Federated Interoperable Semantic IoT/cloud Testbeds and Applications

Rolling Open Call

FIESTA-IoT Rolling Call for Experiments

1. General Call Objectives

The FIESTA-IoT Project herewith announces its Rolling Open Call for Experimenters, targeting advance and innovative developments in the Internet of Things over the Experimentation as a Service platform and the underlying IoT testbeds that support the FIESTA-IoT Consortium.

Overall, the project's experimental infrastructure provides experimenters in the IoT domain with the following unique capabilities:

- Access to and sharing of IoT datasets in a testbed-agnostic way. FIESTA-IoT will provide researchers with tools for accessing IoT data resources (including Linked sensor data sets) independently of their source IoT platform/testbed.
- Execution of experiments across multiple IoT testbeds, based on a single API for submitting the experiment and a single set of credentials for the researcher.
- Portability of IoT experiments across different testbeds, through the provision of interoperable standards-based IoT/cloud interfaces over diverse IoT experimental facilities.

More information on the scope of this Rolling Open Call of the FIESTA-IoT project can be found in section 4 of this document.

2. Call Information

Project full name:	**FIESTA-IoT - Federated Interoperable Semantic IoT/cloud Testbeds and Applications**
Project grant agreement number:	**CNECT-ICT-643943**
Call identifier:	**FIESTA-IoT-OC_Rolling**
Call title:	**FIESTA-IoT Rolling Open Call for Experiments**
Submission deadline:	**Open**

Financial information

Experiments allowed in the FIESTA-IoT Rolling Open Call for Experiments will not receive any funding.

Requirements related to the proposer:

- Proposals will only be accepted from a single party.

Other conditions:

- Language in which the proposal must be submitted: English
- Proposals must follow the provided template (see section 6 of this document)
- Proposals must be submitted as pdf document through oc-info@fiesta-iot.eu e-mail address

3. Background information on the FIESTA-IoT project

Training material for the FIESTA-IoT Platform can be found at: http://moodle.fiesta-iot.eu/course/view.php?id=4

Video footages of FIESTA-IoT Training sessions can be found at:
https://www.youtube.com/channel/UCPMOblIYoYh_QlLxukcrzew/playlists

FIESTA-IoT focuses on the problem of formulating and managing IoT data from heterogeneous systems and environments and their entity resources (such as smart devices, sensors, actuators, etc.). This vision of integrating IoT platforms, testbeds and their associated silo applications within cloud infrastructures is related to several scientific challenges, such as the need to aggregate and ensure the interoperability of data streams stemming from different IoT platforms or testbeds, as well as the need to provide tools and techniques for building applications that horizontally integrate diverse IoT Solutions.

The main aim of the FIESTA-IoT federation is to enable an Experimentation-as-a-Service (EaaS) paradigm for IoT experiments. However, instead of deploying yet another physical IoT infrastructure, FIESTA-IoT will enable experimenters to use a single EaaS Application Program Interface (API) for executing experiments over multiple existing IoT testbeds that are federated in a testbed agnostic way. Testbed agnostic implies the ability to expose a single testbed that virtualizes the access to the underlying physical IoT testbeds. Experimenters will be therefore able to learn the EaaS API once, and accordingly use it to access data and Resources from any of the underlying testbeds.

To this end, the testbeds willing to participate in the federation will have to implement the common standardized semantics and interfaces that are being defined within the FIESTA-IoT project. This will enable the FIESTA-IoT meta-platform to access their data, resources' and services' descriptions and other low-level capabilities.

As can be seen in the figure below, the central component of the FIESTA-IoT meta-platform will be a directory service (so-called FIESTA-IoT meta-directory), where resources from multiple testbeds will be registered. In the same way, the observations produced by them will be also stored. This directory will enable the dynamic discovery and use of resources (e.g., sensors, services, etc.) from all the interconnected testbeds.

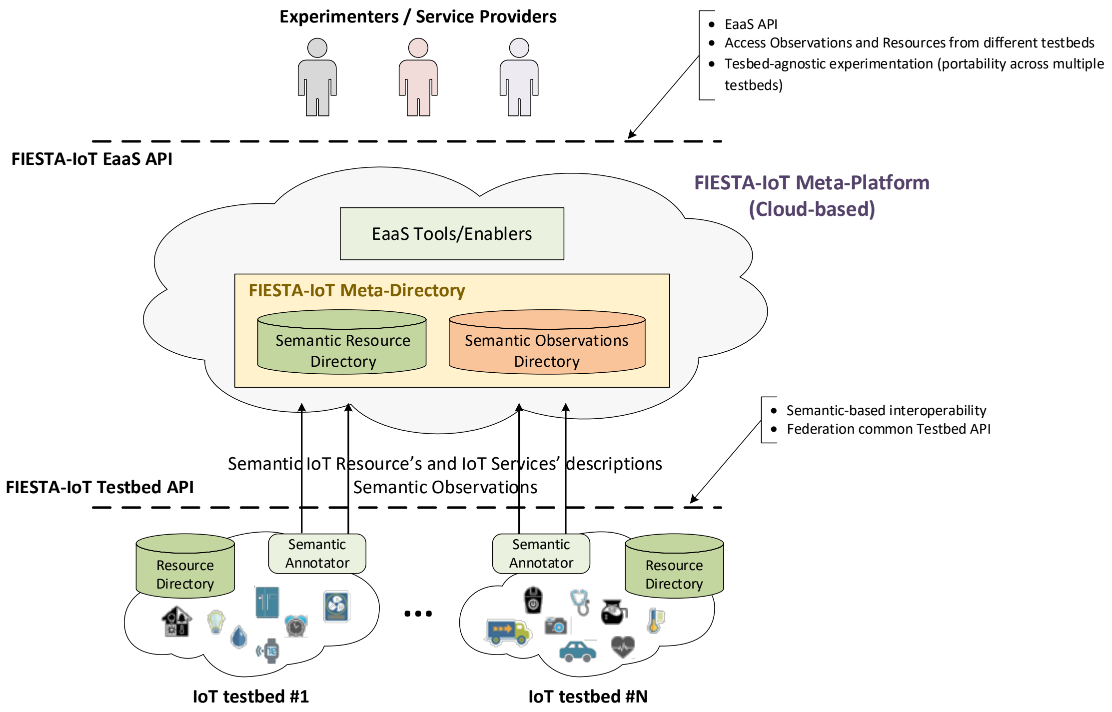

Figure 1 FIESTA-IoT testbed federation concept overview

The key concept behind the federation of IoT testbeds is the specification of a common testbed API that will comprise the interfaces to carry out the registration of the testbed resources as well as push the observations to the meta-platform. Besides the actual technologies used for implementing these interfaces, the main feature that underlies the FIESTA-IoT Testbed API is the fact that the information is exchanged in a semantically annotated format. In this sense, federated testbeds will have to implement their own semantic annotators, by means of the transformation of the information they handle internally to a common semantic ontology, defined by the FIESTA-IoT meta-platform. Different Resource Description Framework (RDF) representation formats (i.e., RDF/XML, JSON-LD, Turtle, etc.) are supported as long as the common ontology is used.

A primary decision of the FIESTA-IoT project was to take as reference the IoT ARM as defined in the IoT-A project[1]. This choice has particularly resulted in the observation of the domain model and the information model defined in the ARM. The domain model identifies the key concepts that appear in an IoT environment and the relations between these concepts. The information model defines a meta-model of how to structure information in IoT platforms.

The second main design decision is the use of semantic technologies to support the interoperability between heterogeneous IoT platforms and testbeds. The first step towards a testbed federation is the use of a common language and the definition of relationships between

[1] IoT-A Consortium; Carrez, F. Final architectural reference model for the IoT v3.0. Available online: http://www.meet-iot.eu/deliverables-IOTA/D1_5.pdf (accessed on 10 May 2017).

concepts. The taxonomies and ontologies make it possible to seamlessly deal with data from different sources.

The foremost aspect that these choices have implied is that a FIESTA-IoT ontology[2] has been defined to rule the semantic annotation of the core concepts that compose the aforementioned Domain and Information Models. These core concepts are:

- The resource: is a "computational element that gives access to information about or actuation capabilities on a physical entity". In FIESTA-IoT, this concept is realized through the Device Class and its SubClasses (SensingDevice, ActuatingDevice and TagDevice).
- The virtual entity: is a "computational or data element representing a physical entity".
- The IoT Service: is a "software component enabling interaction with resources through a well-defined interface. It can be orchestrated together with non-IoT services (e.g., enterprise services). Interaction with the service is done via the network".

These concepts conform the baseline for representing the devices and overall IoT infrastructure. However, there is still a major concept that is not tackled within the ARM models. This concept relates to the actual data that is gathered by the devices and offered through the services that expose them. Namely, it is the observation concept:

- An observation is a piece of information obtained after a sensing method has been used to estimate or calculate a value of a property of an Entity. In FIESTA-IoT data from a SensingDevice will be available through the Observations that it has produced.

Linked to this concept and its relation to the entity one through the property idea, another important aspect that has been also addressed during the construction of the FIESTA-IoT ontology is the definition of a taxonomy that sets a common ground for the description of the physical phenomena and units of measurement captured in the observations.

[2] http://ontology.fiesta-iot.eu/ontologyDocs/fiesta-iot.html

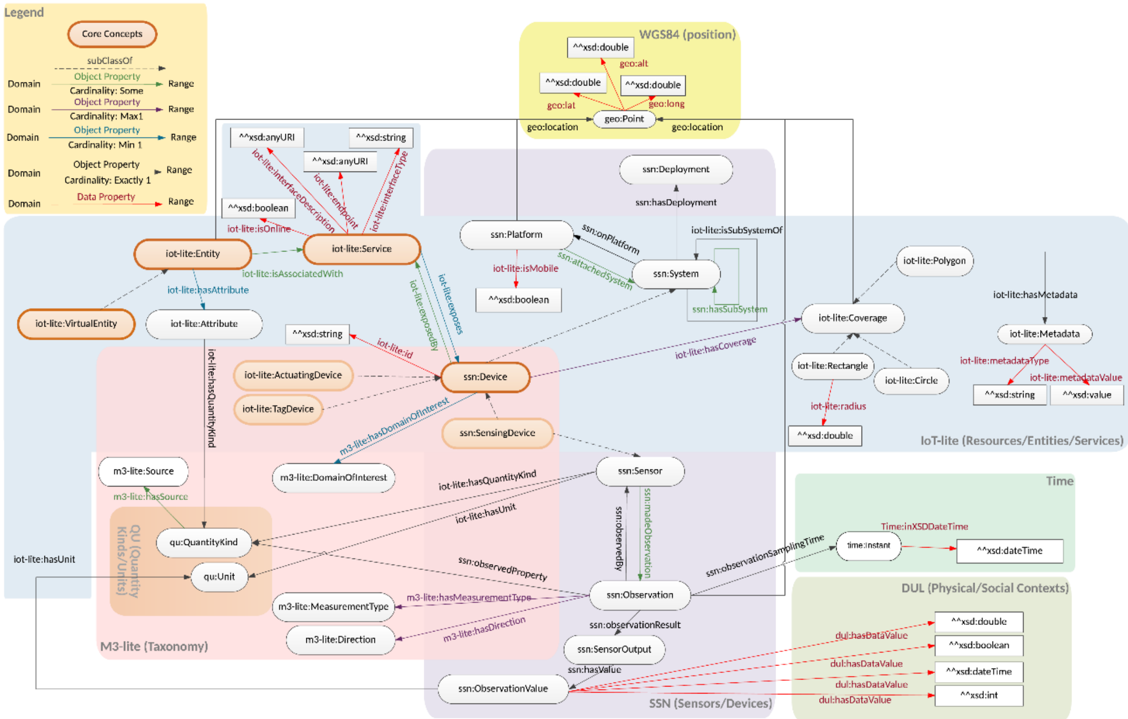

Figure 2 FIESTA-IoT Ontology

It is important to emphasize that this ontology is the baseline for the interoperability of the heterogeneous testbeds and IoT platforms that are expected to be federated in the FIESTA-IoT meta-platform. The different testbeds have to converge for participating in the federation and they must use this ontology as the reference for this convergence.

3.1 Tools/services for experimenters

Experimenters will be provided with a set of tools for the interaction with the aforementioned FIESTA-IoT EaaS meta-platform. These tools will comprise both EaaS REST APIs as well as a basic UI that experimenters can use to get familiar with the available services in a friendly manner. Experimenters can decide which of the two options best fit their experiment requirements and their technological skills. The main Use Cases that these tools will support are as follows:

- **Registration as experimenters.** In order to keep track of the Authentication, Authorization and Accounting (AAA) of all the users who interact with the FIESTA-IoT platform they must sign up before using the enablers that offers the FIESTA-IoT core functionalities. This way, an individual user management can be achieved and the means to provide a secure access can be accomplished. Experimenters will receive individual credentials to guarantee their private access to the platform experimentation services.
- **Experiment registration.** Beside the registration of the experimenter described in the previous point, each experiment is to be registered so as to: (i) bind the experiment with its actual owner, (ii) facilitate the management, (iii) permit the dissemination of the experiment with other users.

- **Discovery of resources.** The first step that an experiment has to carry out is to search or browse among all the available assets deployed throughout the FIESTA-IoT federation. Through this service, the platform will generate a list of all the resources that match the experiment requirements, where it can specify:
  1. **No filters**: in this default case, where users do not showcase any kind of preference, the response will be a list with all the resources registered at the FIESTA-IoT repository, with no exception.
  2. **Location-based queries:** Instead of gathering the whole list of assets that the platform can actually provide to users, experimenters could only focus on the ones that are deployed within a particular area (or areas).
  3. **Physical phenomena-based queries:** Another possibility is to indicate only the application domain (e.g. through the specification of the set of physical phenomena that matches the context of the experiment). This way, experimenters will filter out all those resources that are not of their interest.
- **Testbed-Agnostic query of datasets and data-streams.** Apart from fetching the very last observations captured by FIESTA-IoT's underlying resources, experimenters might want to opt for the analysis of data already captured and stored within the FIESTA-IoT distributed repositories. In order to facilitate the harvesting of this historical information, a service will be available so that experimenters could specify a temporal window within which the observed measurements will be returned back to them.

As it has been described, FIESTA-IoT EaaS meta-platform uses semantic technologies to enable testbeds interoperability so that experimenters can have access to the datasets and data-streams generated by any of the underlying testbeds in a testbed-agnostic manner.

While some of the tools will intentionally hide the complexity introduced by the use of semantic technologies, others will enable the experimenter to exploit the potentials of semantic and linked data (e.g. use of SPARQL, access to RDF-annotated information, etc.).

4. Scope of the present Call

This Call solicits for experiments that design and deploy advanced (experimental) applications, notably applications that will leverage data and resources from multiple administratively and geographically dispersed IoT testbeds.

The scope of the Call is focused on **Novel IoT technologies and services**. FIESTA-IoT will provide the means for testbed agnostic access to experimental IoT datasets and data-streams, thereby open new horizons associated with the development of novel/niche IoT technologies and services in areas such as cloud and IoT integration, IoT and Big Data integration, large scale smart cities applications, ambient assisted living environments, management of emergencies and more. Therefore, FIESTA-IoT could allow cutting-edge researchers and innovative enterprises or individuals to develop, validate and test innovative technologies, applications and services, thereby improving their bottom lines. This will be particularly important for SMEs, which do not usually have the resources and equity capital for large scale experimentation.

The main added-value of the FIESTA-IoT platform is that it will provide the opportunity for accessing shared IoT resources, and for using them in the scope of experiments that will combine data from multiple testbeds. The FIESTA-IoT platform offers this interoperability among the datasets from the underlying testbeds employing semantic models and technologies. Experimenters should exploit the semantic and interoperable nature of the datasets and data-streams within their experiments.

A major innovation introduced by FIESTA-IoT relates to the dynamic discovery and use of IoT data from any of the underlying interoperable IoT testbeds.

Benefits for an experimenter to participate in this open call are:

- The EaaS infrastructure will facilitate experimenters/researchers to conduct large scale experiments that will leverage data, information and services from multiple heterogeneous IoT testbeds, thereby enabling a whole new range of innovative applications and experiments that are nowadays not possible.
- It will enable researchers to share and access IoT-related datasets in a seamless testbed agnostic manner i.e. similar to accessing a large scale distributed database. The objective will also involve linking of diverse IoT datasets, based on the linked sensor data concept. This allows the experimenter to focus on his core task of experimentation, instead of on practical aspects such as learning to work with different tools for each testbed, requesting accounts on each testbed separately, etc.;
- The simplified application process compared to the one from the standard H2020 calls together with a rapid review process by independent external evaluators;
- An extra benefit is the dedicated support from skilled FIESTA-IoT members. This will include their general training on IoT interoperability in general and in FIESTA-IoT interoperability in particular, targeted consulting services associated with the interoperability of their platforms/testbeds, as well as continuous support in their efforts to use the FIESTA-IoT results/tools towards improving the level of interoperability of their systems and applications.

These experiments should be of a short duration. **Experimenters allowed to use the FIESTA-IoT Platform on the FIESTA-IoT Rolling Open Call for Experiments should provide a short report of their experimentation no later than 15th June 2018.** However, experimenters will be allowed to use the FIESTA-IoT Platform further if they need it.

Submitted proposals will be evaluated by a board of FIESTA-IoT Consortium partners in order to assess its feasibility and eligibility. Additionally, proposers should pay attention on the ethical issues of their proposals, especially considering the privacy of the data to be gathered and published through their experiment.

It is required that the experiments are performed by a **single organization**.

5. Inclusion into the consortium

Once a proposer is selected to perform the proposed Experiment, no further relationship with the FIESTA-IoT Consortium will be established.

The FIESTA-IoT Platform that is offered through the FIESTA-IoT Rolling Open Call for Experiments is an experimental platform and it is offered as it is. FIESTA-IoT Consortium will not accept any liability on its performance or use by the experimenters.

By 15th June 2018 the experimenter have to submit a "Final Report" consisting of feedback on their experiments and the platform tools used.

6. Proposal template

The use of a specific proposal format as described in this section is mandatory. The template is limited in size and is focusing on "what the proposer wants to do" and "what the expected result is".

Section A — Summary (maximum 300 words). The information in this section may be used in public documents and reports by the FIESTA-IoT consortium.

Section B — Detailed description and expected results (minimum 4 to maximum 8 pages)

This section describes the details on the planned experiment (what does the proposer hope to obtain, how, why is it relevant). This section should also include all information with respect to the State-of-the-Art or a comparison to competing commercial solutions in case of experiments of category 'Innovation' to show the innovative character of the experiment and the expected scientific or business impact.

Section C — Requested FIESTA-IoT testbeds, resources and/or datasets or data-streams (target length 1 page)

The information in this section needs to be collected in collaboration with the FIESTA-IoT Consortium. For this section a specific format needs to be used, which is included in the proposal template

Section D — Use of proposal information

In this section the proposing party is asked to include some statements related to sharing information of their proposal within the FIESTA-IoT consortium. Proposals are treated in a confidential way, meaning that only successful proposals must be disclosed to the FIESTA-IoT consortium. Open calls previously organized by other FIRE projects were very successful and have revealed that many submitted non-granted proposals also contain very interesting and valuable information that could be used for setting up collaborations or to extract ideas for further improving the federated test infrastructures. Therefore the FIESTA-IoT project would like to have the opportunity to collect more detailed information and further use this information, also if the proposal is not selected for funding. In any case, the FIESTA-IoT consortium will treat all information of a proposal confidentially.

The full proposal template can be found in Annex A to this document.

7. Support during experiment and testbed integration

FIESTA-IoT will establish and operate the Ecosystem Desk; this is a help desk providing first point of contact support for users of the FIESTA-IoT facility. The desk consists of two roles: i) a research desk to help experimental researchers with problems and information to get started, ii) a Global Market confidence desk to support SME stakeholders.

8. Funding scheme

Experimenters on the FIESTA-IoT Rolling Open Call will not be funded.

9. Access to Foreground information from the project

Experimenters on the FIESTA-IoT Rolling Open Call do not have any IPR rights on the foreground of the project.

10. Reporting

A short report needs to be submitted by 15th June 2018.

A specific template needs to be used and will include:

Part A. Publishable summary

Part B. Detailed description

This section should describe the details on the experiment. It includes:

- Concept, Objectives, Set-up and Background
- Impact
- Lessons learned
- Impact

Part C. Feedback to FIESTA-IoT

This section contains valuable information for the FIESTA-IoT consortium and describes the recipient's experiences while performing the experiment. Note that the production of this feedback is one of the key motivations for the existence of the FIESTA-IoT open calls. It includes:

- C.1 Resources & tools used
- C.2 Feedback based on design / set-up / executing the experiment within FIESTA-IoT
- C.3 Why FIESTA-IoT was useful for the recipient?

This report will serve as (1) input to the evaluation of the user-friendliness of the FIESTA-IoT platform and EaaS interfaces, and (2) identification of missing gaps in both testbeds and EaaS platform.

Part of this report may be used by the FIESTA-IoT consortium for inclusion in their reporting documents to the EC and in public presentations. Inclusion of confidential information should therefore be indicated and discussed with the FIESTA-IoT consortium.

This report, code and documentation will also be used for the formal review by the European Commission.

11. Criteria for evaluation of Experiments

Evaluation of the proposal will be carried out by a board composed by members of the FIESTA-IoT Consortium.

Selection will mainly be based upon the following criteria:

1. Scientific/Industrial innovation: the degree of scientific and industrial innovation of the proposed experiment (cf. Section B of the proposal template)

2. Scientific/Industrial relevance: potential for take-up of the results by either the broader scientific community or the industrial community creating new IoT products (cf. Section B of the proposal template)

3. Publication/impact potential: Prospective dissemination of the results in relevant international conference and journals or industrial events and field trials (cf. Section B of the proposal template)

4. Clarity and methodology (Cf. Section B of the Proposal Template)

   The experiment should be scientifically and/or technically sound. There should be a clear problem statement, a solid experiment design, a good methodology, etc.

5. Feasibility (Cf. Section C of the Proposal Template)

   Experiments with low chances for success or requiring excessive support from the FIESTA-IoT partners will get a lower score.

6. Potential for Feedback (Cf. Sections C and D of the Proposal Template)

   The FIESTA-IoT consortium is seeking feedback regarding the FIESTA-IoT platform and the benefits of providing interoperability among different testbeds. Proposals that can actually get full benefit of the FIESTA-IoT testbeds' federation and provide valuable feedback on the exploitation of the semantic approach leveraged by the FIESTA-IoT platform will be provided, will get a higher score.

Amongst all above listed criteria, criteria 1, 2, 3 and 6 will be weighted higher.

12. Timing of the evaluation and experiments

The duration of the evaluation of the proposals and its approval will be kept within 1 week.

Experiments in the FIESTA-IoT Rolling Open Call should provide a short experiment report before 15th June 2018.

13. Submission

Submission deadline:	**FIESTA-IoT Rolling Open Call is continuously open**

The proposal must be:

1. Submitted via e-mail through: oc-info@fiesta-iot.eu
2. Submitted in English

Annex A. Full proposal template

Federated Interoperable Semantic IoT/cloud Testbeds and Applications

Rolling Open Call

FIESTA-IoT Rolling Call for Experiments

Full title of your proposal

Acronym of your proposal (optional)

Call / category (for Experiments only) / Identifier	FIESTA-IoT-Rolling-EXP
Date of preparation of your proposal	mm/dd/yyyy
Your organization name	Your organization name
Type of the organisation	University/Research Institute/SME/Industry/etc.
Name of the coordinating person	Name of the coordinating person
Coordinator telephone number	Coordinator telephone number
Coordinator e-mail address: [This is the email address to which the Acknowledgment of receipt will be sent]	Coordinator e-mail

Note: Grey highlighted areas needs to be filled and/or removed as they are intended to provide clarification on the expected content. Word template can be downloaded from FIESTA-IoT project website (see http://fiesta-iot.eu/index.php/opencall/)

Section A Project Summary

(Maximum 300 words)

Summary of the proposed work

Remark: The information in this section may be used in public documents and reports by the FIESTA-IoT consortium.

Note: It has to be evident from the project summary the domain on which the proposal is focusing. Check the call text for more details

Section B Detailed description and expected results

(maximum 2 pages)

This section describes the details on the planned experiment: what does the proposer hope to obtain, how, why is it relevant? This section should also include all information with respect to the State-of-the-Art or a comparison to competing commercial applications and services in case of experiments of category 'Innovation' to show the innovative character of the experiment, and the expected scientific or business impact.

B.1 Concept and objectives

Describe the specific objectives of the proposed experiment, which should be clear, measurable, realistic and achievable within the duration of the experiment (not through subsequent development). Show how they relate to the topic(s) addressed in the scope of this competitive call and how and why FIESTA-IoT meta-platform is needed for realizing them. Describe and explain the overall concept that forms the basis for your experiment. Describe the main ideas, models or assumptions involved.

B.2 Impact

Show that the proposed experiment has sufficient sustainable benefits for the FIESTA-IoT project, meaning that there should be an added value for the FIESTA-IoT project, after the proposer has finished his experiment.

Describe how this experiment extents the current literature and how the broader research community can benefit from the results of the experiment.

Describe how this experiment can be used to create industrial impact, either to an existing company or a startup.

Describe the impact of the proposed experiment on the domain of interest and how this relates with the specific domains of interest of the 4th Open Call.

B.3 Methodology and associated Work Plan

Provide a work plan. Provide clear goals and verifiable results, and also a clear timing.

The work plan involves at least the following phases:

1. *Design of experiment*
2. *Executing the experiment, or integration of the testbed*
3. *Analysis & feedback*
    - *Analysis of the results of the experiment or testbed integration process*
    - *Feedback on user experience*
    - *Recommendations for improvements and/or future extensions of FIESTA-IoT meta-platform and testbeds*
4. *Showcase: Set up of a showcase (demonstration) to be used for the evaluation of the experiment at the review meeting with the EC, and for further promotion of FIESTA-IoT*
5. *Dissemination: Regular dissemination actions (journal publications, conferences, workshops, exhibitions, FIRE events, advertising of results at FIESTA-IoT website, etc.)*
6. *Final report, code and documentation*

Section C Requested FIESTA-IoT testbeds, resources and/or datasets or data-streams

(target length 1 page - fill the tables below)

***For experimenters**: Please visit the following websites to get details on the specific testbeds, datasets and data-streams, and services available*

- http://fiesta-iot.eu/index.php/fiesta-testbeds/
- http://fiesta-iot.eu/index.php/fiesta-experiments/

TESTBEDS	**Required (Yes/No)**
SmartSantander	
SmartICS	
KETI	
SoundCity	
ADREAM	
NITOS	
EXTEND	
FINE	
RealDC	
Tera4Agri	
Grasse Smart Territory	

DATASET / DATA-STREAM	HISTORICAL or CURRENT VALUE	FREQUENCY
Identify the phenomena your are interested in. (One per row)	*Do you require access to bunch of values in a given time or just access to the value at the moment of the request?*	*How often will you require data from FIESTA-IoT?*
Identify the phenomena your are interested in. (One per row)	*Do you require access to bunch of values in a given time or just access to the value at the moment of the request?*	*How often will you require data from FIESTA-IoT?*
Identify the phenomena your are interested in. (One per row)	*Do you require access to bunch of values in a given time or just access to the value at the moment of the request?*	*How often will you require data from FIESTA-IoT?*
…	…	…

SERVICE / TOOL	Required (Yes / No)
Experiment management tool	
SPARQL endpoint (resources and observations)	
Resource browser	
REST access to datasets	
Subscription-based access to data-streams	

Section D Use of proposal information

(maximum 1 page)

In this section the proposing party is asked to include some statements related to sharing information of their proposal within the FIESTA-IoT consortium.

Proposals are treated in a confidential way, meaning that only successful proposals must be disclosed to the FIESTA-IoT consortium. Open calls previously organized by other FIRE projects were very successful and have revealed that many submitted non-granted proposals also contain very interesting and valuable information that could be used for setting up collaborations or to extract ideas for further improving the federated test infrastructures. Therefore the FIESTA-IoT project would like to have the opportunity to collect more detailed information and further use this information, also if the proposal is not selected. In any case, the FIESTA-IoT consortium will treat all information of a proposal confidentially.

Two types of information usage are envisaged:

- *Information which is part of the Sections A, B, C, D and F will be used within the FIESTA-IoT project as input for tasks related to testbed and software platform optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this open call. All proposals submitted to this competitive open call are obliged to allow this form of information access and usage.*
- *Other information belonging to this proposal might also be accessed by the FIESTA-IoT consortium, if allowed by the corresponding proposer. Any use of such information will be discussed and agreed upon with the proposers. Proposers have the freedom to select if they wish to support this kind of information usage.*

I allow that the material provided in Sections A, B, C, D and F of this proposal may be accessed by the FIESTA-IoT consortium, also if the proposal is not selected. In any case, the FIESTA-IoT consortium will treat all this information confidentially. It will be used within the FIESTA-IoT project as input for tasks related to testbed and software platform optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this open call.	Yes ☐	
Furthermore, I allow that the other parts of this proposal may be accessed by the FIESTA-IoT consortium, also if the proposal is not selected. In any case, the FIESTA-IoT consortium will treat all information of this proposal confidentially. Any use of this information will be discussed and agreed upon with the proposers.	Yes ☐	No ☐

Annex B. Non-binding description of available testbeds

The FIESTA-IoT project offers access to several IoT testbeds, such as SmartSantander (University of Cantabria), Smart ICS (University of Surrey), KETI and SoundCity, complemented by six (6) testbeds integrated to FIESTA-IoT through the previous open calls. All these testbeds are installed in either outdoor or indoor environments ranging four different domains (i.e. Smart City, Smart Campus, Cellular Networks and Smart Office). A summarized description of each of them follows:

SmartSantander

The SmartSantander testbed is located in Santander, a seaside town settled in the north of Spain. With a population of nearly 200,000 inhabitants, this city was chosen to deploy an experimental test facility (i.e. open laboratory) for the research and experimentation of big-scale architectures, in the context of a Smart City environment. Amongst its assets, the platform spans a number of domains that will be made available for the experimenters under the scope of the FIESTA-IoT's Experiment as a Service (EaaS) interface. Numerically speaking, the SmartSantander testbed manages around 3,000 IoT devices (which communicate through IEEE 802.15.4 interfaces), another 200 devices that play the role of gateways (with cellular communication capabilities) that establish a link between the abovementioned devices and the core of the platform, 2,000+ joint Radio Frequency Identification (RFID) tags/Quick Response (QR) code labels and more than 2,000 points of interest pertaining to a wide range of events (e.g. shopping, restaurants, cultural events, etc.). Table below summarizes the principal domains supported by the SmartSantander platform that will be available in the scope of the FIESTA-IoT federation. Besides, the table also describes the main assets associated to each of these domains, as well as the number of resources available in each of the cases.

Summary of SmartSantander's domains and assets

Domain	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Environmental monitoring	Air Particles Concentration, Ambient Temperature, Altitude, Atmospheric Pressure, CO concentration, Illuminance, Mass, NO_2 concentration, O_3 concentration, Rainfall, Relative Humidity, Soil Moisture Tension, Solar Radiation PAR, Sound Pressure Level, Soil Temperature, Wind Direction, Wind Speed	Fixed & Mobile Sensors	1000+ (fixed) & 150 (deployed on public vehicles)
Traffic monitoring	Vehicle Speed (Average & Instantaneous), Traffic Congestion, Traffic Intensity	Fixed sensors	48+
Bike stops	Bike presence detectors	Fixed sensors	16 bike stops
Bus tracking	Location (fleet management) + Remaining time for the next bus	Mobile sensors	400+

Taxi stops	Location (fleet management system) + Taxis available in each stop	Mobile sensors	50+
Garbage management	Waste container fill level gauge + Trash truck (fleet management)	Fixed sensors (Waste containers) + Mobile sensors (tracking)	50+
Indoor parking	Vehicle presence detectors	Fixed sensors	12 public parking facilities (managed by private companies)
Outdoor parking	Vehicle presence detectors (buried under the asphalt)	Fixed sensors + Information panels	400+ sensors & 10 panels to display the information
Parks & gardens irrigation	Ambient temperature, Atmospheric Pressure, Rainfall, Relative Humidity, Soil Moisture Tension, Solar Radiation PAR, Wind Direction, Wind Speed	Fixed sensors	48 IoT sensors nodes, covering three different areas (i.e. Las Llamas Park, La Marga Park and Finca Altamira)
Presence & luminosity	Pedestrian presence detector, Luminosity Sensors	Fixed sensors	10
NFC & QR tags	General information (e.g. transportation, cultural elements and shops)	NFC & QR Tags	2000+ tags deployed throughout the city
Electromagnetic exposure	Electric Field in the bands of 900, 1800, 2100 and 2400 MHz	Fixed sensors	48 sensor nodes
Augmented Reality	Contextual information (shops, restaurants, cultural points of interest, etc.)	Points of interest	2000+
Participatory Sensing	Events generated by citizens (Pace Of The City)	Smartphone apps	20000+ apps installed into citizens' smartphones

SmartICS

The SmartICS testbed is located in the Institute of Communication Systems (ICS) at the University of Surrey. The University is located about 40 kilometers south of London in the town of Guildford. The SmartICS testbed provides a smart environment, based on an indoor sensor nodes deployment located in the on all floors of the building. It serves as initial core and experimental micro-cosmos for the envisioned Smart Campus facility.

The IoT node tier consists of up to 200 sensor nodes deployed across all offices and desks in ICS with various sensing modalities, which include temperature, light, noise, motion, and electricity consumption of attached devices. The availability of these sensing modalities may vary across some of the nodes. The IoT nodes consist of 200 TelosB based platforms. Other sensor node platforms are planned to be deployed soon in order to achieve additional hardware heterogeneity in the testbed. The nodes' deployment currently stretches over three floors of the building.

Summary of SmartICS's domains and assets

Domain	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Desk Electricity consumption	Power	Fixed Sensor	200 (fixed)
Desk Ambient Environment	Temperature, Light Intensity, noise, presence (Infrared).	Fixed Sensor	200 (fixed)

KETI

The KETI testbed (originally installed for monitoring building energy consumption) has been implemented on the 5th floor of a Korea Electronic Technology Institute (KETI)'s building in Seoul, Korea. It aims to collect sensing data from a set of areas of offices (e.g., meeting area, relaxing area, and work area) and the parking lot. The deployed sensors (for measuring indoor climate, energy consumption of office utilities, people's presence in offices, and parking lot status) collect information about the physical status of indoor and outdoor building environment, and transfer it to the IoT server platform, Mobius, an oneM2M standard-compatible server platform, which allows further processing and analysis.

The testbed is composed of 40 compound sensors, each of them having 4 kind of raw sensors (temperature, humidity, illumination and presence sensor), 10 CO2 (Carbon dioxide) concentration detection sensors, 10 smart sockets for measuring the electrical power consumption, and 20 parking lot sensors, with total of 200 sensors (i.e., 160 raw sensors + 10 CO2 + 10 sockets + 20 parking sensors). Table x summarizes IoT devices supported by the KETI's testbed that will be available in the scope of the FIESTA-IoT federation.

Summary of KETI's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Temperature sensor	Ambient temperature of Office area (meeting area, relaxing area, and work area)	Fixed Sensor (compound sensor)	40
Humidity sensor	Relative humidity	Fixed Sensor (compound sensor)	40

Illumination sensor	Illumination	Fixed Sensor (compound sensor)	40
PIR sensor	User occupancy in an office	Fixed Sensor (compound sensor)	40
CO2 (Carbon dioxide) sensor	CO concentration	Fixed Sensor	10
Smart socket	Electrical power consumption	Fixed Sensor	10
Parking lot sensor	Vehicle presence detectors	Fixed Sensor	20

SoundCity

The Soundcity testbed is a large-scale crowdsensing testbed developed by Inria-Paris in collaboration with an SME Ambiciti. The testbed comprises of data coming from so called Ambiciti application that is installed on user's mobile phone. The Ambiciti application uses in-built sensors on mobile phones to sense various phenomena such as noise, motion and proximity. Due to privacy reasons, users have to explicitly confirm about their data to be shared to FIESTA-IoT platform, thus the number of Soundcity devices attached to FIESTA-IoT platform varies from time to time. The Soundcity testbed is not bound to any specific location due to the fact that users of Ambiciti application can be anywhere in the world.

Summary of SoundCity's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Smartphone – Device surroundings	Noise, Proximity	Smartphone apps	Variable (less than 10)
Smartphone – Anonymised Mobility Information	Speed, Accelerometer, location	Smartphone apps	Variable (less than 10)

ADREAM

LAAS-CNRS has built a smart building called ADREAM (https://www.laas.fr/public/en/adream). This building already has more than 6500 sensors that collect 500.000 measures per day (solar panel activity, energy consumption, HVAC, lighting, weather). This is completed by a reproduction of a flat where researchers can deploy extra sensors and actuators.

Summary of ADREAM's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Lighting	Luminosity, presence, state of ballast	Fixed Sensor	3700

Electricity	Smart meter for building, plug	Fixed Sensor	500
HVAC	Temperature, pump flow, valve status, etc. : all the necessary sensors and actuators to manage the HVAC of a building	Fixed Sensor	1000
Solar panels and batteries and weather	Smart meter, inverter state, wind, luminescence, temperature	Fixed Sensor	1200
Instrumented flat	luminescence, temperature, presence, plug, pressure, smart phone, tablet, relay, contact, fire detection, motor	Fixed sensors and mobile	100

NITOS

NITOS will bring to FIESTA-IoT a set of heterogeneous resources including nodes equipped with Wi-Fi, WiMAX, LTE and Bluetooth, 4G/5G terminals, software defined radios, SDN resources, cloud infrastructure and two wireless sensor networks comprised by commercial and custom made sensor platforms. On top of these diverse and heterogeneous resources, NITOS brings a vast number of experimental datasets generated through the various experiments conducted all these years that NITOS has been operating.

The wireless sensor network consists of a controllable deployment in an indoor environment (Figure 1), as well as an office/building deployment. Most of the sensor platforms are custom-made, developed by UTH, and some others commercial, all supporting open-source and easy to use firmware and exploit several wireless technologies for communication (ZigBee, Wi-Fi, BLE and LoRa). The office/building setup provides metrics related to the environment conditions and composes an integrated application of WSN in real-life scenarios. On the other hand, the WSN which is deployed in an indoor testbed environment is targeted to provide the necessary experimentation capabilities with a plethora of IoT communication interfaces.

Summary of NITOS's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Lora Experimental Network	Luminosity sensors, Ambient Temperature, Relative Humidity, Lora Network metrics (e.g. RSSI, latency)	Fixed sensors	20 deployed in the NITOS indoor deployment

Office Sensor deployment over ZigBee network	Human presence (PIR), Thermal sensors, Luminosity sensors, Ambient Temperature, Relative Humidity, Sound Pressure Level, Link State Info (e.g. RSSI)	Fixed sensors	40 deployed in office environment & 20 deployed in the NITOS indoor deployment

EXTEND

The facility is located in a bathing and recreation coastal area, offering support for new IoT experimentation scenarios in the unique sea and underwater environment. Moreover, a wide range of communication interfaces (ZigBee, Wi-Fi, LoRa, LTE, Iridium) and types of measurements (sea water and air quality parameters) are supported on all testbed nodes.

Testbed nodes exploit heterogeneous communication technologies to connect with the shoreside network. Moreover, they act as independent sensing units, featuring a vast variety of bathing water and air quality monitoring sensors. They are built on the BeagleBone Black Rev. C board [7], which is characterized by sufficient processing power capabilities (1GHz with 512MB RAM), low power consumption and several communication ports (USB, UARTs, SPI, I2C, etc.) for interconnecting external hardware. Sea nodes feature several types of water quality sensors, such as Ammonium (NH4+), Nitrine (NO2-), Nitrate (NO2-), Temperature, Conductivity (Salinity), pH and Dissolved Oxygen (DO) as well as air quality sensors like air temperature & humidity, Nitric Dioxide (NO2), Sulfur Dioxide (SO2), Dust Sensor, Carbon Monoxide (CO), Ozone (O3) and Ammonia (NH3). The develop buoys feature several communication interfaces, consisting the overall testbed a versatile experimental platform.

Summary of EXTEND's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Sea Water quality monitoring and Air pollution characterization	Sea water parameters: Ammonium (NH4+), Nitrine (NO2-), Nitrate (NO3-), Temperature, Conductivity (Salinity), pH, Dissolved Oxygen (DO). Atmospheric parameters: Air temperature & humidity, Nitric Dioxide (NO2), Sulfur Dioxide (SO2), Dust Sensor, Carbon Monoxide (CO), Ozone (O3), Ammonia (NH3).	Fixed floating platform	1

Sea Water quality monitoring and Air pollution characterization	Sea water parameters: Ammonium (NH4+), Nitrine (NO2-), Nitrate (NO3-), Temperature, Conductivity (Salinity), pH, Dissolved Oxygen (DO). Atmospheric parameters: Air temperature & humidity, Nitric Dioxide (NO2), Sulfur Dioxide (SO2), Dust Sensor, Carbon Monoxide (CO), Ozone (O3), Ammonia (NH3).	Movable Buoys	4
Power Consumption Measurements	High precision power consumption measurements of the on-board wireless interfaces (WiFi, LTE, XBee, LoRa).	Fixed floating platform & Movable Buoys	5

FINE

FINE aims to design and develop a FIESTA-enabled heterogeneous testbed, significantly contributing to FIESTA-IoT vision. FINE will re-use the architecture, software and hardware components of RERUM, a successful IoT platform. The functional architecture of RERUM is based on the architectural reference model of IoT-A; however, it follows not only a service-oriented approach like IoT-A and most IERC projects, but also assumes that the devices have an important role into ensuring the security and privacy of the architecture. Moreover, RERUM adopts the concept of virtualisation, abstracting the real world objects into virtual objects, for concealing their heterogeneity. All devices are virtualised, and all functionalities related to service management, device discovery, federation formulation, etc., are supported by the RERUM Middleware (RMW).

At the lower layer, RERUM provides a set of functionalities for device registration, data fetching, service activation and de-activation, mainly provided by the RERUM Gateway (RGW). RGW has a southbound interface that communicates directly with the IoT devices, and a northbound virtual interface that binds to the RMW, and provides functionalities like device registration, deregistration, re-registration, measurement provision, etc. The IoT devices, namely the RERUM devices (RDs), are heterogeneous in nature, as they contain both resource-constrained devices (miniature sensors) and non-constrained ones (smartphones). The RERUM Device Adaptor (RDA) is the software API implemented in the RDs that provides the necessary abstractions in order to enable them for reporting various types of measurements to the RGW. Such measurements include ambient light and temperature, noise, humidity, as well as power consumption measurements related to RD’s operation, and network statistics like the number of the corrupted UDP packets within a time period.

Summary of FINE’s domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Environmental monitoring	Ambient temperature, humidity	Fixed sensors	40

	Ambient light		10
	Noise		23
	PM10		18
	NOx, O3, SO2, VOC		5
	Atmospheric pressure, wind direction, wind speed, rainfall		3
Electricity consumption	AC current, AC voltage	Fixed sensors	2
Network monitoring	RSSI, LQI, corrupted/lost/correctly decoded packets in all layers (MAC, IP, TCP, IP), routing statistics	Fixed sensors	40
Device (sensor) energy consumption	CPU, LPM, Transmit, Listen operations	Fixed sensors	40
Device (sensor) operating information	Uptime, chip temperature, software version, input voltage	Fixed sensors	40
Outdoor parking	Differentiations of the magnetic field	Fixed sensors	6
Smart home management	Voice capturing, software for automatic speech recognition in the form of voice to text processing	Digital microphone array	2
		Actuators	2
		Servomotors	2

RealDC

Data centres (DCs) are currently consuming an average of 2% of electricity produced (based on U.S. consumption alone). Efforts to improve the efficiency of these facilities has yielded impressive results in the last 5 years but authoritative sources assert that better data is needed to continue further. We believe that IoT in DCs provides the best solution to monitor and improve DC efficiencies. A critical mass of DCs publishing their usage data is required to correlate and develop best practice solutions for energy savings. Different types of data centres have varying power and water consumption profiles. The current best practice of using PUE (Power Usage Efficiency) doesn't provide the full picture of DC performance.

In response to the above, the purpose of this proposal is to integrate a live Data Centre into the FIESTA-IoT ecosystem. This integration comes in the form of sensor data on power, cooling and ambient weather, which will be made available to experimenters and other data centre owners as open linked data set through the FIESTA-IoT facilities. We will leverage the technology and ontology developed by the FIESTA-IoT consortium.

Where additional software is required to integrate our sensors, testbed and historical observations, this will be made available as open source software. Through targeted workshops and online training, we intend to grow a community of data centre operators and experimenters in the Higher Educational Institute, Telecoms and Manufacturing sectors who can use the data and tools for experimentation and operational support. Our view is that removing barriers to access our data will be for the benefit all.

Summary of RealDC's domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Campus and DC Operations	Schneider Electric PowerLogic PM210 connected to Modbus infrastructure (real, apparent and reactive power, current and voltage data for all circuits)	Fixed Sensors	83
DC Operations	Rittal LCP-Plus SK 3301.480 Liquid Cooling Packages for 26 variable density cabinets	Fixed Sensors	16
Campus and DC Operations	Davis Vantage Vue Weather station data (Temperature, Wind, Humidity, Precipitation, Barometric Pressure)	Fixed Sensors	1
DC Operations	Power metering historical data about to July 2014 (real, apparent and reactive power, current and voltage data for all circuits)	Data set	1
DC Operations	Cooling and cabinet temperature data from LCPs back to July 2014	Data set	1
DC Operations	Historical weather data back to July	Data set	1

	2014		

Tera4Agri

The basic idea of the Tera4Agri extension is to introduce in the FIESTA-IoT platform the new smart agriculture domain. The testbed is located in Minervino Murge (BT – Apulia Region - Italy) in the Tormaresca - “Bocca di Lupo” estate: a farm which covers an area of about 500 hectares of which 350 are planted with vines and 85 with olive trees. The extension will be compliant with the FIESTA-IoT semantic models and interfaces. The original GIoE solution in the testbed is the Tera project whose object is to enhance the energy efficiency with related reduction of energy bills and it will be customized and increased in this call with new sensors in the meantime product quality, minimizing the chemical treatments in the production chain. The testbed will collect data by sensors that TERA will install in the estate for smart agriculture domain and will give resources and observations for the FIESTA-IoT platform. Experimenters will be able to use and consume data and resource from Tera4Agri testbed.

Summary of Tera4Agri’s domains and assets

IoT Device	Asset (physical phenomena, etc.)	Resource Type	Deployed devices
Environmental monitoring	Temperature Humidity Thermal flow Rain measurement Wind measurement Dew Point Sun light measurement	Fixed Sensor	tbd*
Soil monitoring	Humidity Temperature Water in the soil	Fixed Sensor	tbd*
Tree monitoring	Water on the leaves measurement	Fixed Sensor	tbd*

*to be defined, however not less than 10 deployed device per measurement in order to cover the whole estate area