > Guide for 3rd Parties > FIESTA-IoT Security Framework > FIESTA-IoT Security Framework

TABLE OF CONTENTS

- 1 User registration
- 2 User roles
- 3 Security access
- 3.1 Invoking the service with my credentials
- 3.2 Invoking the OpenAM Authentication API to obtain a SSO token
- 3.3 Invoking the IoT-Registry API with authentication credentials
- 3.4 Configuring the Java Throttles

FIESTA-IoT Security Framework

1 User registration

In order to use any FIESTA-IoT service or tool, regardless of the future role within the system (i.e. FIESTA-IoT administrator, testbed administrator, experimenter or observer), a user must first sign up to the **FIESTA-IoT platform** as a regular user. Attempting to access FIESTA-IoT resources while not logged in will redirect the user to the FIESTA-IoT's authentication Portal (as shown in the 1st Figure). Assuming that you have not been registered yet, you will need to create a new account. For this, just click the "Create an account" link that you can see below the "LOG IN" button. Then, you will see what is shown in 2nd Figure.

Figure 5 - FIESTA-IoT Security Framework section.

⁷ <http://moodle.fiesta-iot.eu/mod/book/view.php?id=106>

The information provided in this section aims to guide how to deal with all the process of the FIESTA-IoT authentication and authorization standpoint, covering the registration process, role definition, and subsequent use of user credentials to gain access to the FIESTA-IoT framework.

Guide for Experimenters

In this section⁸, users can find relevant information about the integration of Experiments in the FIESTA-IoT Platform. A guide is provided to help in questions related with the Experiment management tools and IoT-Registry API for advanced experimenters.

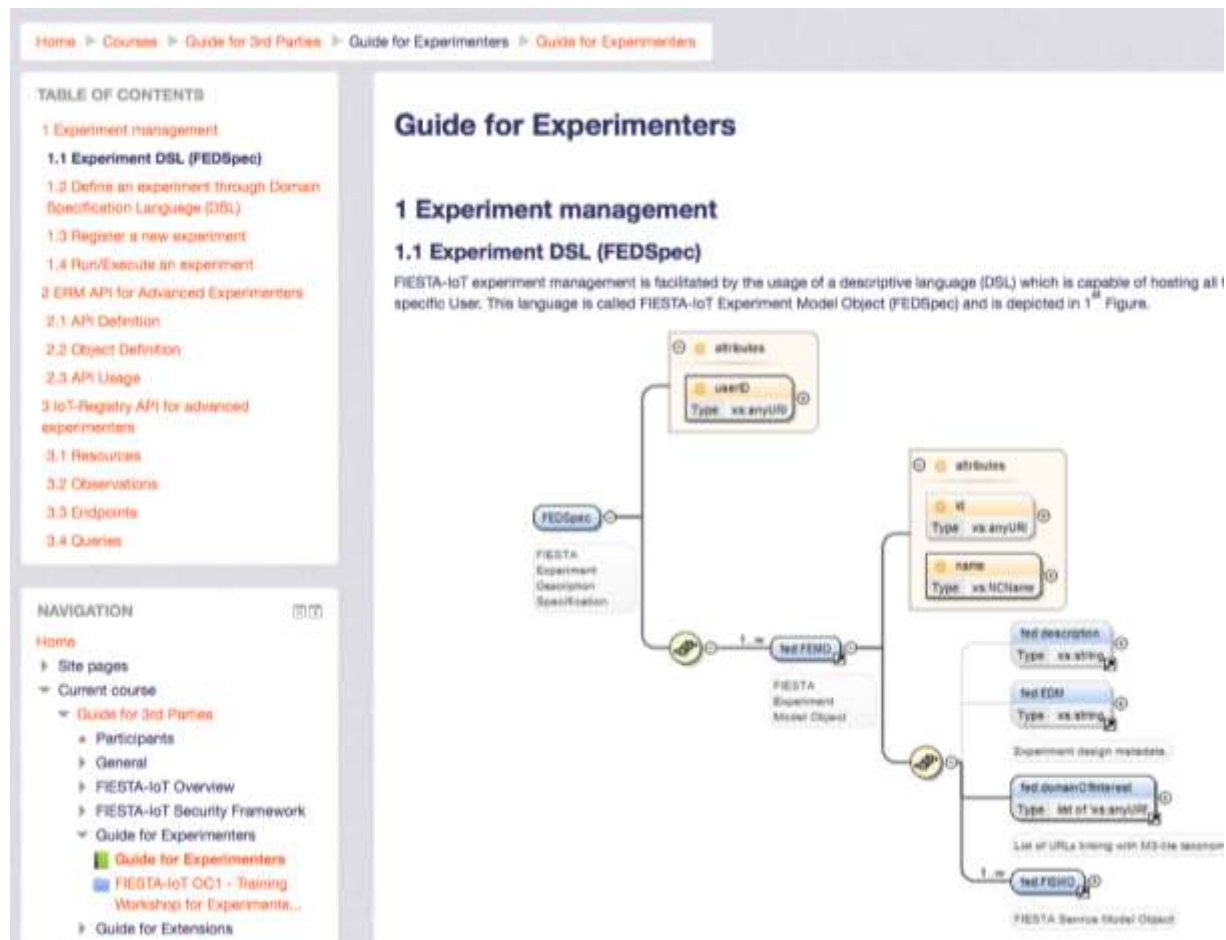


Figure 6 - Section with the Guide for Experimenters.

A folder for “Training Workshop for Experimenters”⁹ is also provided, including all the content used and/or presented during the Workshops for Experimenters from the FIESTA-IoT Open Calls. This material is also available in the video¹⁰ presentations of each workshop.

⁸ <http://moodle.fiesta-iot.eu/mod/book/view.php?id=104>

⁹ <http://moodle.fiesta-iot.eu/mod/folder/view.php?id=108>

¹⁰ https://www.youtube.com/playlist?list=PLm2gIQ0ki_ZW3IMVv8CGajkV2JU8PnWx

Guide for Extensions

This guide¹¹ gathers all the necessary information related with the integration of new testbeds into FIESTA-IoT. As such, this guide address topics as how to semantic align with FIESTA-IoT's semantic data models, testbed and resource registration, send data/observations and testbed management.

Guide for Extensions

Home > Courses > Guide for 3rd Parties > Guide for Extensions > Guide for Extensions

TABLE OF CONTENTS

- 1 Getting aligned with FIESTA-IoT's semantic data models
 - 1.1 FIESTA-IoT ontology alignment phase
 - 1.2 MD-its taxonomy alignment phase
 - 1.3 FIESTA-IoT Amendment proposals
 - 1.4 Implementation of Testbed to FIESTA-IoT annotations
 - 1.5 Annotation as a Service (IoT-registry url)
- 2 Resource registration
 - 2.1 Register Devices Manual
 - 2.2 Register Devices by text
 - 2.3 Register Devices by Upload
- 3 Testbed Provider Services (Testbed to FIESTA-IoT)
 - 3.1 Configuration and Runtime Sequence example
 - 3.2 TPS API Definition
 - 3.3 TPS Implementation (Ankky Container)
 - 3.4 Testbed Configuration management

NAVIGATION

- Home
- Site pages
- Current course
 - Guide for 3rd Parties
 - Participants
 - General
 - FIESTA-IoT Overview
 - FIESTA-IoT Security Framework
 - Guide for Experimenters
 - Guide for Extensions
 - Guide for Extensions
 - FIESTA-IoT OCT - Training Workshop for Extensions
- Courses

1 Getting aligned with FIESTA-IoT's semantic data models

When it comes to put your testbed into the FIESTA-IoT federation, it is deemed necessary to get aligned to the data model (i.e. ontology) we have defined under the umbrella of the whole project. Otherwise, you will not be able to put your data into our repositories, since it will not pass the validation stage (nor the testbed registration module beforehand). As a direct consequence, as a testbed administrator, you will have to undertake the role of adapting your datasets into the semantically annotated formats that have been shaped up in our project.

Before going any further, we strongly recommend that you take a look at the ontology's [webpage](#) and the deliverable responsible for digging into its depths: (FIESTA-IoT D6.1, 2016).

Moreover, we include herewith the raw graph that depicts the ontology:

FIESTA-IoT ONTOLOGY

Figure 7 - Section with the Guide for Extensions

The Training Workshop for Extensions folder¹² is provided with all the content used and/or presented during the Workshop for Extensions from the FIESTA-IoT Open Calls. The presentations performed on each workshop are also available in video¹³.

FIESTA-IoT Handbook

This course⁴ presents the “Handbook for Experimenters and Extensions”, whose main objective is to provide a complete vision of all the features that FIESTA-IoT can support in this current release.

¹¹ <http://moodle.fiesta-iot.eu/mod/book/view.php?id=96>

¹² <http://moodle.fiesta-iot.eu/mod/folder/view.php?id=114>

¹³ https://www.youtube.com/playlist?list=PLm2glQ0ki_ZXtW10Yh-SWXZ3w8n8W_VBd

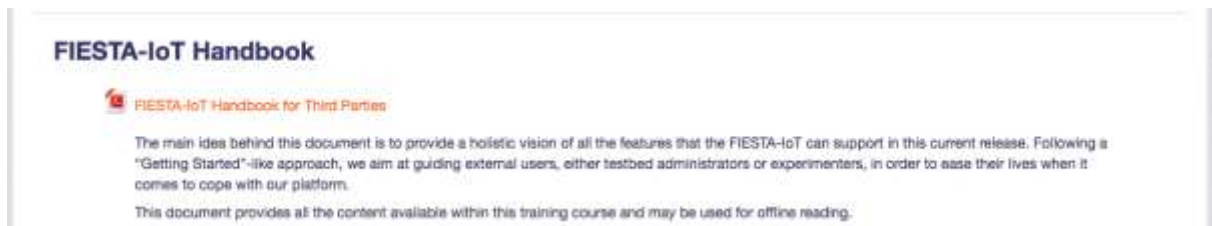


Figure 8 - Section with the FIESTA-IoT Handbook.

This guide¹⁴ aims at helping external users, either testbed administrators or experimenters, in using the all the functionalities provided by FIESTA-IoT platform.

This is a document available for download and provides all the content available within this training course and may be used for offline reading.

1.3 FIESTA-IoT Open Calls

This course provides a range of indispensable support services to the participants of the FIESTA-IoT Open Calls.



Figure 9 - FIESTA-IoT Open Calls course.

It changes during each Open Call period, focusing on the specifics of the Open Call that is currently underway. It also includes documentation related to the available and federated testbeds, guidelines on how prepare proposals for the upcoming FIESTA-

¹⁴ http://moodle.fiesta-iot.eu/pluginfile.php/711/mod_resource/content/2/FIESTAIoT_Handbook4ThirdParties_v1.0.pdf

Under the FIESTA-IoT Open Calls, Training Workshops for Experimenters and for Extensions were organized where the FIESTA-IoT platform and its specific characteristics were presented to the third parties.

In the Training Workshop for Experimenters, relevant information was presented to help experimenters setup their experiments using the tools provided by the FIESTA-IoT platform. The resources used/presented in this workshop can be accessed on a folder¹⁵ on the Guide for 3rd Parties module course.



The 1st workshop was held remotely on the 14th March 2017 through the GoToMeeting¹⁶ platform. The 3rd Parties were previously invited and contacted to participate in this workshop organized by the FIESTA-IoT consortium. The attendance list includes the teams responsible for the Experiments accepted in the Open Call:

¹⁶ <https://www.gotomeeting.com/>

- DATAQUEST (Data quality and easy services creation in FIESTA-IoT) from Technical University of Madrid;
- DATE (IoT data management at the network edge by decentralized community service) from UPC;
- CREDIT (CorRelations Between Data graphs and IoT topologies) from Institute of Communications and Computer Systems (ICCS);
- Talk2Fiesta (Conversational Information Services for FIESTA-IoT) from U-Hopper srl;
- SPIAM (Smart Polyhedron Indicator for Asset Management) from Heritas Soluciones Tecnológicas S.L.;
- SMT (Smart Monitoring) from SRC solution.

In this workshop some topics about the FIESTA-IoT Training and support tool were presented and discussed, followed by a detailed description of the four in-house Testbeds providers, the FIESTA-IoT Ontology, methods for user authentication and authorization to access the FIESTA-IoT facility, the platform overview focused on northbound, the portal-based platform services and a detailed description of the three in-house Experimenters. The complete agenda of this workshop can be found in Annex A.

The presentations of this workshop are also available in video and anyone can watch the training workshop for Experimenters in the Guide for 3rd Parties course⁴.

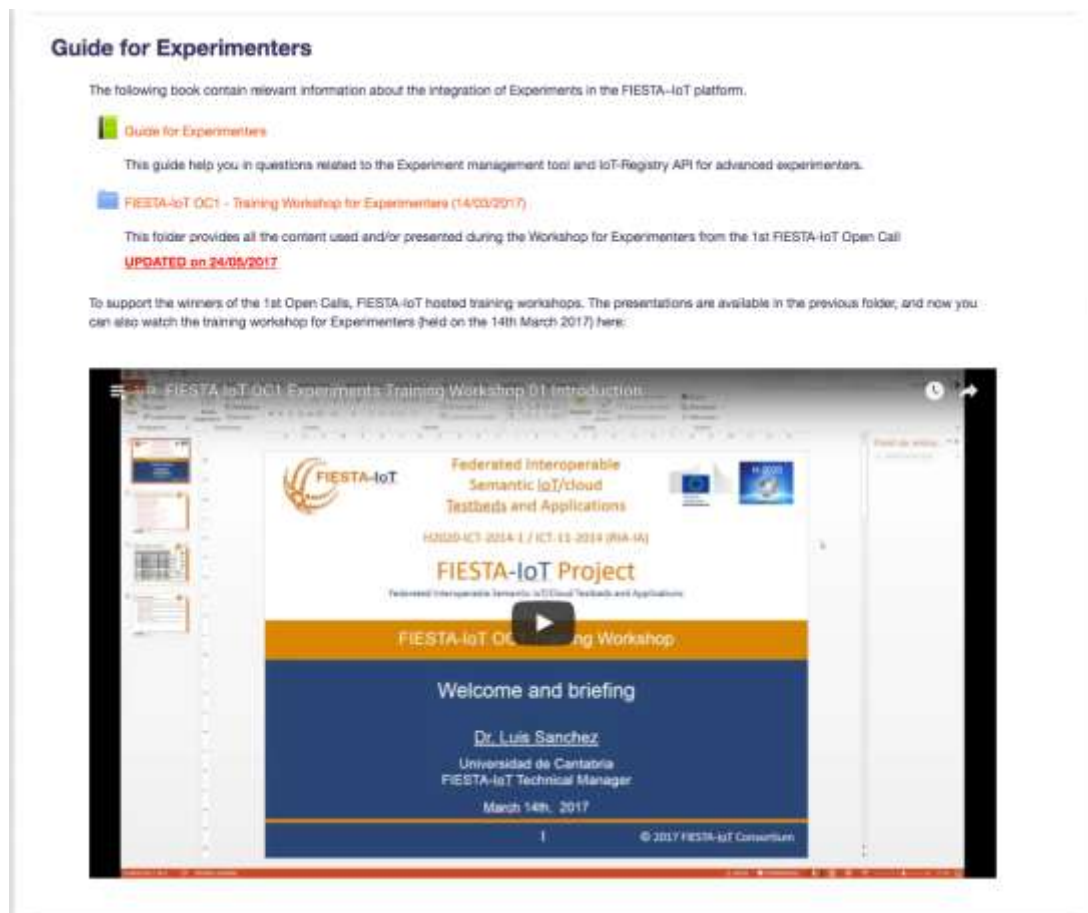


Figure 11 - Section with the presentation videos for Experimenters.

2.2 Training Workshops for Extensions

With a similar objective to the workshop for the Experimenters, the Training Workshop for Extensions of the FIESTA-IoT Open Calls was held to present the necessary information for the integration of Extensions with FIESTA-IoT platform. The resources used in each workshop can also be accessed on a folder¹² on the Guide for 3rd Parties module course.

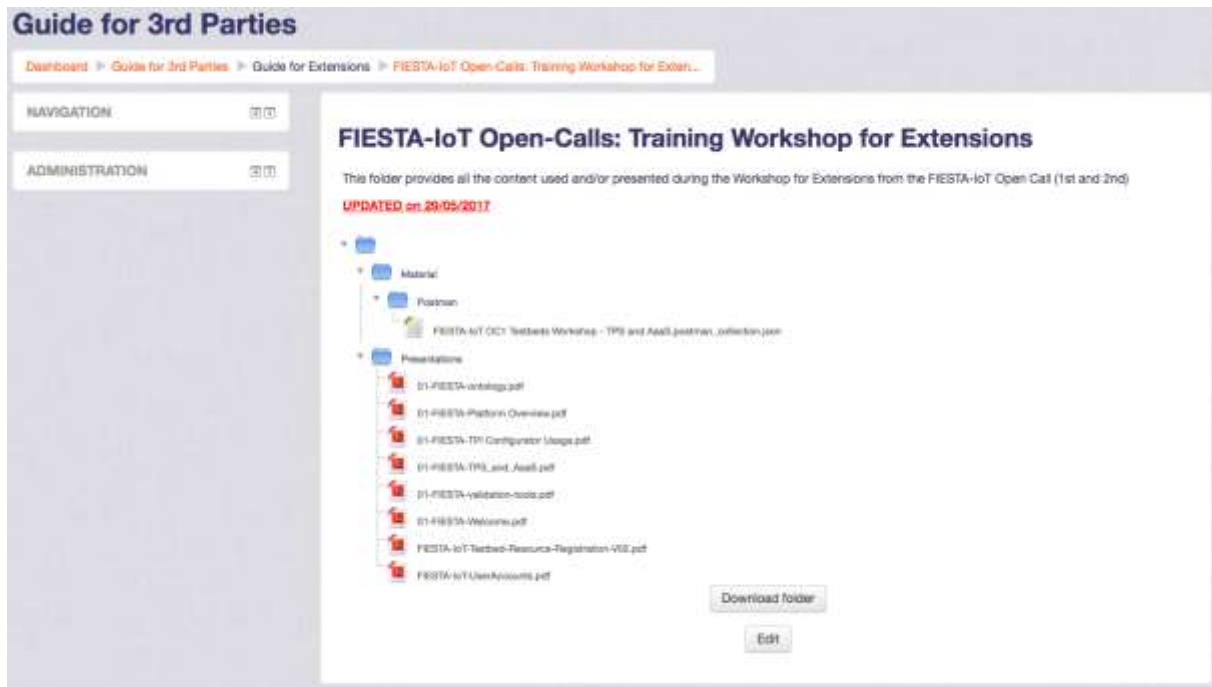


Figure 12 - Folder with the resources presented in the Training Workshop.

In each workshop for Extensions common topics as in the training workshop for Experimenters were presented. These topics were the FIESTA-IoT Ontology, the methods for user authentication and authorization, and the FIESTA-IoT Training and Support tool.

The topics specific for Extensions were the Testbed Provider Services (TPS), Development and the Annotator as a Service, how to develop the required annotation and validation tools, the required components for the registration of a Testbed or a Resource, and the Testbed Provider Interface (TPI) Configurator usage.


A 1st workshop for Extensions was held on the 17th March 2017, remotely through the GoToMeeting¹⁶ platform, according to the agenda available in Annex B. The 3rd Parties were previously contacted and invited to join the workshop. This workshop was organized by the FIESTA-IoT consortium, and the attendance list included the teams of the Extensions accepted in the 1st Open Call:

- NITOS (Network Implementation Testbed using Open Source Platforms) from University of Thessaly (UTH);
- MARINE (MARine Infrastructure for moNitoring and Experimentation) from GRIDNET S.A.;
- ADREAM FIESTA from LAAS-CNRS.


This Workshop is also available in video and anyone can watch it in the Guide for 3rd Parties course⁴.

Guide for Extensions

Here is gathered all the necessary information related to the integration of Extensions with FIESTA-IoT.

 **Guide for Extensions**

Issues like getting aligned with FIESTA-IoT's semantic data models, testbed and resource registration, send data/observations and testbed management are explained in detail here.

 **FIESTA-IoT Open-Calls: Training Workshop for Extensions**

This folder provides all the content used and/or presented during the Workshop for Extensions from the FIESTA-IoT Open Call (1st and 2nd)

UPDATED on 29/05/2017

To support the winners of the 1st Open Calls, FIESTA-IoT hosted training workshops. The presentations are available in the previous folder, and now you can also watch the training workshop for Extensions (held on the 17th March 2017) here:




Figure 13 - Training Workshop folder and the presentation videos for Extensions.

The 2nd workshop was held in 29th May 2017 remotely through the GoToMeeting¹⁶ Platform, according to the agenda available in Annex C. The 3rd Parties accepted via the 2nd Open-Call were previously contacted and invited to participate. This workshop was organized by the FIESTA-IoT consortium, and the attendance list included the teams responsible for the Extensions accepted in the Open Call:

- Tera4Agri (Tera testbed in smart agriculture domain) from TERA Srl;
- REALDC (Operational Data Centre, Campus Energy and Weather Sensors) from WIT;
- FINE (A FIESTA-enabled IoT Architecture based on RERUM) from FORTH.

This 2nd training workshop for Extensions was also recorded in video, however it is currently being edited, so it will be provided as soon as possible and made available in the Guide for 3rd Parties course⁴.

2.3 Training Workshop at IoT Week 2017

A physical training workshop was organized by the FIESTA-IoT consortium which was held on 8th June 2017 at IoT Week 2017¹⁷.

The “FIESTA-IoT - Experimentation as a Service over Interoperable IoT Testbeds” presented the latest results from the FIESTA-IoT project. The focus was on the description of the IoT experimentation that is enabled by the FIESTA-IoT Platform not only from a technical and practical perspective but also through the presentation of the 3rd FIESTA-IoT Open Call for Experimentation that was open and hosted proposals till the 15th of June.

This session was held in International Conference Centre of Geneva (CICG) according to the following agenda:

- 16:15 - 16:20: Welcome and presentation of the session;
- 16.20 - 16.50: Overview of the EaaS tools for experimentation on top of the FIESTA-IoT platform;
- 16.50 - 17.10: FIESTA-IoT Training and Support for 3rd Parties;
- 17.10 - 17.30: FIESTA-IoT NEC SmartCity Magnifier demonstrator;
- 17.30 - 18.00: FIESTA-IoT 3rd and 4th Open-Calls and conclusions.

3 SUPPORT TOOLS STATISTICS

3.1.1 FIESTA-IoT Support Suite

3.1.1.1 *Mantis Solved/Unsolved Issues*

MantisBT is a web based bug tracking system. Over time it has matured and gained a lot of popularity, and now it has become one of the most popular open source bug/issue tracking systems. MantisBT is developed in PHP, with support to multiple database backends including MySQL, MS SQL, PostgreSQL and DB2.

Using MantisStats plugin for Mantis summary report. It is a collection of 20+ statistical reports grouped in 'Issues', 'People', 'Time' and 'Trends' bundles for the Mantis system.

¹⁷ <http://iot-week.eu/>

It operates on real-time data and provides it with (growing) number of managerial reports, including comparison charts.

A summary of the usage of Mantis System:



Figure 14 - Summary of Mantis System.

Using MantisStats to show how many issues were opened, how many issues are solved: (filter by Trends: opened vs resolved):

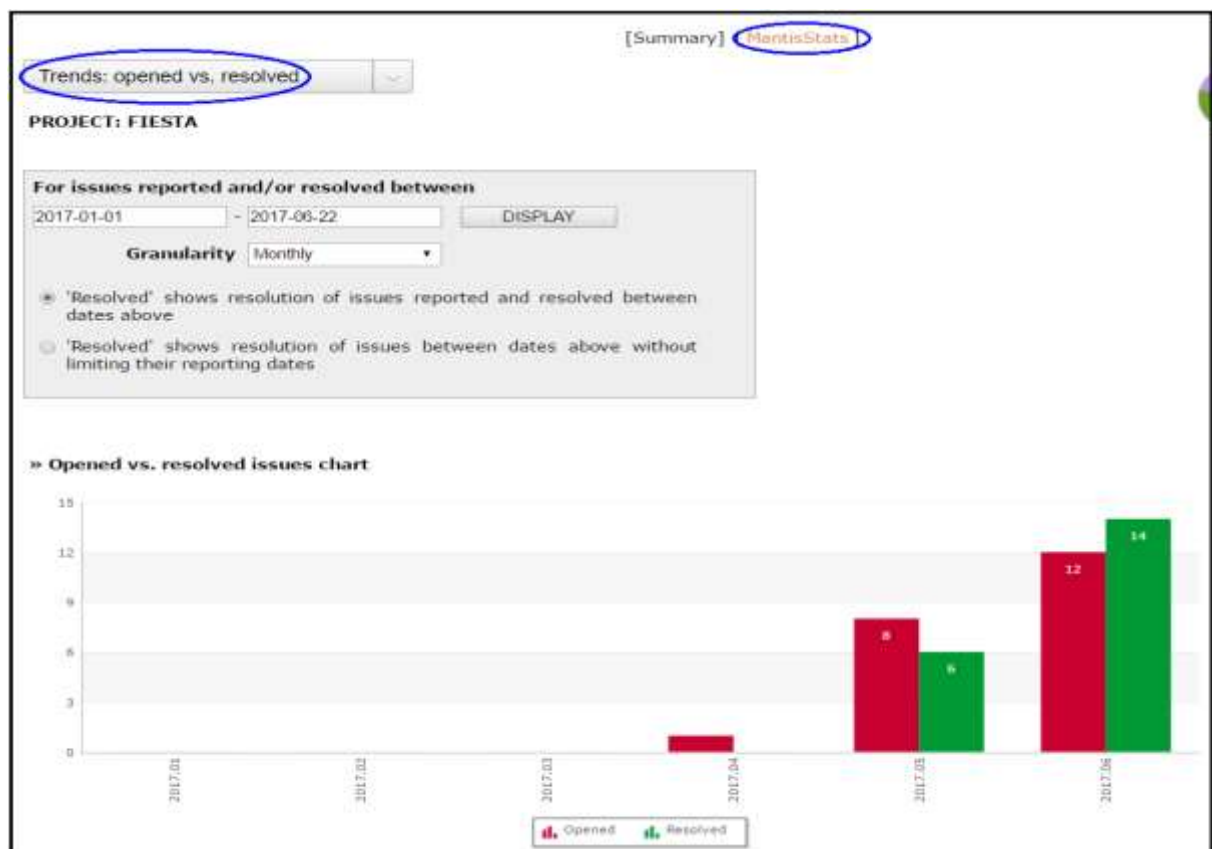


Figure 15 - Chart of Opened and Resolved Issues.

For each supporter, it shows how many issues ended up solved:
(Group by: handlers)

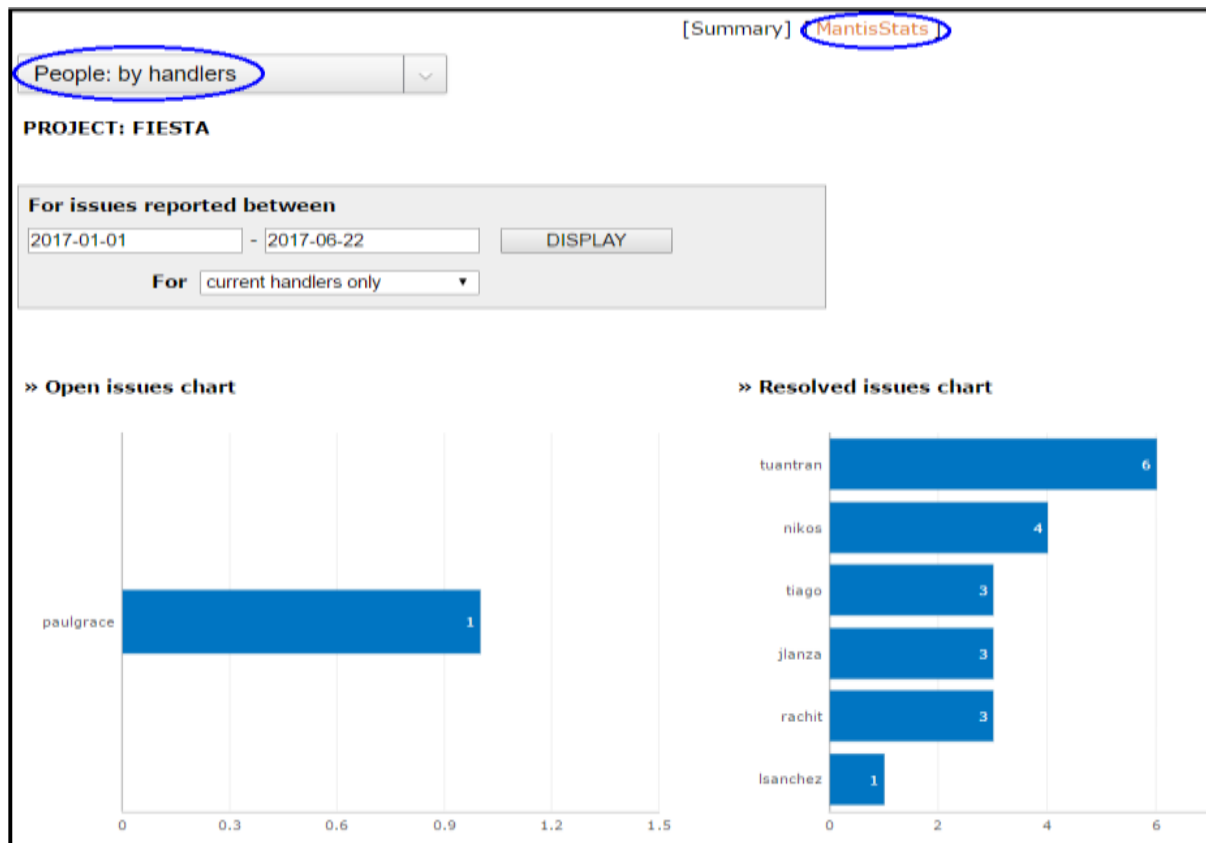


Figure 16 - Chart of Resolved Issues by helpdesk.

3.1.1.2 Chat Solved/Unsolved Issues

A summary of the chat history of Chat System:

The screenshot shows the Chat System history list. It includes a search bar, a 'Has unread messages' checkbox, and a table of chat sessions. The table has two main columns: 'Information' and 'Status'.

Information	Status
Felix, 2017-06-08 11:19:43, EU	Active chat
Felix, 2017-06-23 14:24:01, EU	Active chat
potenciaExperimentar, 2017-05-23 18:02:34, EU	Active chat
Paulo Marques, 2017-03-17 14:33:22, EU	Active chat
subhash, 2017-03-18 18:31:02, EU	Active chat
Emmanouil, 2017-03-15 13:12:00, EU	Active chat
Tiago, 2017-03-13 13:05:13, EU	Active chat
Achille, 2017-03-13 17:02:49, EU	Active chat
admin, 2017-03-04 13:32:08, EU	Active chat

Figure 17 - History Chats List.

The chart shows how many issues in Live Chat were resolved, how many issues are still unsolved:

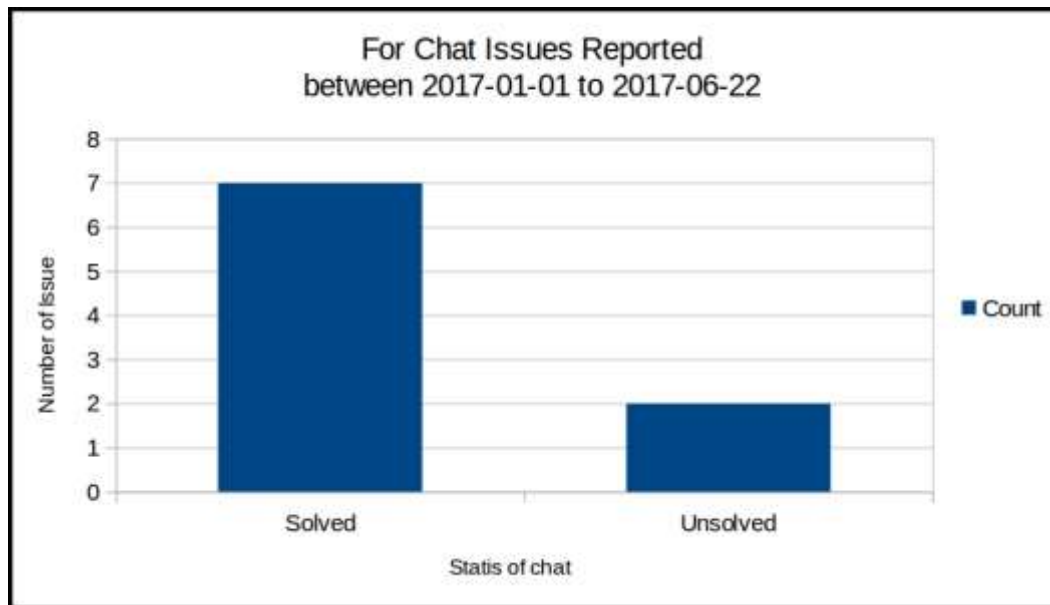


Figure 18 - Chart of Solved and Unsolved Issues.

3.1.2 GitHub Issue Tracker

The GitHub Issue Tracker¹⁸ is a page provided by the FIESTA-IoT project and has information that can be used by users to better understand various aspects related to the FIESTA-IoT platform. In this page, the information about the following FIESTA-IoT components can be accessed:

- in-house-dynamic-discovery
- testbed.tpi
- ontology
- experiment.data.receiver

Figure 19 to Figure 22 report the access statistics to each repository available on the GitHub Issue tracker. It is possible to acquire the number of views and the number of unique visitors from the last fourteen days since the date of delivery of this document.

3.1.2.1 in-house-dynamic-discovery

This “in-house-dynamic-discovery”¹⁹ application focuses on the dynamic collection of sensor data from heterogeneous platforms into a single application. For this experiment, the focus is put on the climate domain so that only the features and observations related to a subset of physical phenomena such as temperature, illumination, wind speed, etc. are displayed on the application’s dashboard.

¹⁸ <https://github.com/fiesta-iot>

¹⁹ <https://github.com/fiesta-iot/in-house-dynamic-discovery>



Figure 19 - Statistics of “in-house-dynamic-discovery” repository.

3.1.2.2 *testbed.tpi*

The “testbed.tpi”²⁰ is a repository that provides a reference implementation of the TPS (Testbed Service Provider) which is the interface for testbed to interact with FIESTA-IoT.



Figure 20 - Statistics of “testbed.tpi” repository.

3.1.2.3 *ontology*

Many testbeds have devices or applications that interact with the sensors and store the data in their own proprietary formats. Different data formats lead to interoperability issues.

The “ontology”²¹ is a unified semantic model that follows the best practices and enables the interoperability between testbeds. The FIESTA-IoT Ontology is a fusion of concepts from several ontologies, such as IoT-lite, M3-lite Taxonomy, SSN, Time and DUL.

²⁰ <https://github.com/fiesta-iot/testbed.tpi>

²¹ <https://github.com/fiesta-iot/ontology>



Figure 21 - Statistics of “ontology” repository.

3.1.2.4 *experiment.data.receiver*

The “experiment.data.receiver”²² repository contains a sample experiment Server that receives a file from the Experiment Execution Engine (EEE).

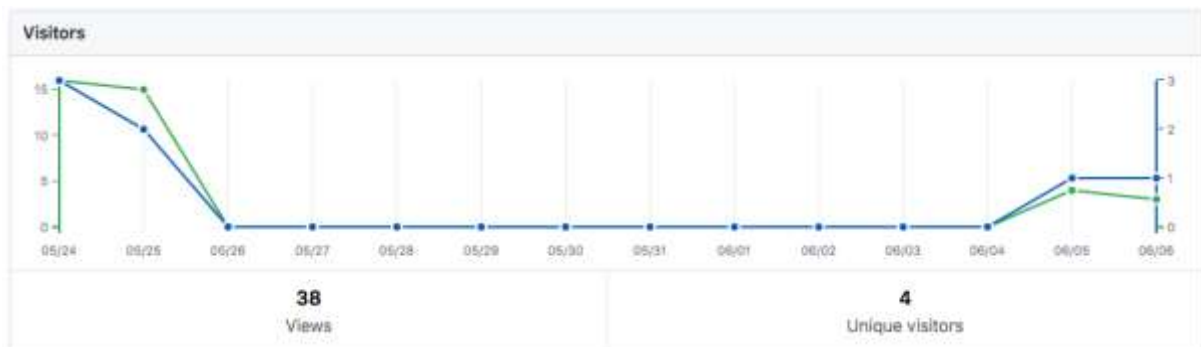


Figure 22 - Statistics of “experiment.data.receiver” repository.

3.1.3 FIESTA-IoT Training Platform

The following figures report the user’s access statistics to each course available on the FIESTA-IoT Training Platform. It is possible to acquire the number of views, number of users and the last access date for each activity since the publication of the specific course up to the date of delivery of this document. (Note that most of the content available in the courses can be viewed as “Guest” account but only counts as one user).

In Figure 23 is presented a summary of the statistics regarding the “FIESTA-IoT: What is it ?” course.

²² <https://github.com/fiesta-iot/experiment.data.receiver>

FIESTA-IoT: What is it ?		
Computed from logs since Tuesday, 26 July 2016, 10:30 PM.		
Activity	Views	Last access
Announcements	61 by 4 users	Tuesday, 6 June 2017, 11:22 AM (2 hours 41 mins)
What is FIESTA-IoT ?		
What is FIESTA-IoT	502 by 8 users	Tuesday, 6 June 2017, 1:56 PM (6 mins 31 secs)
Testbeds & Experiments		
Testbeds	793 by 8 users	Tuesday, 6 June 2017, 12:59 PM (1 hour 12 mins)
Experiments	343 by 8 users	Tuesday, 6 June 2017, 12:50 PM (1 hour 12 mins)

Figure 23 - Statistics of “FIESTA-IoT: What is it ?” course.

From the analysis done we can obtain the number of views of each section in this course. The Announcements section had a total of 61 views by 4 users. The section with the information about “what is FIESTA-IoT” has reached a total of 502 views by 8 users.

The section about FIESTA-IoT Experimenters got 343 views by 8 users. The largest number of views in this course was reached by the Testbeds section that has achieved a total of 793 views by 8 users.

Guide for 3rd Parties		
Computed from logs since Tuesday, 26 July 2016, 10:30 PM.		
Activity	Views	Last access
Announcements	70 by 4 users	Tuesday, 6 June 2017, 1:30 PM (50 mins 29 secs)
Contact Us	57 by 5 users	Tuesday, 6 June 2017, 9:59 AM (6 hours 21 mins)
FIESTA-IoT Github page	100 by 8 users	Tuesday, 6 June 2017, 8:47 AM (5 hours 33 mins)
FIESTA-IoT Help-Geek Support	99 by 7 users	Sunday, 4 June 2017, 9:34 PM (1 day 33 hours)
FIESTA-IoT Platform	337 by 4 users	Tuesday, 6 June 2017, 12:47 PM (1 hour 35 mins)
FIESTA-IoT Overview		
FIESTA-IoT Overview	763 by 7 users	Tuesday, 6 June 2017, 1:10 PM (1 hour 12 mins)
FIESTA-IoT Security Framework		
FIESTA-IoT Security Framework	941 by 9 users	Tuesday, 6 June 2017, 1:10 PM (1 hour 12 mins)
Guide for Experimenters		
Guide for Experimenters	2896 by 10 users	Tuesday, 6 June 2017, 2:14 PM (5 mins 46 secs)
FIESTA-IoT OC1 - Training Workshop for Experimenters (14/05/2017)	336 by 8 users	Tuesday, 6 June 2017, 1:41 PM (39 mins 18 secs)
Guide for Extensions		
Guide for Extensions	1093 by 8 users	Tuesday, 6 June 2017, 2:14 PM (5 mins 51 secs)
FIESTA-IoT Open-Geeks Training Workshop for Extensions	174 by 7 users	Tuesday, 6 June 2017, 1:11 PM (1 hour 6 mins)
FIESTA-IoT Handbook		
FIESTA-IoT Handbook for Third Parties	121 by 8 users	Tuesday, 6 June 2017, 11:29 AM (2 hours 55 mins)

Figure 24 - Statistics of “Guide for 3rd Parties” course.

The statistics for the “Guide for 3rd Parties” course are shown in Figure 24

The section with some useful links and relevant information had a total of 665 views and the “FIESTA-IoT Handbook for Third Parties” document was consulted at least 121 times by 8 users through this training platform.

The “FIESTA-IoT Overview” section was viewed 763 times by 7 users while the section about the “FIESTA-IoT Security Framework” was visited by 9 users with a total of 941 views. Regarding the “Guide for Extensions”, was consulted by 8 users 1863 times and the folder with the contents used in the FIESTA-IoT Open Calls Training Workshop for Extensions was accessed 174 times.

The following Figure 25, Figure 26 and Figure 27 show the acquired statistics for the “FIESTA-IoT Open Calls” course.

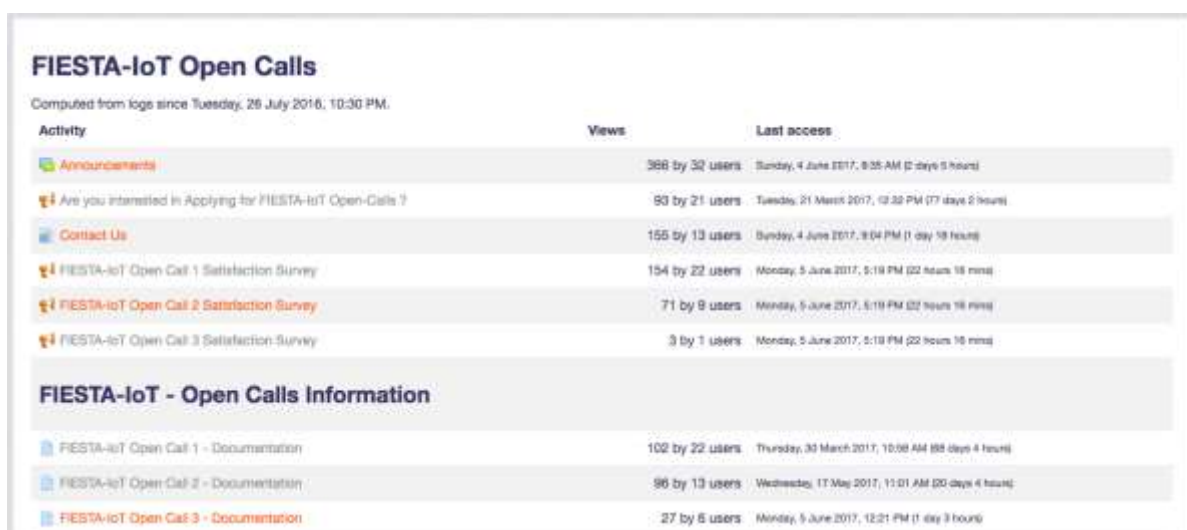


Figure 25 - Statistics of “FIESTA-IoT Open Calls” course.

Figure 25 shows that the section with contacts and the satisfaction survey for each Open Call were viewed a total of 842 times. The documentation for the 1st FIESTA-IoT Open Call was viewed by 22 users 102 times, the documentation for the 2nd FIESTA-IoT Open Call had 96 views by 13 users while the documentation for the 3rd FIESTA-IoT Open Call has only 27 views by 6 users so far.

Figure 26 shows the statistics for each Open Call for Experimenters and Extension section. The "Open Call 1 - Experiments" section reached 886 views (where 458 views by 33 users were relative to "Experiment Feasibility"), the "Open Call 1 - Extensions" section reached a total of 1086 views (being "Testbed Data Models" the most viewed with 360 views of 30 users) and the section "Open Call 2 - Extensions" reached 570 views (where the most viewed was the "Testbed Data Models" with 143 views of 11 users followed by "Instructions on how to fill The Scorecards" with 8 users viewing 132 times). The section "Open Call 3 - Experiments" reached so far a total of 66 views: the most consulted was the "Experiment Feasibility" with 34 views by 6 users followed by "Instructions on how to fill The Scorecards" with 3 users viewing 18 times and the least consulted, until the delivery of this document, is the “Experiment Feedback” with 14 views by 4 users.

Open Call 1 - Experiments		
Instructions on how to fill the Scorecards	115 by 22 users	Wednesday, 1 February 2017, 5:42 PM (124 days 25 hours)
Experiment Feasibility	458 by 33 users	Tuesday, 21 March 2017, 11:14 AM (77 days 5 hours)
Experiment Feedback	313 by 32 users	Tuesday, 21 March 2017, 11:14 AM (77 days 5 hours)
Open Call 1 - Extensions		
Instructions on how to fill the Scorecards	43 by 13 users	Tuesday, 21 March 2017, 10:58 AM (77 days 5 hours)
Testbed Data Models	360 by 30 users	Tuesday, 21 March 2017, 11:14 AM (77 days 5 hours)
Interfaces & Services	196 by 25 users	Tuesday, 21 March 2017, 11:11 AM (77 days 5 hours)
Security	151 by 21 users	Tuesday, 21 March 2017, 11:11 AM (77 days 5 hours)
Quality Auditing Aspects	132 by 18 users	Monday, 20 November 2016, 12:58 PM (193 days 1 hour)
Generic	204 by 24 users	Tuesday, 21 March 2017, 11:10 AM (77 days 5 hours)
Open Call 2 - Extensions		
Instructions on how to fill the Scorecards	132 by 8 users	Wednesday, 17 May 2017, 5:04 PM (18 days 22 hours)
Testbed Data Models	143 by 11 users	Sunday, 7 May 2017, 5:40 AM (30 days 9 hours)
Interfaces & Services	85 by 10 users	Sunday, 7 May 2017, 5:40 AM (30 days 9 hours)
Security	75 by 10 users	Sunday, 7 May 2017, 5:40 AM (30 days 9 hours)
Quality Auditing Aspects	62 by 9 users	Sunday, 7 May 2017, 5:40 AM (30 days 9 hours)
Generic	73 by 10 users	Sunday, 7 May 2017, 5:40 AM (30 days 9 hours)
Open Call 3 - Experiments		
Instructions on how to fill the Scorecards	18 by 3 users	Monday, 5 June 2017, 11:39 AM (1 day 4 hours)
Experiment Feasibility	34 by 6 users	Tuesday, 6 June 2017, 9:44 AM (5 hours 51 mins)
Experiment Feedback	14 by 4 users	Tuesday, 6 June 2017, 9:44 AM (5 hours 50 mins)

Figure 26 - Statistics of Open Calls for Experiments and Extensions.

The following Figure 27 refers to the presentation and submission of Proposals for each Open Call where, until the delivery of this document, only is active the Open Call 3 for Experiments.

Submission of Proposals for OC1		
FIESTA-IoT Open Call Proposal Template	141 by 27 users	Friday, 28 April 2017, 3:04 PM (38 days 2 hours)
Submit Proposal for OC1	1217 by 41 users	Tuesday, 21 March 2017, 10:25 AM (77 days 4 hours)
Submission of Proposals for OC2		
FIESTA-IoT Open Call 2 - Proposal Template	133 by 8 users	Wednesday, 17 May 2017, 3:39 AM (25 days 12 hours)
Submit Proposal for OC2	244 by 14 users	Wednesday, 31 May 2017, 12:49 PM (6 days 2 hours)
Submission of Proposals for OC3		
FIESTA-IoT Open Call 3 - Proposal Template	25 by 5 users	Tuesday, 6 June 2017, 9:44 AM (5 hours 51 mins)
Submit Proposal for OC3	50 by 6 users	Tuesday, 6 June 2017, 1:12 PM (2 hours 23 mins)

Figure 27 - Statistics of Submission of Proposals for each Open Call.

In the “Submission of Proposals for OC1” section the “Proposal Template” was consulted 141 times while the “Submit Proposal” area was consulted by 41 users 1217 times. Regarding the section “Submission of Proposals for OC2” the “Proposal Template” was consulted by 8 users 133 times and the “Submit Proposal area has 224 consults by 14 users. The active section of “Submission of Proposals for OC3” until the delivery of this document has 5 users that consulted 25 times the “Proposal Template” and 50 consults by 6 users related to the “Submit Proposal” area.

4 INTEROPERABILITY TESTING AND VALIDATION

4.1 Introduction

This section describes the use of the certification suite (and of the accompanying interoperability testing tools) to test and validate IoT platforms in terms of their openness and interoperability. Interoperability is defined as “*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*” [1]. An interoperability test therefore tests **only** that the correct messages are exchanged between the two systems. It does not test any overall functionality of the integrated platform, just that the two systems interact.

FIESTA-IoT performs interoperability testing for two purposes:

- *Certification.* FIESTA-IoT executes a set of interoperability tests to validate that a developer’s software has achieved interoperability with a given API specification. The developer requests the test be executed using the certification portal²³. The results of these interoperability tests are stored, and can then be provided by the developer to the certification process as the evidence to achieve a given certificate.
- *Developer Support.* The developer executes their own interoperability tests. The developer downloads a copy of the MBT-Interoperability Testing Tool to their environment and executes the suite of tests locally. The purpose is to help the developer identify when they have correctly implemented their technology to semantically interoperate with a given API specification or Technology standard.

Certification by FIESTA-IoT

Certification illustrates how FIESTA-IoT performs interoperability testing of systems in order to certify that the functionality of the 3rd party developed system conforms to a specification or standard.

1. In the *general case*: two systems (A and B) will interoperate based upon a standard or specification. System B wishes to certify that it complies with the specification, so that System A which also complies with the specification can automatically talk to it. FIESTA-IoT sends a series of test messages to System B and based upon the responses it determines compliance with the specification. If System B passes these compliance test then it is awarded a compliance certificate.
2. In the case of *FIESTA-IoT testbed interoperability*, the general case is applied to the FIESTA-IoT TPS specification [2]. The testbed wishes to certify that they comply with the specification in order to interoperate with the FIESTA-IoT platform. FIESTA-IoT performs the compliance tests on the testbed and awards a certificate where the testbed passes the criteria.
3. Interoperability with IoT Market Standards. In this case, the certification testing of FIESTA-IoT tests the compliance of System B with a given market standard e.g. ETSI OneM2M, NGSI, etc. such that it will interoperate with a System A that also complies with the standard.

²³ <http://certificate.fiesta-iot.eu/>

In this version of the deliverable, we concentrate on the case of *FIESTA-IoT testbed interoperability*. Providing a set of Interoperability tests for interacting with the FIESTA-IoT platform. We evaluate these tests by showing how the current FIESTA-IoT testbeds have been validated to interoperate correctly. In the second version of the deliverable we will present the interoperability and validation tests for IoT Market Standards.

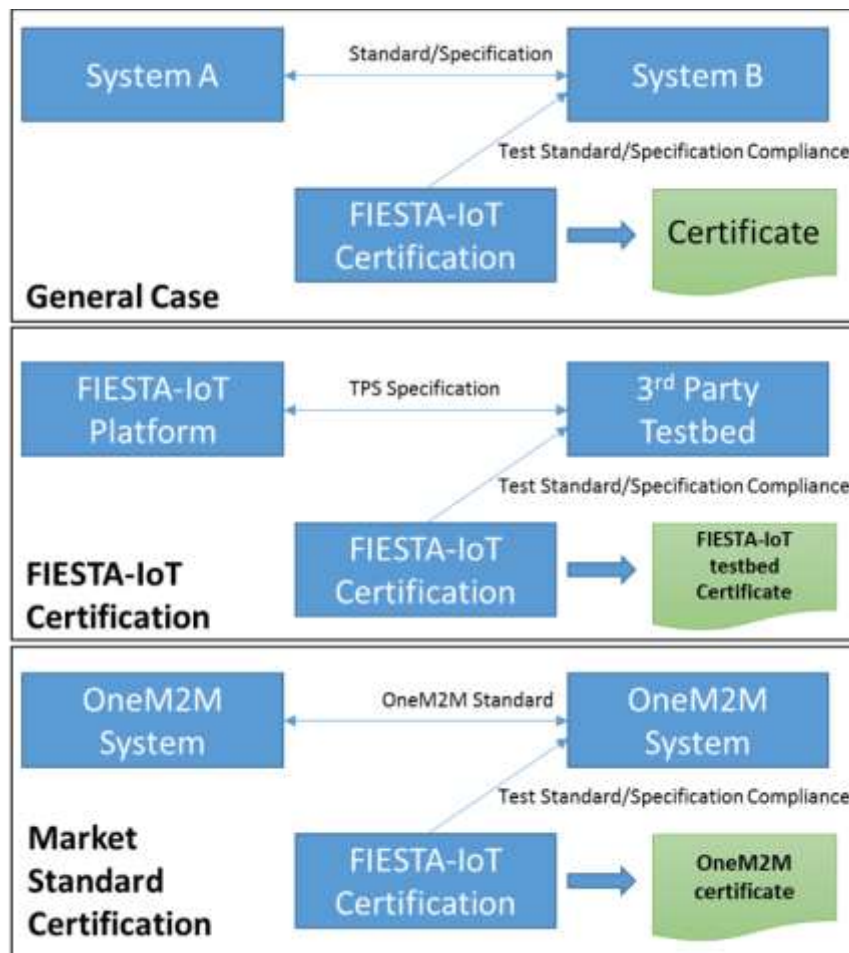


Figure 28 - Testing for Certification.

Developer Support

In the case where we provide support for developers via the downloadable MBT Interoperability testing tool—the developer carries out the same types of tests as described in Figure 28 (i.e. testing that testbed complies with the FIESTA-IoT certification or that a platform complies with a market standard), except in this case the test is carried out by the developer in their own development environment. Hence, it can be considered:

- (I) a pre-step before asking for certification; or
- (II) local testing by a developer to ensure their systems interoperate before live deployments.

4.2 Certification of FIESTA-IoT Specification Compliance

The FIESTA-IoT architecture is shown in **Error! Reference source not found.** This highlights the interoperability testing to be achieved. Essentially, it is the bottom portion of the figure where actions called on the TPS are tested to ensure that the integration between TPS and testbed URL is correct. For example, in the NGSI case - a GetObservation method call on the TPS API is translated onto a queryContext method call in the NGSI-10 API. In order for a testbed to join FIESTA-IoT:

- 1) It must **implement the TPS API** that the FIESTA-IoT facility leverages to communicate with the testbed data.
- 2) It must ensure that the data it makes available to FIESTA-IoT aligns with the FIESTA-IoT ontology and follows specified best practises.
- 3) It must use the certification portal to gain a **TPS compliance certificate**. Performing these three actions correctly will ensure that a testbed correctly interoperates with FIESTA-IoT. It is the task of interoperability testing to help the integrator carry out these tasks – identifying when an outcome is successfully achieved and the reasons if it failed (to help fix the interoperability error).

To investigate the interoperability testing further, we first examine the request/response TPS operations translated onto NGSI operations.

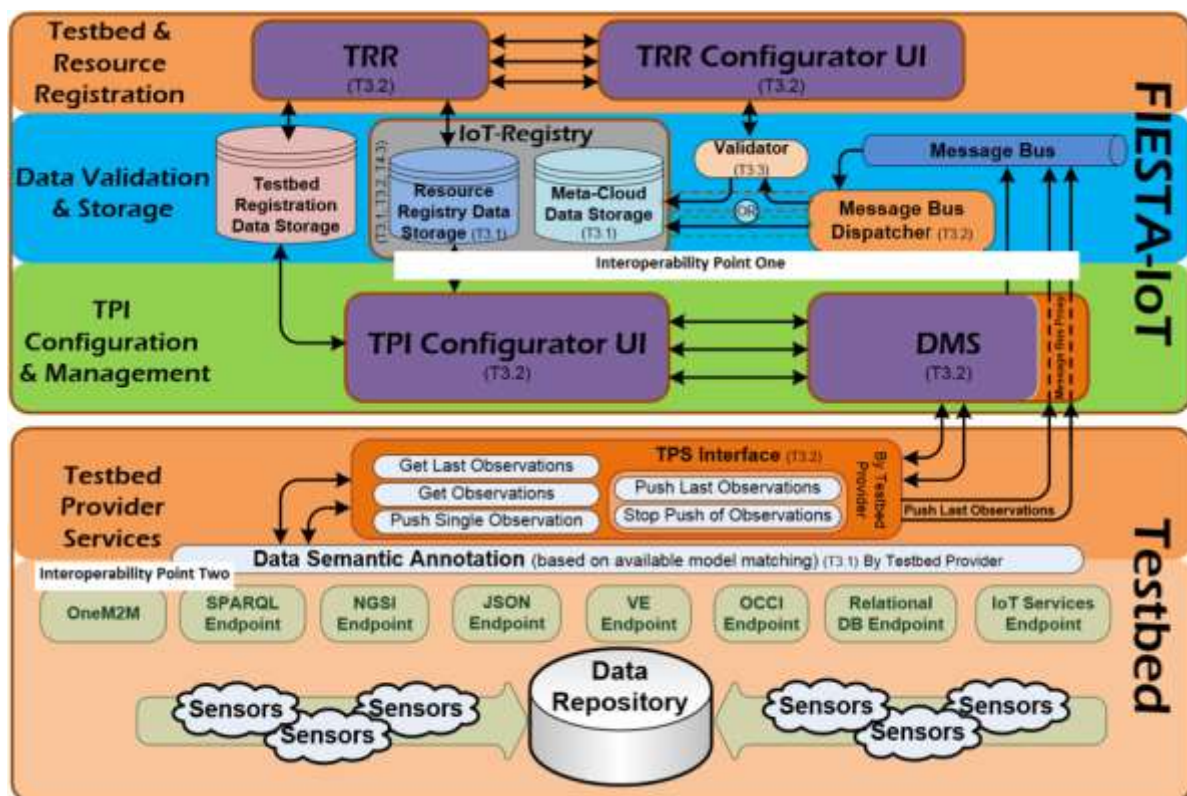


Figure 29 - The FIESTA-IoT Platform <-> Testbed Architecture [3].

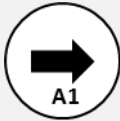
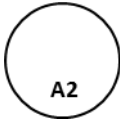


4.2.1 Individual Interoperability Compliance Tests

In this section, we list the individual and independent interoperability tests. These perform a reusable subset of the larger interoperability tests, where these tests are chained together to determine if a **testbed complies with the TPS specification and interoperates or not with FIESTA-IoT**.

Each individual test is described using the following template:

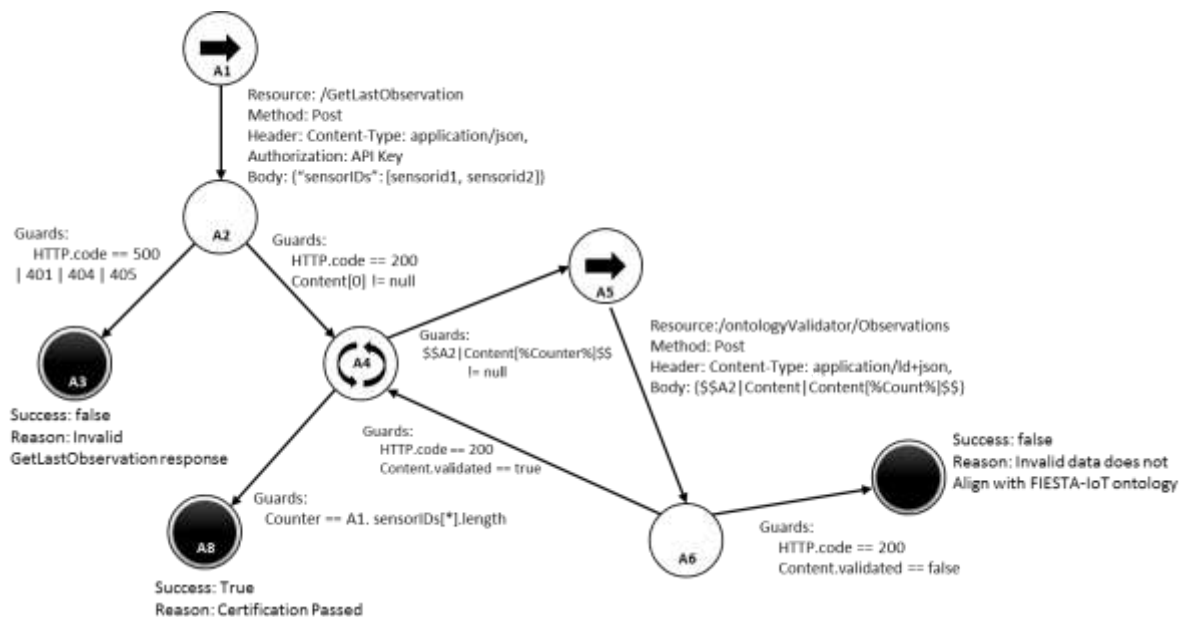
- Test identifier: the unique identifier of the test.
- Test description: a short description of what the individual test aims to validate.
- Test model: the model of the test in the format used by the interoperability testing tool, this visualises the test and supports re-use of the interoperability test in other situations.
- User Input: the input fields containing parameters for executing the test.
- Interoperability Test pass criteria: the measures used to determine if a test had been passed or not.
- Comments: a short discussion on the extent to which the test can be fully automated.

As a reminder, the following legend explains the test models used in each test specification:

Model element	Description
	<i>Trigger Node</i> This indicates that the test will create and send a message e.g. it will make a HTTP Post method call on a URL. The transition describes the message and content sent
	<i>Guard Node</i> This evaluates an observed message sent between the two parties interoperating. The transition have labels with rules that must be observed, e.g. the HTTP message response must have a 200 code.
	<i>Loop Node</i> This ensures that tests are repeated until a counter condition is true. Each time the state is reached the counter is increased. For example, the counter is equal to the number of elements in an array response.
	<i>End Node</i> This indicates the end of the test. This is either a success state (the whole interoperability test has passed) or a fail state (where the reason explains why the test failed).

Test identifier: *TBI_GetLastObservation_1***Test description:**

This TPS methods provides the latest values of a specific Sensor list within an annotated document. It also provides the annotated document's Content-Type. This test determines if the correct response is provided for the list of sensor ids sent in a request.

Test model:**User Input:**

- 1) **API Key** – the security key credentials for accessing the TPS API implementation (optional).
- 2) **URL location** – the URL of the TPS API to be tested.
- 3) **The Sensor ID list** – comma separated list of identifiers to test (at least 1).
- 4) **The data type of the observation** – e.g. json+ld, turtle etc.

Pass Criteria:

- Every input sensor id returns a valid observation when the /GetLastObservation method is called.

Comments:

The test receives input of a list of sensor ids and the testbeds URL for the TPS implementation. The getLastObservation is called (A1 to A2) this must return a list of sensor observations for every ID in the method body. The loop node A4 calls the FIESTA-IoT ontology validator with each observation value. If all are valid, and the number of observations matches the number of input sensor ids then the test has succeeded.

TBI_GetLastObservation_1 Example

To illustrate how this test is executed, we trace through the model with a real example from the FIESTA-IoT testbeds. First, this requires the tester to input the details of the Santander FIESTA-IoT testbed to be certified:

```
{
  "URL": "**Changed from real value** http://tps.api.santander.testbed/tps,
  "API KEY": "** Changed from real value ** u2344oddo34343ddddd,
  "Sensor IDs": "** Changed from real value ** sensor1, sensor2
  "Data type": ld+json
}
```

The test is then executed and model flows through the following transitions.

Transition: A1 to A2

```
POST http://tps.api.santander.testbed/tps/getLastObservations
Accept: text/plain
Authorization: Basic u2344oddo34343ddddd
Content-Type: application/json
{ "sensorIDs": ["sensor1", "sensor2"] }
```

Transition: A2 to A4

```
200 OK
Content-Type: application/json
Content-Length: 5733
{
  "content-type":"application/ld+json",
  "content":[ Observation1, Observation 2]
}
```

Transition: A5 to A6 (twice for each observation)

```
POST http://platform.fiesta-iot.eu/ontologyValidator/Observations
Accept: application/json
Content-Type: application/ld+json
{ Observation1 }
```

Transition: A6 to A4 (twice for each observation)

```
200 OK
Content-Type: application/json
Content-Length: 401
{
  "owner": "string",
  "extension": "string",
  "validated": true,
  "start": "2017-06-02T14:51:03.337Z",
  "syntactic_duration": "1709 ms",
  "semantic_duration": "24 ms",
  "global_duration": "1733 ms",
  "results": [
```

```
{
  "type": "Namespace and URI validation",
  "value": "Nothing to show here! well done!"
},
"ResourceRegistered": {
  "status": false,
  "details": "testing"
}
}
```

Transition: A4 to A8

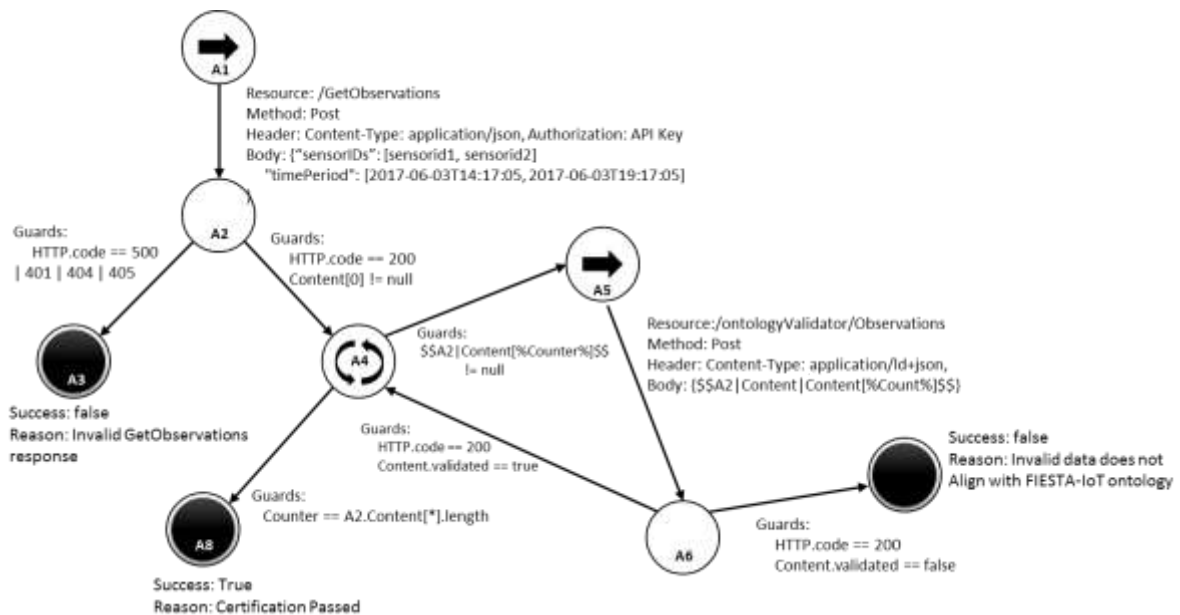
```
{
  "Success": True
  "Reason": "Certification Passed"
}
```

Test identifier: *TBI_GetObservations_1*

Test description:

This service provides the values of a specific Sensor list for a specific time-period in an FIESTA-IoT annotated document once. It also provides the annotated document's Content-Type. This test determines if the correct response is provided for the list of sensor ids sent in a request.

Test model:



User Input:

- 1) **API Key** – the security key credentials for accessing the TPS API implementation (optional).
- 2) **URL location** – the URL of the TPS API to be tested.
- 3) **The Sensor ID list** – comma separated list of identifiers to test (at least 1).
- 4) **The Date range** - the start and stop times that make up the period of observations to return.

5) The data type of the observation – e.g. json+ld, turtle etc.**Pass Criteria:**

- Any observation returned is valid and aligned with the ontology. No observations in the period still passes the test.
- For certification – the test must trace at least once through A4 to A6 to A4. Hence, the developer should input sensor details to allow this to happen.

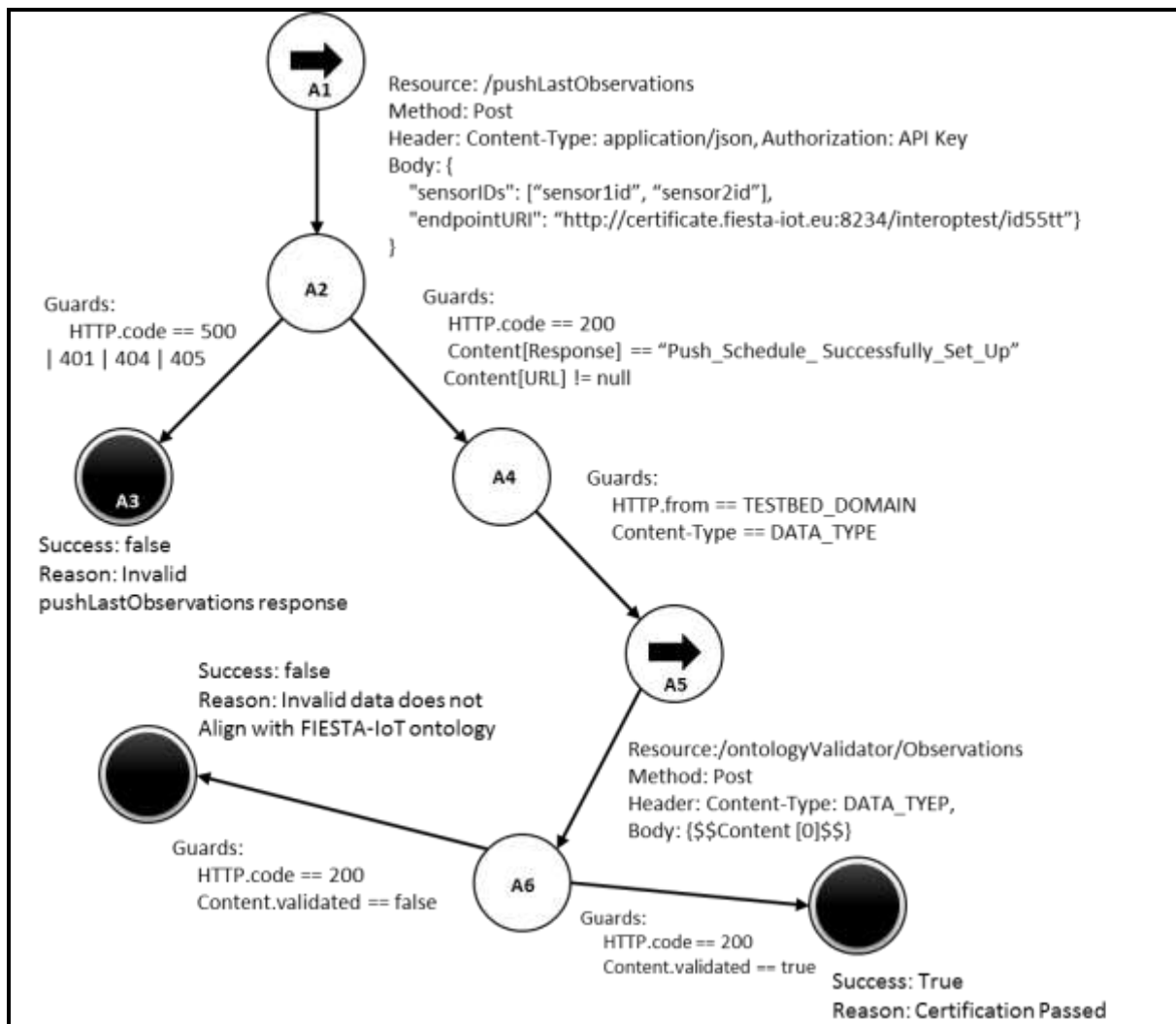
Comments:

This test is similar in structure to the GetLastObservations test. The difference is that in this case the observations may or may not be available (and hence testing for a guaranteed response from any input sensor ID is not appropriate. Therefore, the transition A4 to A8 only requires that the times through the loop to test valid observations must equal the number of responses in the GetObservations responses (this can be 0).

Test identifier: *TBI_*pushLastObservations_1**Test description:**

This method initiates a stream at the Testbed side which pushes continuously the latest values of a specific Sensor list to a specific endpoint in an FIESTA-IoT annotated document. This test checks that sequence will interoperate with FIESTA-IoT i.e. that a valid stream of data does indeed send messages to the identified endpoint.

Test model:

**User Input:**

- 1) **API Key** – the security key credentials for accessing the TPS API implementation (optional).
- 2) **URL location** – the URL of the TPS API to be tested.
- 3) **The Sensor ID list** – comma separated list of identifiers to test (at least 1).
- 4) **The data type of the observation** – e.g. json+ld, turtle etc.
- 5) **The Testbed Domain** – the domain where the messages are pushed from.

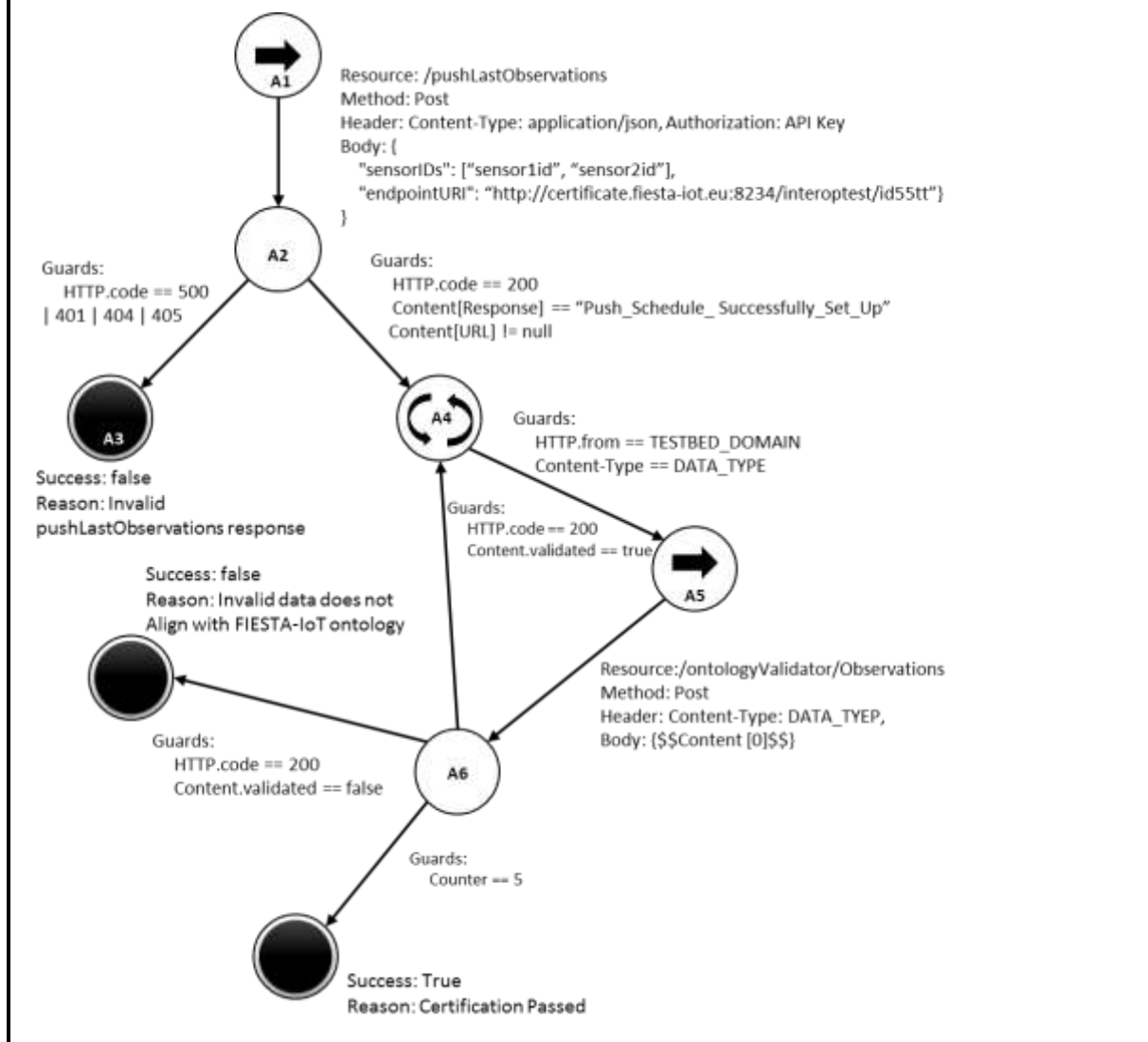
Pass Criteria:

- The testing tool endpoint receives a message with valid observations from the testbed IP domain.

Comments:

The tester provides details of the Testbed: URL, API Key, and domain. Further the list of sensor ids and type of data observations are input. The test sets up the subscription via the pushLastObservation method call; it creates a URL endpoint to listen on. If the method succeeds the test listens for the observations sent to the URL. If a message is received this is tested with the ontology validator to see if the observations align with the FIESTA-IoT ontology. The test can be extended to test that a stream of observations is received. The model below illustrates that the test

loops through 5 times to test that 5 valid messages are received. 5 is chosen to ensure that the implementation interoperates for a period of time, ensuring that the data is streamed correctly,

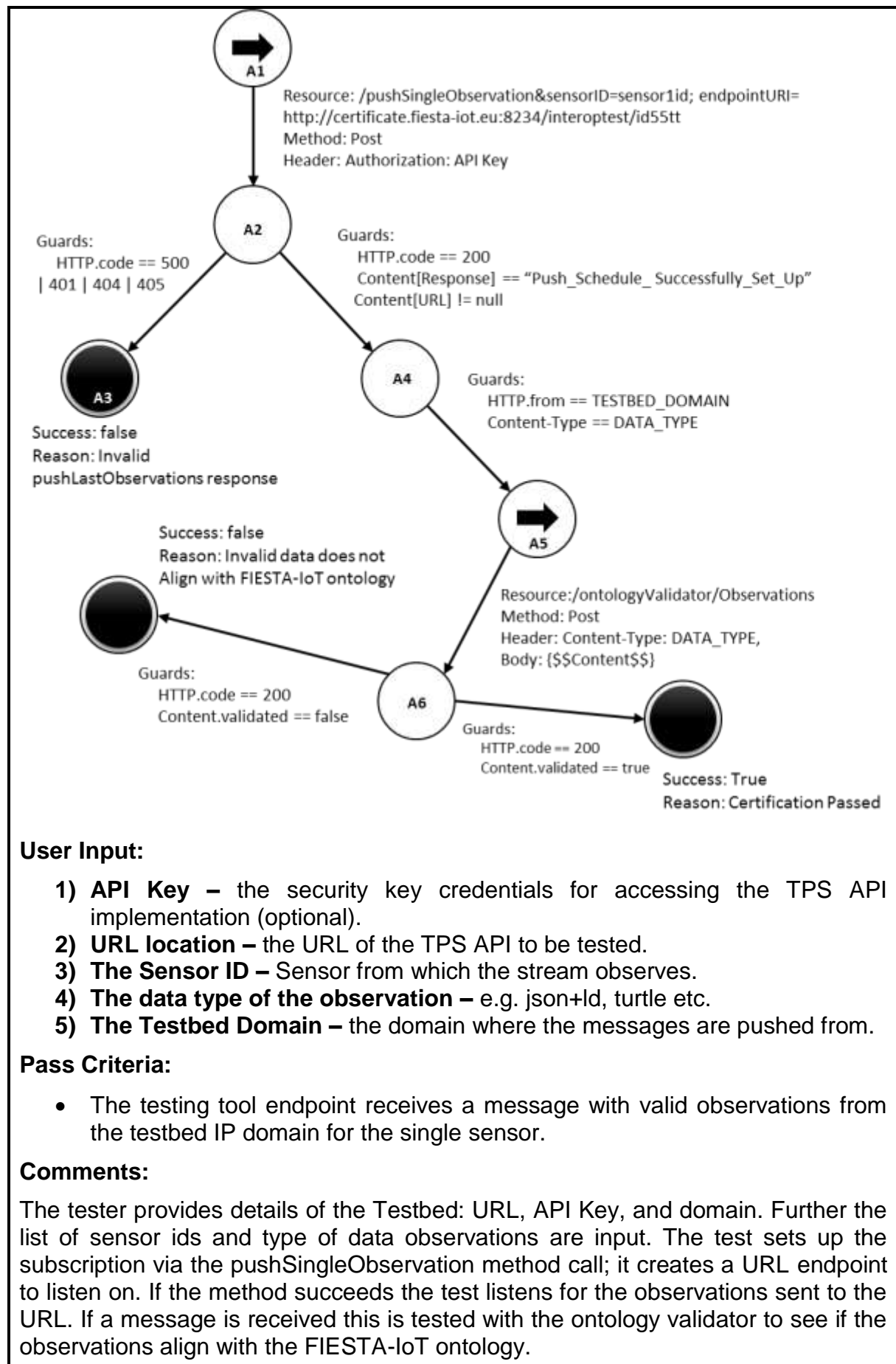


Test identifier: *TBI_pushSingleObservation_1*

Test description:

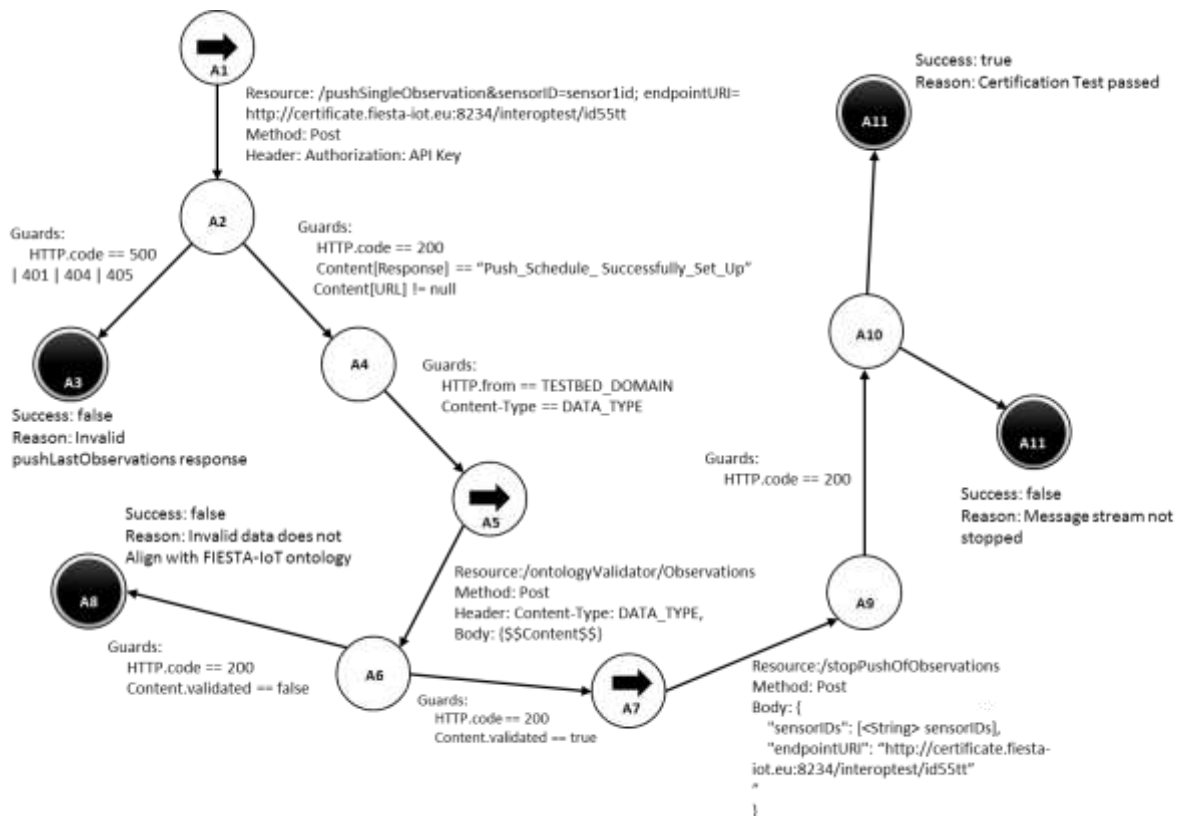
This method pushes continuously the last value of a specific Sensor to a message bus with the Sensor ID as queue topic.

Test model:



Test identifier: TBI_StopPushOfObservations _1**Test description:**

This method stops a stream created via either the pushLast or pushSingle Observation method. The test starts a stream and then tests that the stop method stops the stream from sending observations.

Test model:**User Input:**

- 1) **API Key** – the security key credentials for accessing the TPS API implementation (optional).
- 2) **URL location** – the URL of the TPS API to be tested.
- 3) **The Sensor ID** – Sensor from which the stream observes.
- 4) **The data type of the observation** – e.g. json+ld, turtle etc.
- 5) **The Testbed Domain** – the domain where the messages are pushed from.

Pass Criteria:

- The testing tool endpoint receives a message with valid observations from the testbed IP domain for the single sensor. After the stop push method is called, no more messages are received at the URL endpoint.

Comments:

The test runs the pushSingleObservation method first in order to ensure a valid stream is initiated so that testing of stopping it can be carried out.

4.2.2 TPS Certification and Interoperability Tests

A certification test is a composition of a set of individual tests, taken from the previous section that is carried out in a flow to determine if testbed achieves the provided compliance with the TPS specification. The FIESTA-IoT certification portal executes these tests and assigns a certificate based upon the results.

An interoperability test is a composition of a set of individual tests, taken from the previous section that is carried out in a flow to test how well a testbed interoperates with a given system or standard. It is executed by a testbed developer as a precursor to requesting certification.

The difference between an interoperability test and certification test is as follows:

- An *interoperability test* tests that the two systems interoperate e.g. a testbed interoperates with FIESTA-IoT.
- A *certification test* is an interoperability test carried out by a trusted party, i.e. FIESTA-IoT in order to produce a certificate that states the two systems interoperate.

We now describe a TPS certification test. Figure 30 illustrates the possible workflows through the TPS certification test to validate if a testbed interoperates with FIESTA-IoT or not. It can pass/fail one or more of the four individual tests:

- Pass TBI_GetObservations_1
- Pass TBI_GetLastObservations_1
- Pass TBI_pushLastObservations_1 and TBI_stopPushofObservations _1
- Pass TBI_pushSingleObservation_1 and TBI_stopPushofObservations _1

This is implemented as a single interoperability model that is uploaded to the certification portal and can be then executed during the certification process.

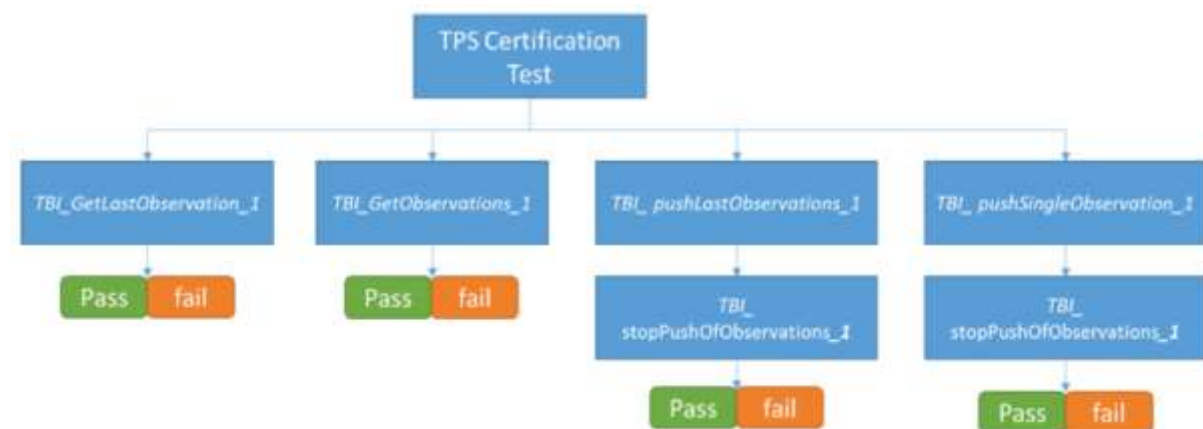


Figure 30 - TPS Certification.

To launch the test, the user selects the TPS certification test from the drop-down menu on the certification portal shown Figure 31. They then enter the required inputs for these tests (these are automatically extracted from the model and displayed as input

text boxes in the portal UI. For example: API_KEY is the security credentials for accessing the testbed's TPS implementation, the DOMAIN is the IP domain, and the TPS_URL is the endpoint to perform the test on.

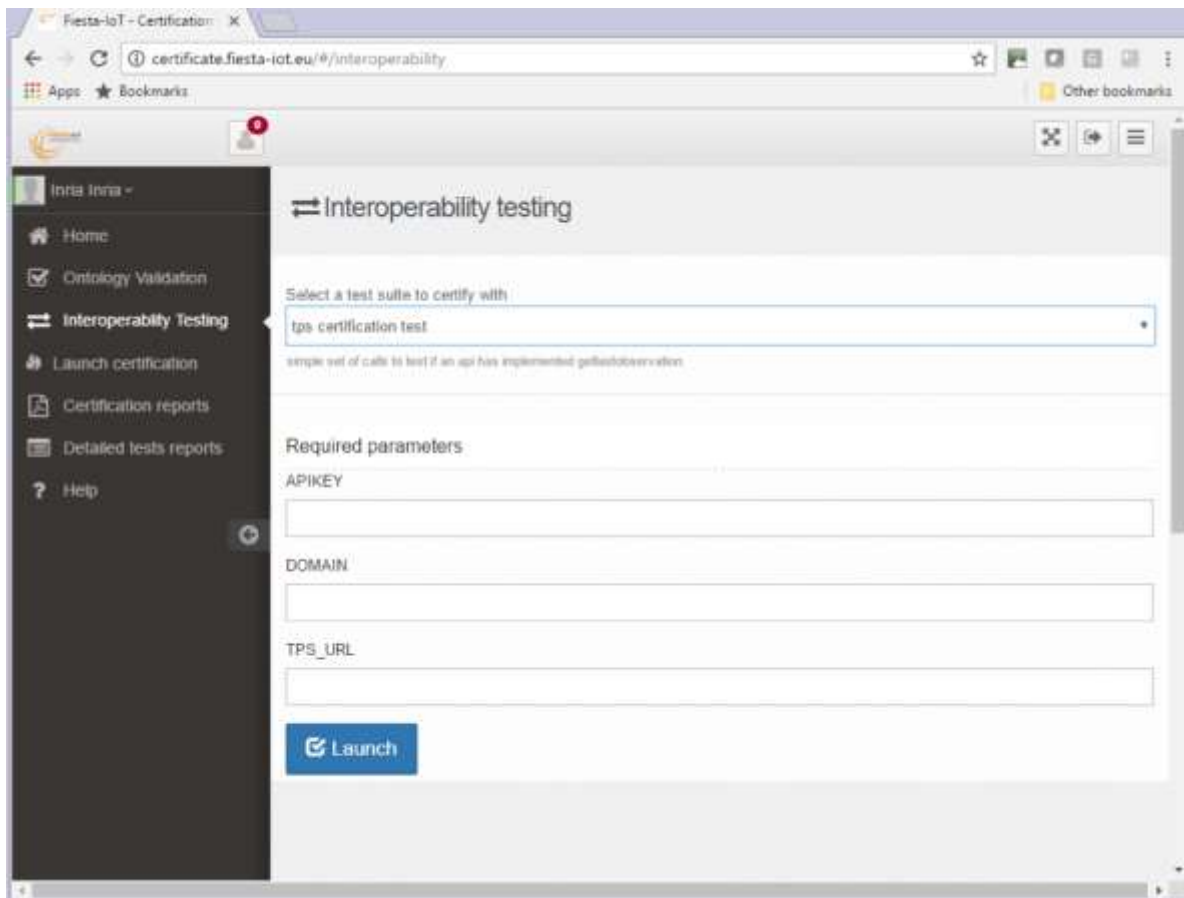


Figure 31 - TPS Certification test in the portal.

4.2.3 FIESTA-IoT Testbed Validation

To summarize this section, we use these certification and interoperability tests to validate each of the current FIESTA-IoT testbeds. In the future, we will evaluate the six additional testbeds from the open calls and evaluate their feedback about the process. It can be seen in Table 1 that all of the FIESTA-IoT testbeds certified correctly and that they used different tests to achieve a valid interoperability mechanism with FIESTA-IoT.

Table 1 - FIESTA-IoT TPS Validation Results

Testbed	TPS test	Result
SmartSantander	TBI_GetLastObservation_1	Pass
SmartICS	TBI_GetObservations_1	Pass
SoundCity	TBI_GetLastObservation_1	Pass
KETI	TBI_GetLastObservation_1	Pass

4.3 Local TPS Interoperability Testing

Testbeds that join FIESTA-IoT will typically be of either of the following:

- An implementation whereby data is stored in its own proprietary format and accessed via a proprietary API.
- An implementation whereby data is stored using standards like:
 - The OneM2M²⁴ data model and using OneM2M interfaces,
 - The NGSI data model and using NGSI interfaces²⁵.

The TPS component is then typically implemented as a wrapper of this testbed implementation. This mapping is illustrated in Figure 32- here FIESTA-IoT calls the TPS URL with an action, the TPS then calls the testbed URL with the standard's equivalent method. However, it may be that it is this mapping that causes interoperability errors where a testbed tries to interoperate with FIESTA-IoT. So it is possible to perform local interoperability testing between the TPS component and a Testbed interface (provided they are distributed components). Such testing aims to help the developer identify if there are any interoperability problems before they propose their TPS to be tested in order to achieve FIESTA-IoT certification.

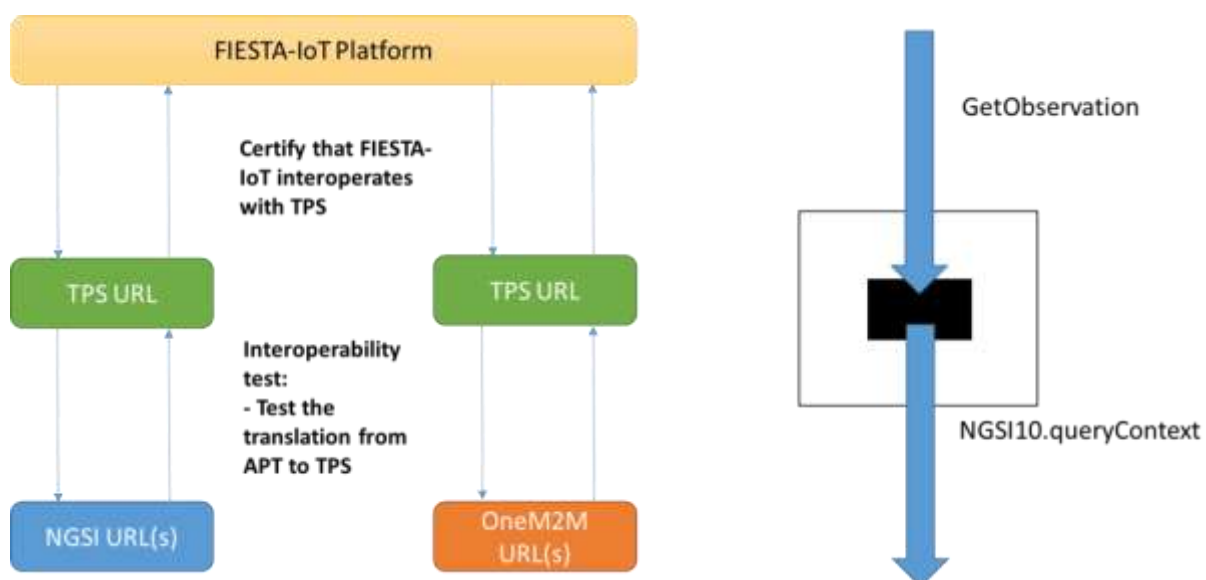


Figure 32 - Interoperability Testing Overview.

4.3.1 FIESTA-IoT Stakeholder (Testbed) Performing Interoperability Testing

It is the stakeholder (in this document we are concentrating on the FIESTA-IoT testbeds joining the federations) who will initiate and execute these interoperability tests for their own value. In the simplest terms: the procedure for this testing is carried out as follows:

- 1) A testbed creates a TPS implementation that is a component that interacts with the pre-existing interface to their deployment of resources. This could be one of

²⁴ <http://www.onem2m.org>

²⁵ https://forge.fiware.org/plugins/mediawiki/wiki/fiware/index.php/FI-WARE_NGSI-10_Open_RESTful_API_Specification

- a number of IoT standards-based interfaces e.g. an NGSI testbed, or a OneM2M testbed.
- 2) The testbed wants to test their TPS implementation (locally) before requesting certification by FIESTA-IoT. So they run local tests to determine if their TPS implementation correctly maps onto the underlying standard i.e., either OneM2M or NGSI, and ensures interoperability between their testbed and FIESTA-IoT.
 - 3) When the interoperability tests have succeeded, the testbed runs the certification tests on the certification portal. Note, this will only test their TPS API and not anything concerned with NGSI; the testbed developer will have used the MBT tool to resolve any interoperability issues before certification is requested.

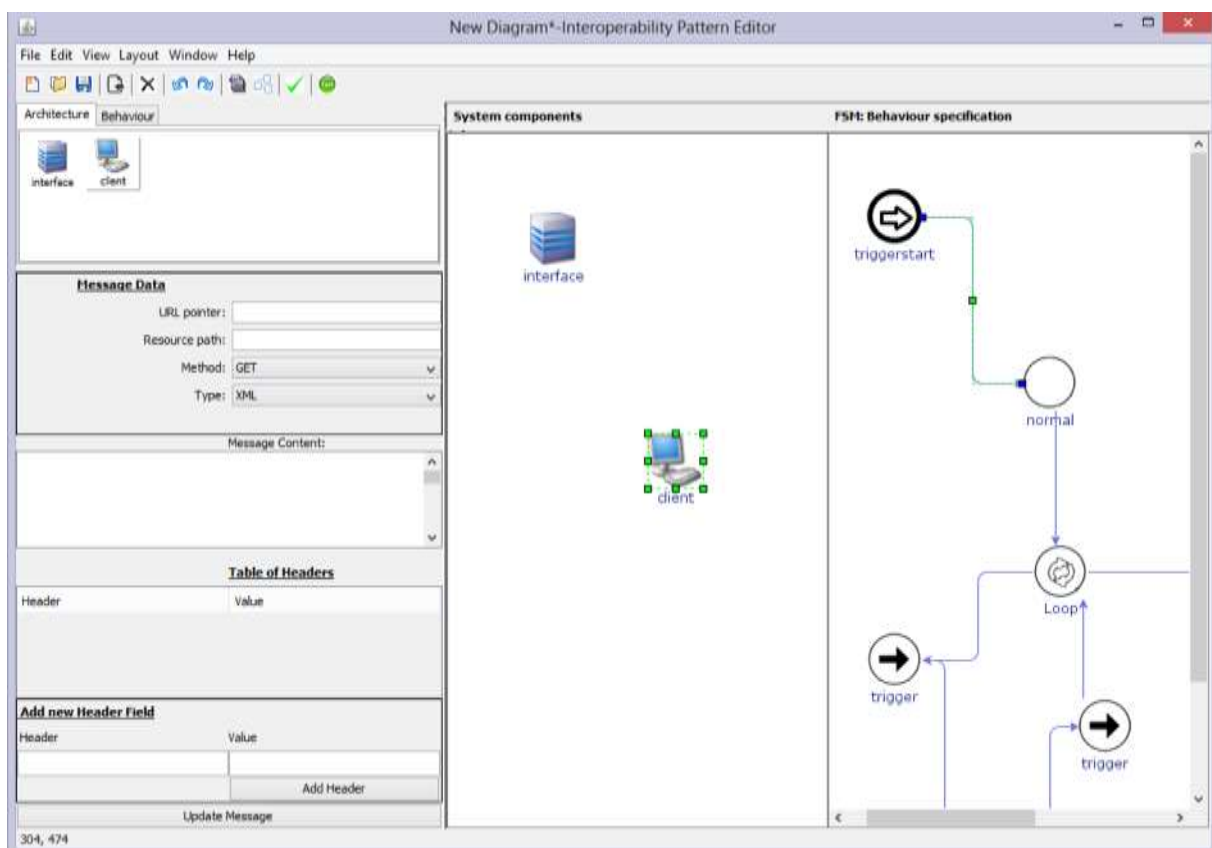


Figure 33 - Interoperability Test in the MBT tool

Figure 32 highlights the interoperability testing to be achieved. Essentially, it is the bottom portion of the figure where actions called on the TPS are tested to ensure that the integration between TPS and testbed URL is correct. For example, in the NGSI case - a GetLastObservation method call on the TPS API is translated onto a queryContext method call in the NGSI-10 API. In order to execute this test, the stakeholder uses the MBT tool which has been presented in previous deliverables²⁶,

²⁶ FIESTA-IoT consortium, "Certification Suite V1", Deliverable D6.2, February 2017.

and is available to download as an open source tool²⁷. A testbed admin must download this tool and install it in their development environment.

To demonstrate this interoperability testing further, we first examine a request/response TPS operation translated onto an NGSI operation, in order to carry out TPS to NGSI interoperability testing. This procedure can then be followed for other actions across other market standards.

4.3.2 An NGSI-10 to FIESTA-IoT TPS Interoperability Test

To retrieve the last sensor value for a given sensor ID, FIESTA-IoT will call the TPS implementation of the testbed via the `getLastObservations` method.

This is of the following format where we assume the unique identifier of the sensor is the same across FIESTA-IoT and the testbed i.e. Room1. Note, if the two are different then the ID can be queried from the IoT-Registry utility service – `GET /utils/{fiesta_identifier}/{to_testbed}` which will return the testbed Id (Room1) that matches a FIESTA-IoT id e.g. `fiesta.testbedX.Room1`.

```
POST http://testbed_tps_url/tps/getLastObservations
Accept: text/plain
Authorization: Basic u2344oddo34343ddddd
Content-Type: application/json
{
  "sensorIDs": ["Room1"]
}
```

The testbed must correctly transfer this to an NGSI-10 `QueryContext` call with the pattern to search for. The interoperability test for this is to ensure that the entities request object below contains the same ID field as from the `getLastObservations` body.

```
{
  "entities": [
    {
      "type": "*",
      "isPattern": "false",
      "id": "Room1"
    }
  ]
}
```

The NGSI `QueryContext` response is as follows:

```
{
  "contextResponses": [
    {
```

²⁷ <https://github.com/pjgrace/connect-iot>

```
"contextElement": {
  "attributes": [
    {
      "name": "temperature",
      "type": "float",
      "value": "23"
    },
    {
      "name": "pressure",
      "type": "integer",
      "value": "720"
    }
  ],
  "id": "Room1",
  "isPattern": "false",
  "type": "Room"
},
"statusCode": {
  "code": "200",
  "reasonPhrase": "OK"
}
}
```

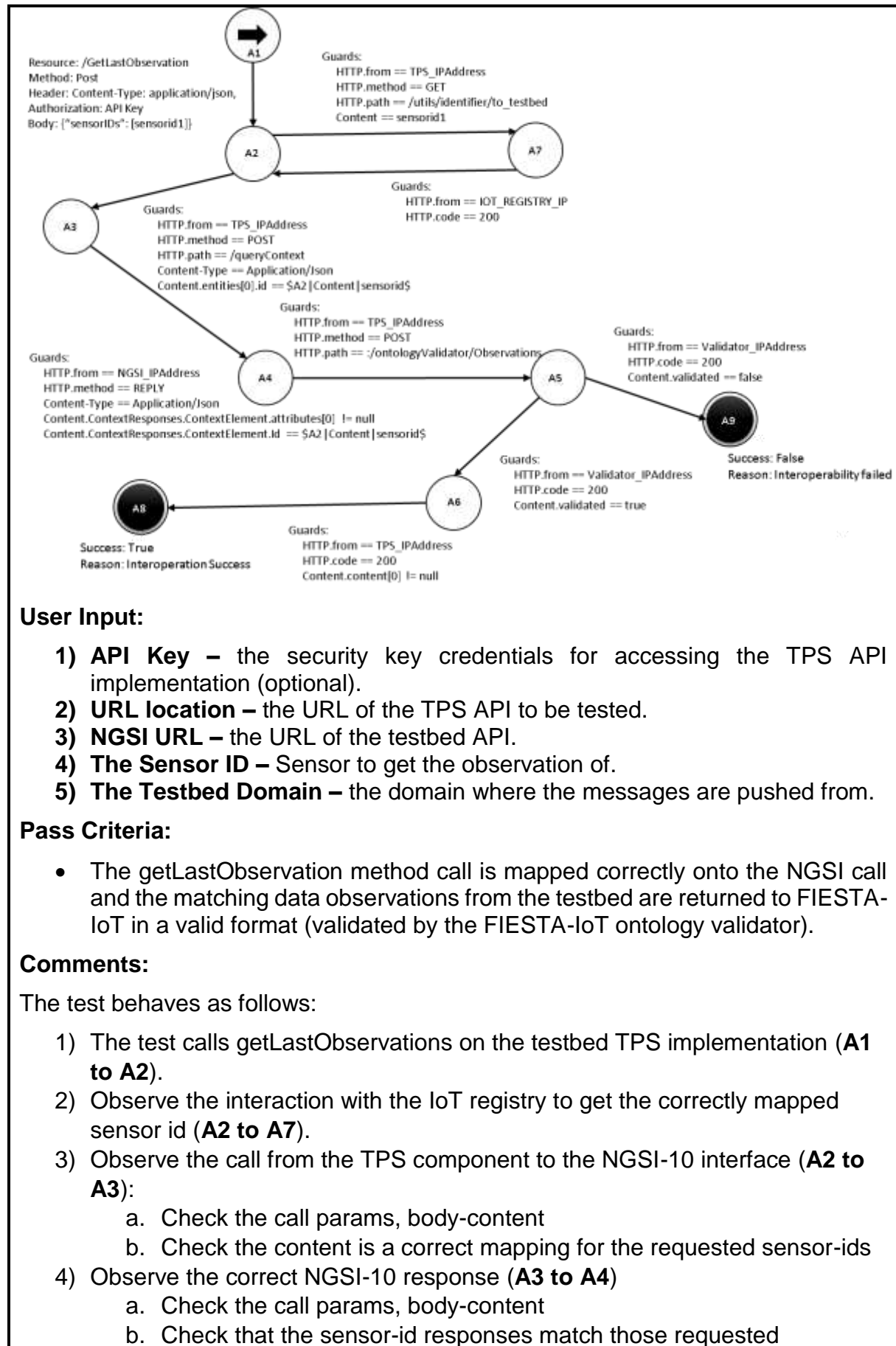
The TPS component then creates the `GetLastObservation` response (which annotates this NGSI message response using the FIESTA-IoT NGSI annotator and returns it as the result of the original TPS method call.

We now describe the interoperability test that can be executed using the MBT tool in order to test that a TPS API component interoperates with a testbed NGSI API.

Test identifier: *MBT_TPSNGSI_1***Test description:**

This method tests the interoperation between a testbed with an NGSI-10 API specification implementation and a FIESTA-IoT TPS component. It tests that the `GetLastObservations` method call is correctly mapped onto the NGSI data model and NGSI-10 methods.

Test model:



- 5) Observe the TPS component validating the observation response (**A4 to A5 to A6**)
- 6) Observe the TPS GetLastObservation response message (**A6 to A8**)
 - a. Check the call params, body-content are correct.
 - b. Check the translation of the NGSI contextResponse matches the annotateMeasurement data in the FIESTA-IoT response (e.g. the sensor value is the same, the sensor type is the same, etc.
- 7) If passed, the interoperability test has shown that the GetLastObservation call correctly

The model of this test is provided to the user and can be executed using the MBT interoperability testing tool (seen in Figure 33). This returns an interoperability report about where the interoperability succeeds and if it fails, which part of the interaction is responsible for the failure e.g. the TPS API part, or the mapping of NGSI data to FIESTA-IoT data format etc.

4.4 Conclusions and Interoperability Testing and Validation Plan

This deliverable has provided details of the certification and interoperability testing of TPS components developed in order to allow a testbed to fully integrate with FIESTA-IoT. That is, we have described specifically how testbeds can use the interoperability testing tools in order to test that their TPS API specification implementation is both correct and will interoperate with FIESTA; and how they can then ask FIESTA-IoT to certify this achieved interoperability.

In the future, the interoperability testing will be extended according to the following plan:

- **Extension of TPS testing** to include a range of testbeds & Certification of the testbeds that joined FIESTA-IoT as part of the first two open calls (Month 30).
- **Market testing.** The further development of models of market standards e.g. OneM2M, NGSI, and OCCI among others. Then the subsequent development of certification tests and reports that will allow FIESTA-IoT to identify where systems comply with these specification and standards (M33).
- **Evaluation of Market testing** (M30 to M39). Use of the certification portal via 3rd parties (open to all) to certify a software against one of the market standards. We will collect feedback from these users in order to evaluate the effectiveness of the certification solutions, and the level of trust users have in these tools.

5 CONCLUSION

This document is a result of the work carried out during the FIESTA-IoT Work Package 6 focusing on the "Training, Consulting and Validation" FIESTA-IoT tools.

This document provided a detailed description of the FIESTA-IoT training platform, which is organized in different and specific courses, to help users in the correct use of the FIESTA-IoT platform. The statistics collected on the interactions with external users, using different FIESTA-IoT support tools, up to the delivery date of this document, were presented as well as a brief description of each of these tools.

This document addressed the Interoperability and Validation tests in the integration process of a testbed into the FIESTA-IoT platform and all the necessary information to support the FIESTA-IoT Open Calls, where training workshops were organized to present the FIESTA-IoT Platform to third parties.

In the next version of this deliverable will be given continuity to these topics, will be included the documentation about the next two FIESTA-IoT Open Calls and relevant information about the next training workshops sessions for third parties.

6 BIBLIOGRAPHY

- [1] IEEE, IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries., New York, 1990.
- [2] FIESTA-IoT, Specification and implementation of common Testbed interfaces V2, 2017.
- [3] FIESTA-IoT, Semantic models for testbeds, interoperability and mobility support and best practices V2, 2016.

ANNEX A – AGENDA: 1ST OPEN-CALL TRAINING WORKSHOP FOR EXPERIMENTERS

Date: **14TH March 2017**

10:00 – Welcome and briefing

10:15 – Training and support

Present training platform and the procedure to get support and to solve issues.

10:35 – FIESTA-IoT available testbeds descriptions – Focus on datasets available

SmartSantander (Smart City)

SmartICS (Smart Building)

KETI (Smart Building)

Inria (Crowdsourcing noise information)

11:00 – FIESTA-IoT Ontology

General aspects of the ontology. Special emphasis to M3-Lite taxonomy

11:25 – Break and refresh

11:40 – Authentication and Authorization – SSO Token

Get and use the token. Roles and access privileges (how to be upgraded)

12:10 – Platform overview

Focus on components that will be actually serving the experimenter. Experimenter Workflow

12:40 – Portal-based platform services

13:15 – Lunch break

14:30 – Meta-Directory REST-based services

SPARQL endpoint, Queries storage; SPARQL Templates

15:00 – Already existing experiments description

Success stories and best practices using the FIESTA-IoT Platform

15:15 – Questions and answers

Time to briefly (5 minutes per experiment) present the experiments

16:30 – Workshop closure

ANNEX B – AGENDA: 1ST OPEN-CALL TRAINING WORKSHOP FOR EXTENSIONS

Date: 17TH March 2017

10:00 – Welcome and briefing

10:15 – Training and support

Present training platform and the procedure to get support and to solve issues.

10:35 – FIESTA-IoT Ontology

General aspects of the ontology. Special emphasis to M3-Lite taxonomy. Template for gathering requirements

11:00 – Platform overview

Focus on Testbed Provider Interface (TPI). Testbed Provider Workflow

11:30 – Break and refresh

11:45 – Authentication and Authorization – SSO Token

Get and use the token. Roles and access privileges (how to be upgraded)

12:15 – TPS Development and Annotator as a Service

Testbed Provider Services (TPS) API description

12:45 – Own annotator development and validation tools

Annotator development best practices and Minimum valid document. Validator and Certification Portal

13:15 – Lunch break

14:30 – Testbed registration and Resources registration process

15:00 – TPI Configurator usage

15:30 – Questions and answers

Time to briefly (5 minutes per testbed) present the testbeds

16:30 – Workshop closure

ANNEX C – AGENDA: 2ND OPEN-CALL TRAINING WORKSHOP FOR EXTENSIONS

Date: 29TH May 2017

10:00 – Welcome and briefing

10:15 – Training and support

Present training platform and the procedure to get support and to solve issues.

10:35 – FIESTA-IoT Ontology

General aspects of the ontology. Special emphasis to M3-Lite taxonomy. Template for gathering requirements

11:00 – Platform overview

Focus on Testbed Provider Interface (TPI). Testbed Provider Workflow

11:30 – Break and refresh

11:45 – Authentication and Authorization – SSO Token

Get and use the token. Roles and access privileges (how to be upgraded)

12:15 – TPS Development and Annotator as a Service

Testbed Provider Services (TPS) API description

12:45 – Own annotator development and validation tools

Annotator development best practices and Minimum valid document. Validator and Certification Portal

13:15 – Lunch break

14:30 – Testbed registration and Resources registration process

15:00 – TPI Configurator usage

15:30 – Questions and answers

Time to briefly (5 minutes per testbed) present the testbeds

16:30 – Workshop closure