Federating IoT and cloud infrastructures to provide scalable and interoperable Smart Cities applications, by introducing novel IoT virtualization technologies

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Deliverable D1.3:

Second Communication, Dissemination and Standardization Report

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Abstract:	Report on 2nd year project activities related to dissemination, communication and standardization of results.
Keyword List:	Dissemination, communication, standardisation

Disclaimer

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1 Introduction

1.1 Deliverable Rationale

This deliverable reports about dissemination, communications and standardization activities made in the context of the Fed4IoT project. It aims at updating the strategy defined within the project proposal and the D1.2 deliverable; it describes actions undertaken within the second year of the project.

1.2 Quality review

The internal Reviewers responsible of this deliverable is A. Detti (CNIT).

VERSION CONTROL TABLE			
VERSION N.	PURPOSE/CHANGES	AUTHOR	DATE
0.1	Creation	G. Orazi (EGM)	05/06/2020
0.2	Outline update	G. Orazi (EGM)	12/06/2020
0.3	Initial contributions	All	23/06/2020
0.4	Overall review and adjustment	G. Orazi (EGM)	25/06/2020
1.0	Quality check	A. Detti (CNIT)	26/06/2020

1.3 Executive summary

To raise the awareness of the different stakeholders about the Fed4IoT project results, and to increase its impact, the project plans to actively communicate and disseminate its results with specific activities including:

- Communication activities: A Web site on the Fed4IoT project has been created and is running with continuous update (see section 2.2.2).
- Open source prototypes: A GitHub organization is hosting the all the contributions to the source code of the project (see section 2.2.3).
- Scientific dissemination: key personnel from Fed4IoT are involved in publication of conference and journal papers reporting main scientific finding of the project (see section Project publications).
- Organization of dissemination events: personnel involved in Fed4IoT is committed to disseminate results through the participation and organization of academic and scientific and marketing-oriented dissemination events (see section 2.2.5).

The following tables report a summary of the Communication and Dissemination activities carried out during the first year of the project.

- A website is online (https://fed4iot.org/) and received more than 3000 visitors this year (**+244%** with respect to first year)
- Open-source dissemination through GitHub
- Number of publications (journals and conferences): **39**
- Number of participations in events: 3
- Number of contributions to standardisation bodies: **14**

2 Communication and dissemination activities

2.1 Overall strategy

2.1.1 Introduction

With a market that will reach $774.8 billion in 2021 and an annual growth rate of 17.7% from 2016 to 2021, Smart City IoT technologies market is promising. Smart technologies are needed to support a sustainable, green, healthy, and efficient growth of cities. However, implementing a greater number of IoT devices leading to a significant amount of generated data poses both interoperability and expenditure problems.

Fed4IoT solution faces interoperability issues to improve and integrate mature interoperability solutions for smart city application on different system levels: device, platform, and information level. Its unique virtualization method allows the re-use of existing infrastructure and devices to thus increasing their return on investment.

2.1.2 Target audiences

The wide scope of this project enables to target several stakeholders' groups which deserve appropriate dissemination.

- The first group includes the platforms developers and integrators.
- The second group includes the cities and users of the application being allowed through the Fed4IoT virtualisation mechanisms.
- Finally, the third group includes the citizen as well, willing to better understand the realm of IoT based smart city platforms and the way they could interact with it.

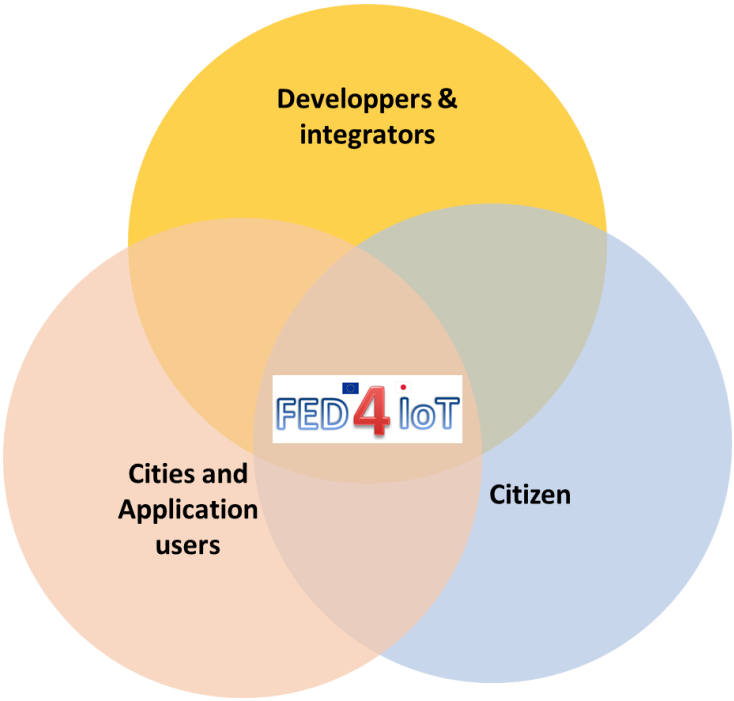


Figure 1: FED4IoT Dissemination targets

2.1.3 Channels

To raise the awareness of the different stakeholders of the project about the Fed4IoT results, and to increase its impact, the project has identified the dissemination channels to be used. They include:

- Online visibility through a website and presence in social media, for which Twitter has been retained as main platform.
- The presentation of results to the scientific community through presentations of papers at workshops and conference and journals.
- The demonstration of the project vision and results at events such as exhibitions and workshops
- Presence in open-source communities, with the publication of the source code and documentation of the project on a dedicated GitHub organization.

In addition, the Fed4IoT project has set high its ambitions in terms of standardisation and contributions to standardisation bodies.

Finally, to increase the dissemination impact, a common look and feel made by a professional designer is applied to all communications channels.

2.2 2nd year activity report

2.2.1 Overview

Table 1: Summary of the Communication and Dissemination Activities: 2nd Year

Dissemination and Communication activities	Number	Comment
Organisation of a Workshop	1 proposal	ACM Workshop
Training	1	Best Lesson
Social Media (new)	1	GitHub
Website (update)	1	fed4iot.org
Journal Publication	6	See Table 3
Participation to a Conference	33	See Table 3
Participation to a Workshop	4 (2 cancelled due to COVID)	- ~~IoT International Symposium 2020~~ - FIWARE Summit - ~~WF IoT 2020~~ - WISP (online due to COVID)
Participation to an Event other than a Conference or a Workshop	3	- Smart SE Consortium - Département des Pyrénées Orientales - Italian Networking Workshop 2020
Participation in activities organized jointly with other H2020 projects	2	- H-CLOUD coordination and support actions - Future Cloud Cluster of European projects in Cloud
Other		

Table 2: Estimated number of persons reached, in the context of all dissemination and communication activities

Scientific Community (Higher Education, Research)	3500 (workshops + website + other events)
Industry	1500 (website)
Policy Makers	5 (other events)

2.2.2 Website

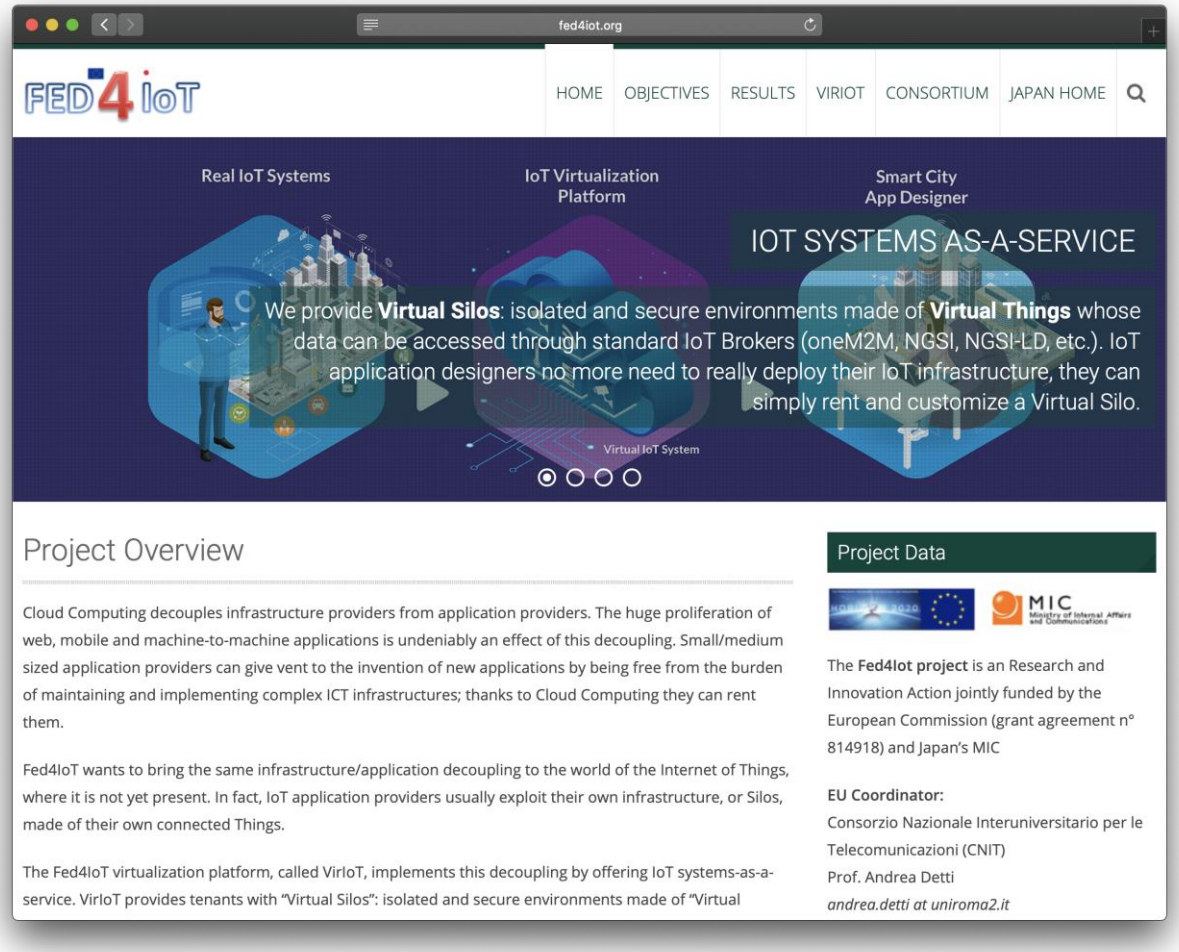


Figure 2: Fed4IoT web site

The Fed4IoT web site is available at www.fed4iot.org. The website has been updated during the second year to be more in line with the evolution of the project. Updates included the project overview, scrolling images, a new VirIoT page describing the Fed4IoT Virtualization platform and the project results. Below we describe the website with a snapshot of these new contents.

The main structure of the pages follows the scheme of the Home page: the main field dedicated to the Project content, with a static section of the right side showing official information about the project, Coordinator Organization, Funding and Official EU Acknowledgement. The footer area contains the Copyright information and references to Twitter social media.

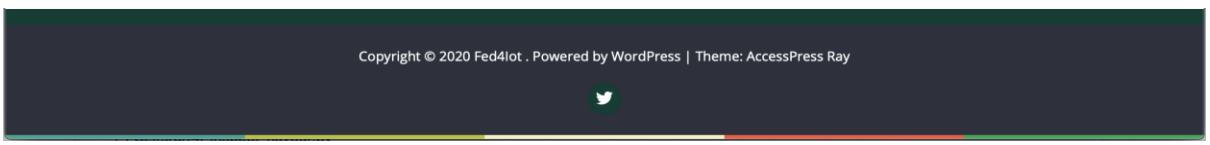
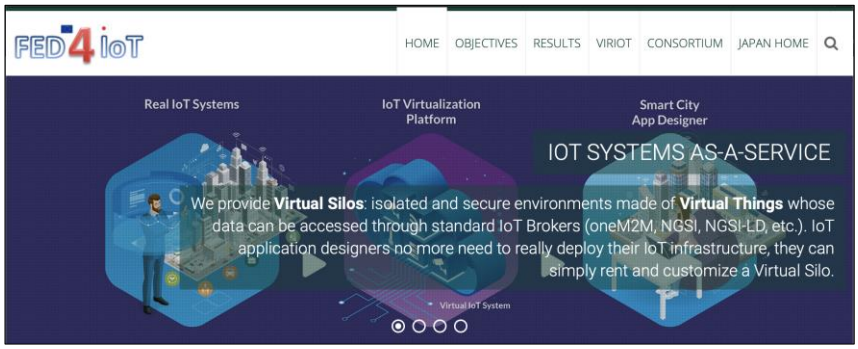
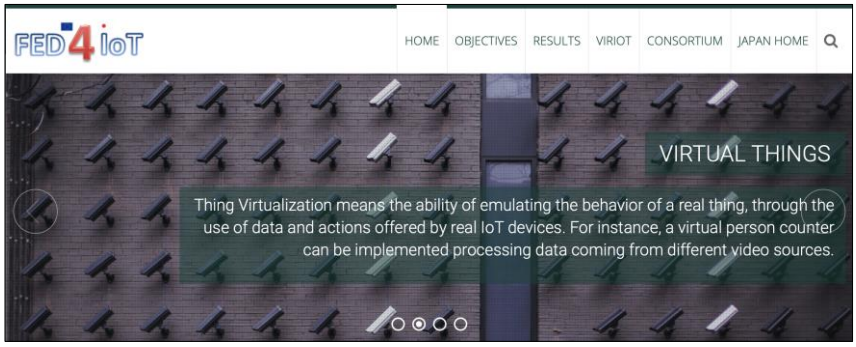


Figure 3: Web Site Footer

The Home page presents four sliding pictures representing different backgrounds and showing four key sentences summarizing in a very short way the main concepts of the project.





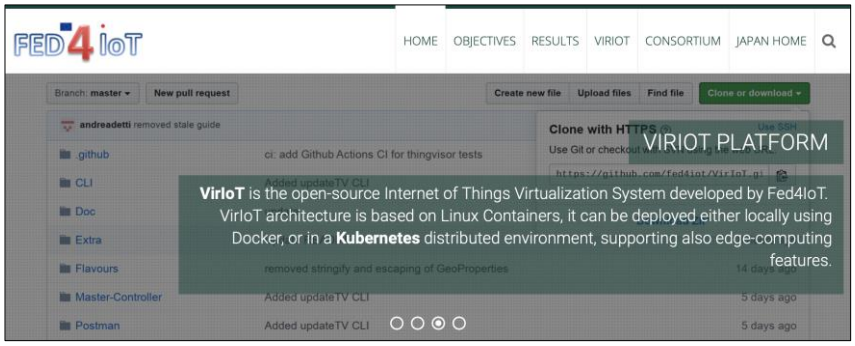


Figure 4: Sliding pictures of the Home page and project data

The Home Page provides information about the Project Overview and accounts for additional five tabs on the Header Menu: **Objectives**, **Results**, **VirIoT**, **Consortium** and **Japan Home**.

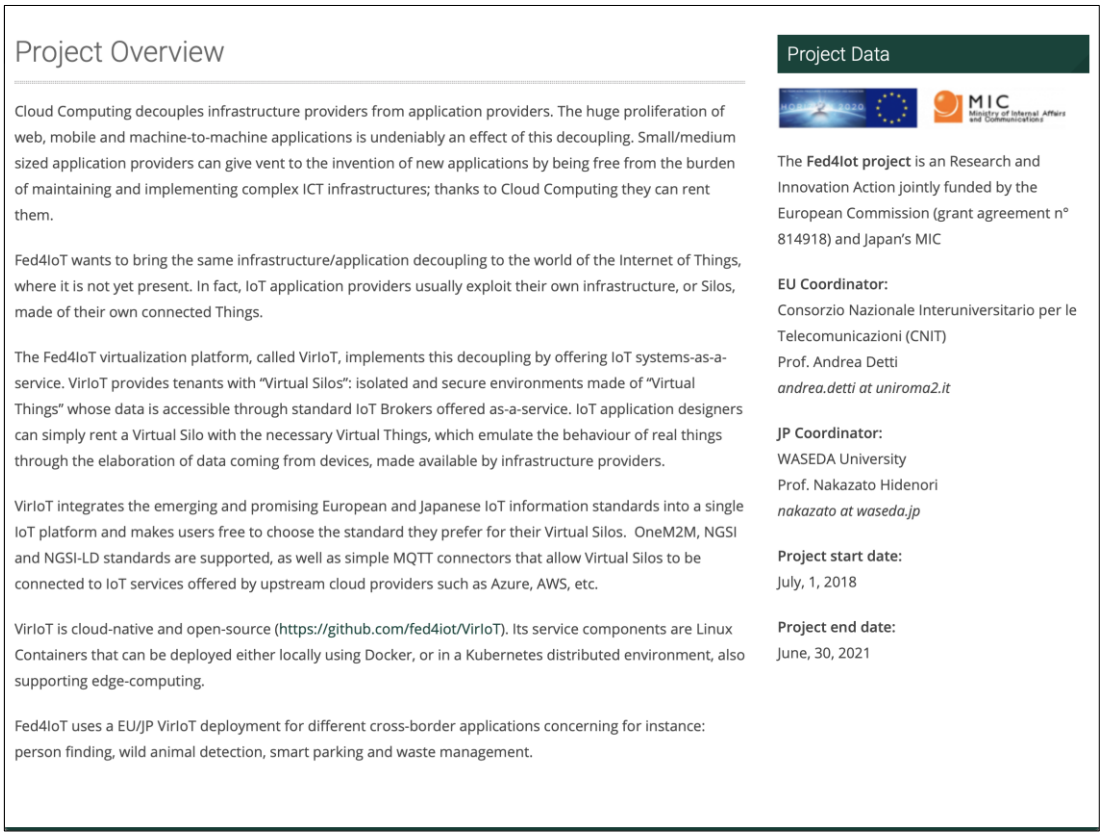


Figure 5: Project Overview

The Objective page presents the main objectives of the project:

- Multi-level IoT interoperability for smart-city, large-scale, cross-domain applications
- Support the evolution and the integration of mature interoperability solutions in Europe and Japan
- Reduction of expenditure for large scale IoT deployments
- Simplification of smart-city application development
- A simple and programmable system for IoT application deployment
- A market sustainable system
- Design of novel IoT Virtualization and multi-tenancy technologies

Objectives

Multi-level IoT interoperability for smart-city, large-scale, cross-domain applications

To Integrate in a single framework a high volume of IoT devices of different vendors, different IoT platforms and information coming from different IoT domains, in order to support cross-domain smart city application development

Support the evolution and the integration of mature interoperability solutions in Europe and Japan

To enforce, extend and integrate interoperability solutions deemed as promising in Europe and Japan, rather than proposing other possible interoperability standards

Reduction of expenditure for large scale IoT deployments

To reduce the cost of deploying large scale IoT infrastructure, including cross-border ones, providing IoT infrastructure-as-a-service.

Simplification of smart-city application development

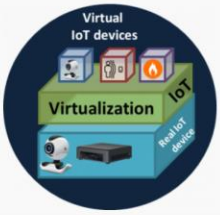
To simplify the access to cross-domain information coming from IoT and other city sources

A simple and programmable system for IoT application deployment

Simplify the deployment of IoT applications exploiting IoT device-level and cloud virtualization technologies

A market sustainable system

The Fed4IoT system is based on a federated pool of resource and information. The system should properly rewards IoT resource providers federating their resources



Design of novel IoT Virtualization and multi-tenancy technologies

Design of technologies for the emulation of IoT devices using real IoT devices and computing resources. Many IoT virtual devices can be based on the same real resources, which are however isolated form the user perspective (multi-tenancy).

Project Data

The **Fed4Iot project** is an Research and Innovation Action jointly funded by the European Commission (grant agreement n° 814918) and Japan's MIC

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Project start date:
July, 1, 2018

Project end date:
June, 30, 2021

Figure 6: Fed4IoT Objectives page

The Results page describes the main results of the project in several sub-sections (see figures below) which will be updated from time to time as contents will become available. The sub-sections are:

- Publications: shows the detail of scientific publications
- Standardization activities: shows the standardization activity (e.g. ITU, ETSI) of the project
- Deliverables: reports the project deliverables with a download link for public deliverables
- Dissemination: reports the dissemination activities including, conferences, workshops and fairs attendance; networking activities with organizations that are external to the Fed4IoT Consortium operating in the specific topic of the project; presentations held, posters, publication and press release realized in connection with Fed4IoT activities; collaborations established with expertise and projects similar to Fed4IoT topics and exploitable synergies; interesting events, Information and calls for the benefit of Fed4IoT objectives.
- GitHub

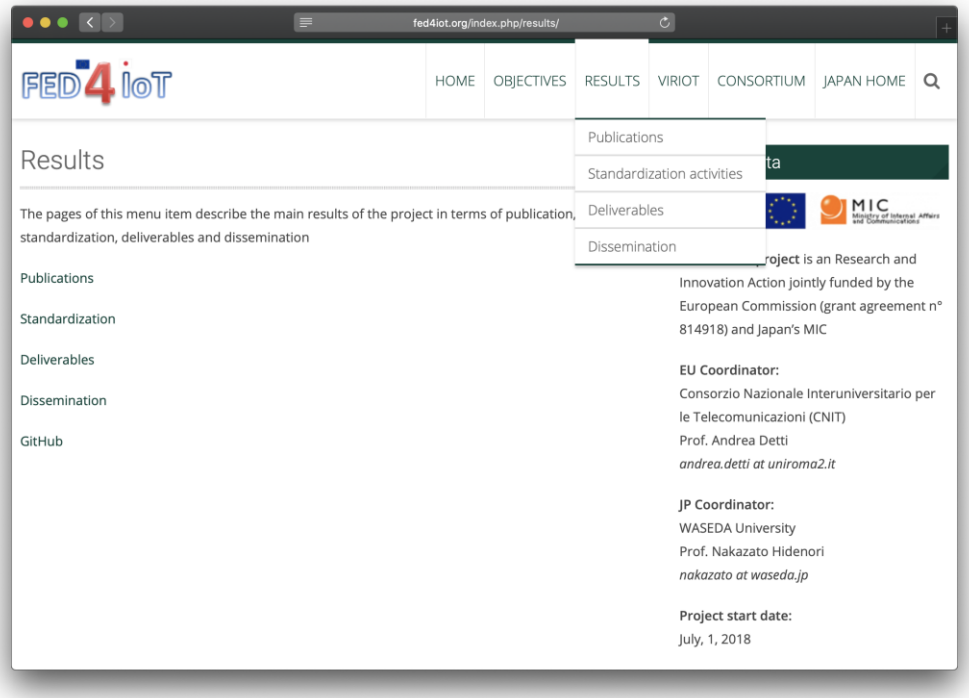


Figure 7: Fed4IoT Results page

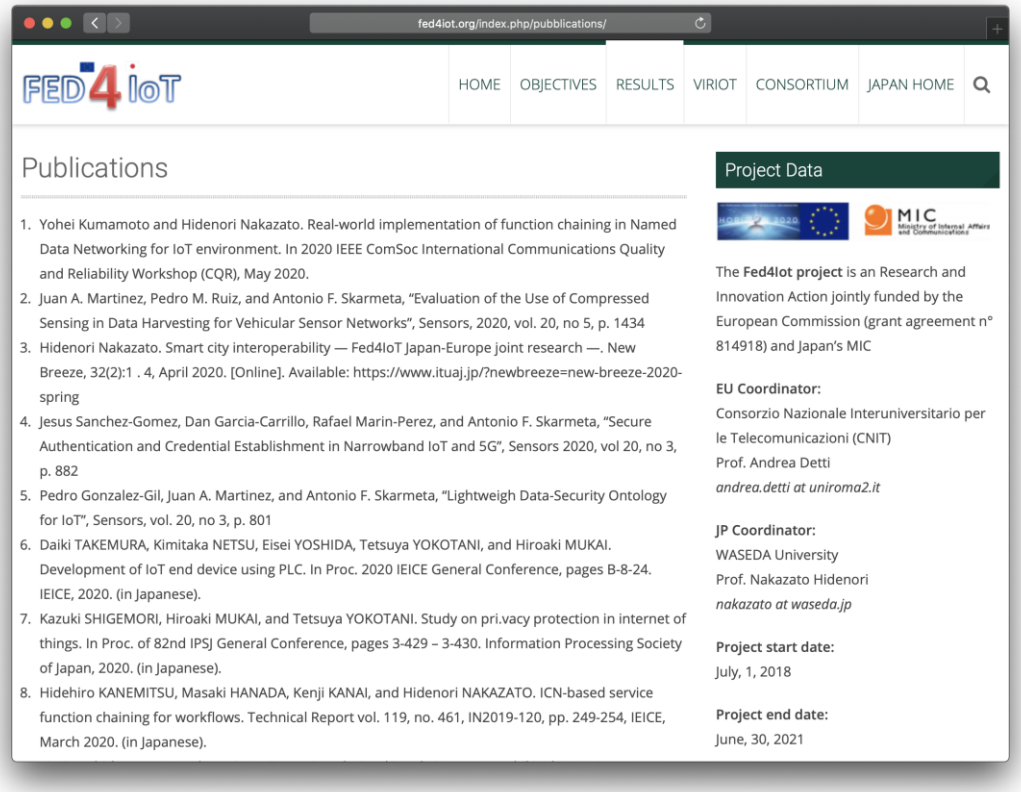


Figure 8: Fed4IoT Publications page

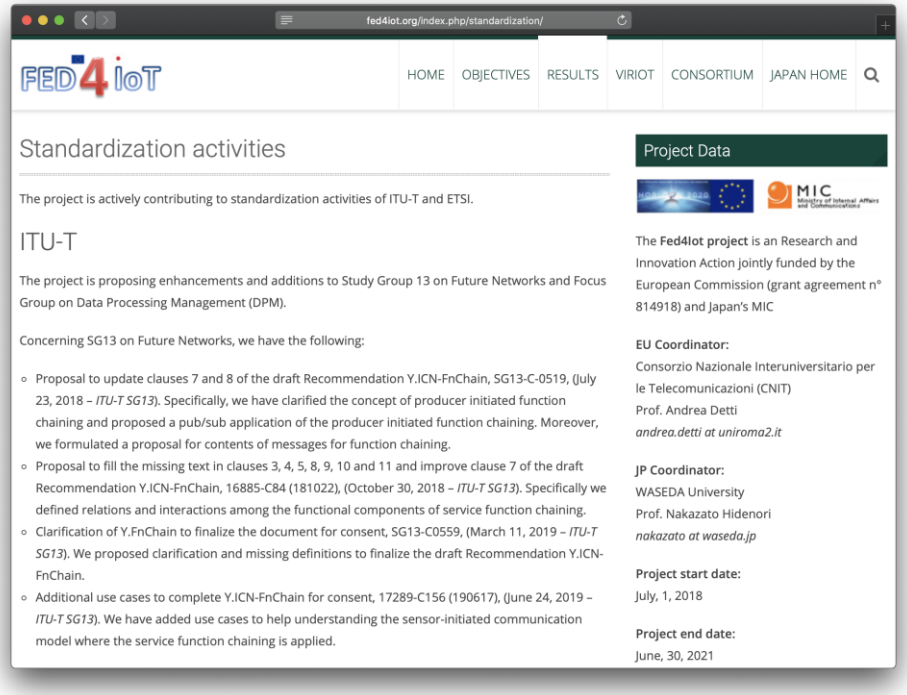


Figure 9: Fed4IoT Standardization activities page

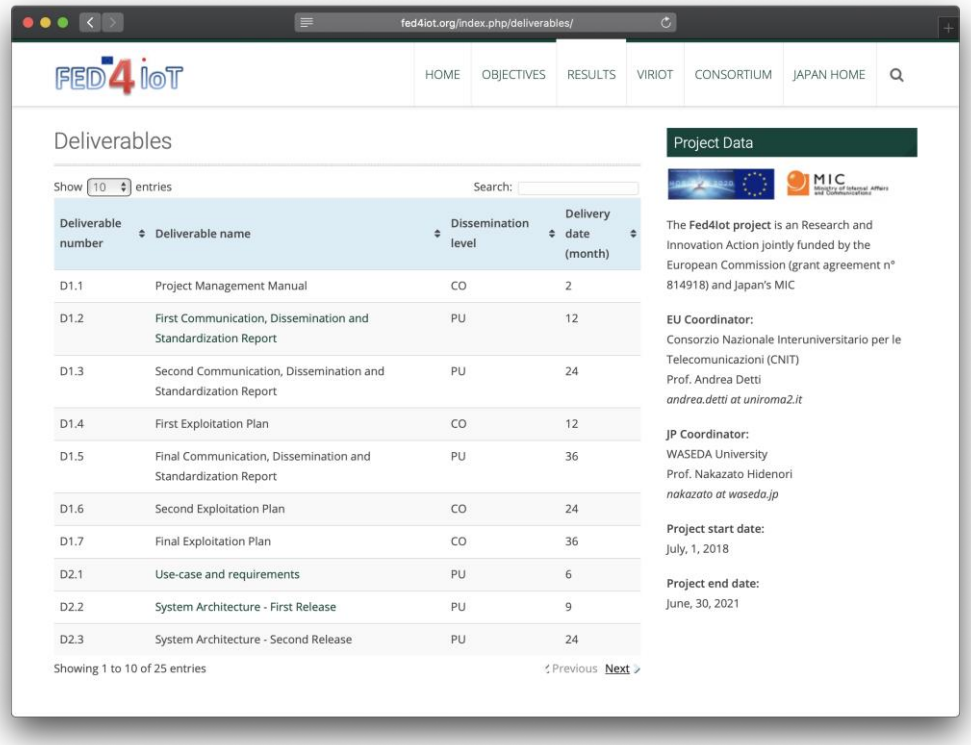


Figure 10: Fed4IoT Deliverables page

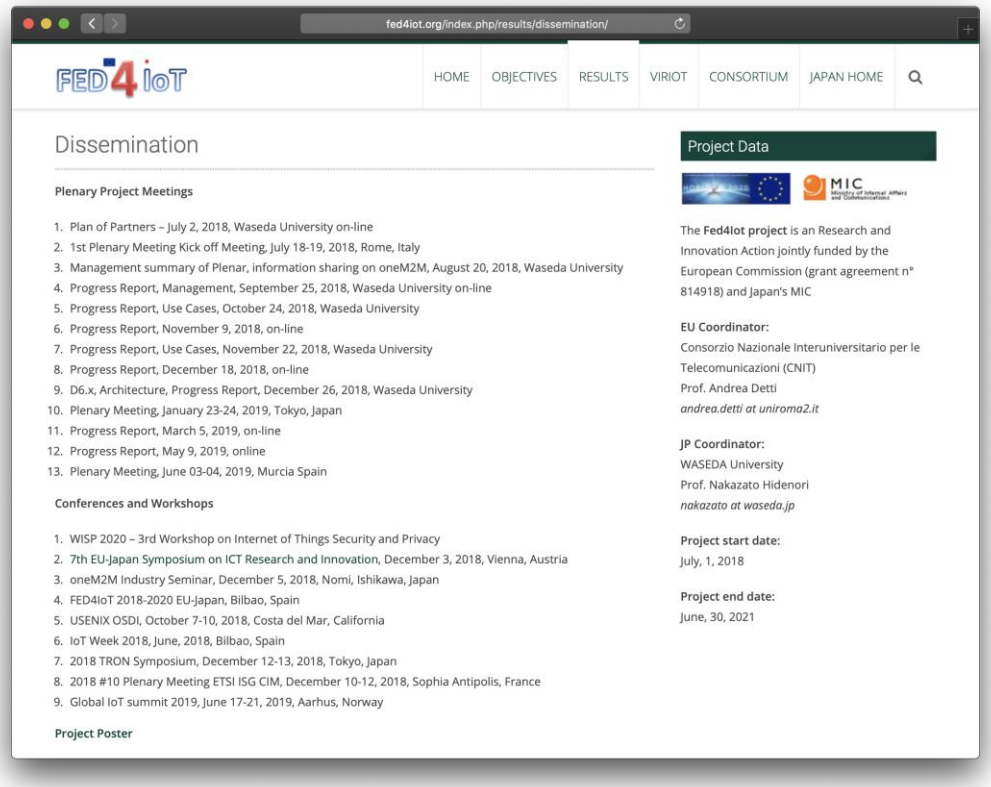


Figure 11: Fed4IoT Dissemination page

The VirIoT page shows a concise but to the point overview of the platform. Presenting also, a high level introduction to the main components and giving the reader further readings for a deeper analysis of the platform.

Figure 12: VirIoT Overview page

The Consortium page shows all the logos of the partners of the Consortium as a whole. Clicking on a logo there is the possibility to see the single pages dedicated to Partners' description and related Teams. All the partners provided their own institutional logos, organization profiles, expertise profiles and the pictures of single person involved in the project.

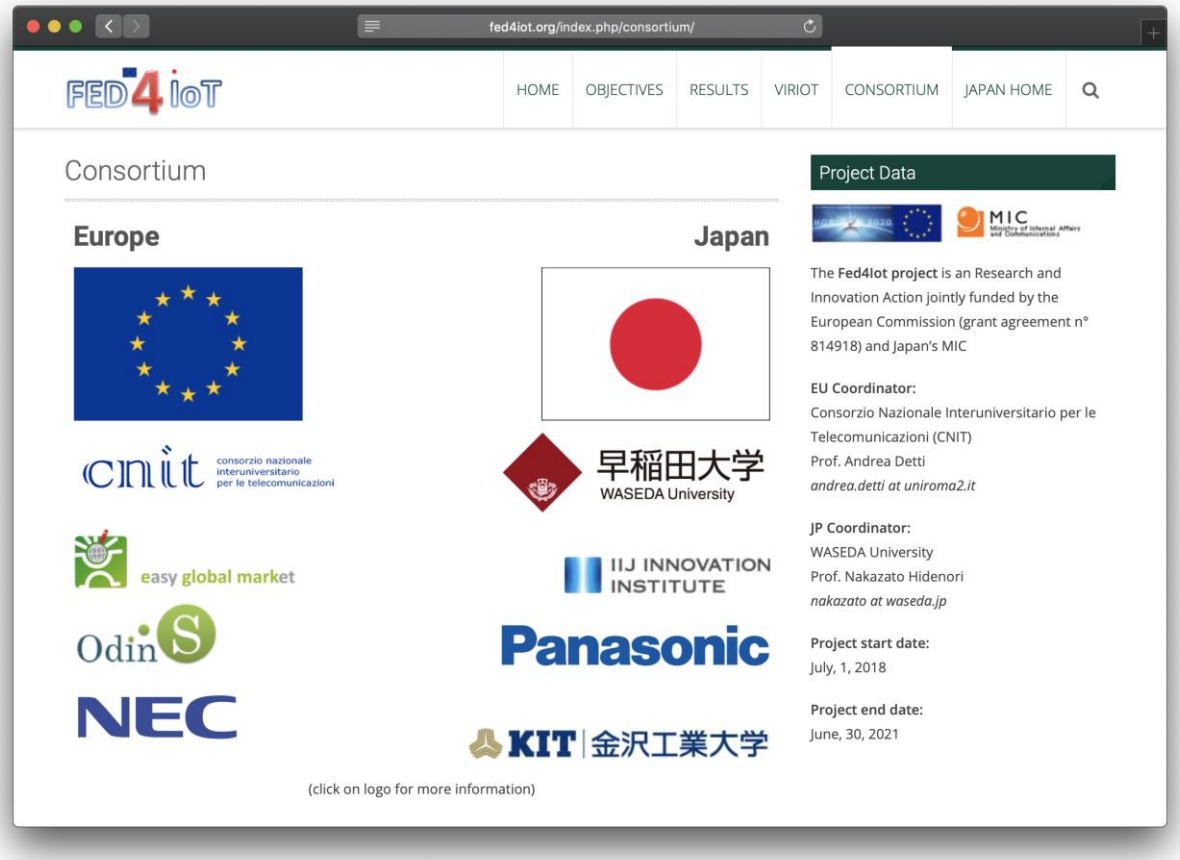


Figure 13: Fed4IoT Consortium page

Finally, the web site contains a Japanese version for improving dissemination in Japan.

Figure 14: Fed4IoT Japan home page

Project Management is responsible for designing, realizing, maintaining, and updating the web site. However, all partners are involved in content production and all partners will be asked to provide feedbacks, information, documents, news, or any other material they consider useful to disseminate progresses and results through the web site.

The maintenance activity consists of (at least):

- Periodic Backup of the website (monthly);
- Renewing of the domain name and hosting services (yearly);
- Traffic check (accesses, traffic sources, etc.) for security guarantee (monthly).

2.2.2.1 **Access Statistics**

We added the Google Analytics tracking code in the template of Fed4IoT website, enabling the tracking of statistics of the project's website. In this Deliverable we give a General Overview about analytic metrics in the period June 2019 – June 2020.

Google Analytics measured the Audience data shown in Figure 15. We observe that the 95.4 % of total visiting users (3253) are new ones demonstrating the spreading of the information towards

different persons. During the first year of the project we have had 1332 total visiting users, therefore in the second year of the project we achieved an increase of 244% visiting users.

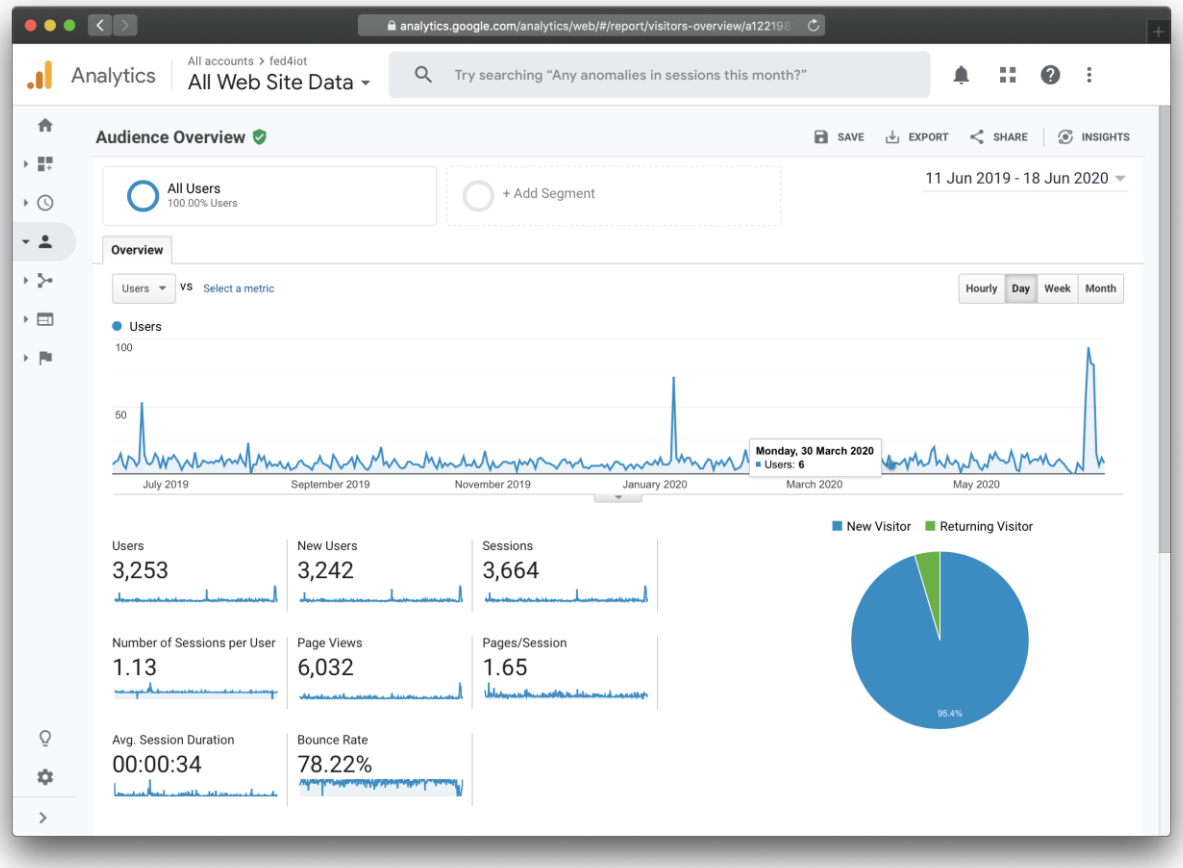
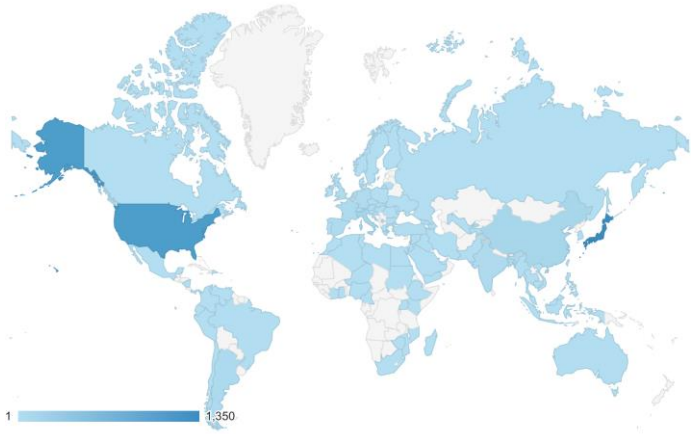


Figure 15: Audience Data

The picture below shows an analytics map about the number of accesses from different countries. We observe that most of the access comes from Japan, United States, and EU.



Country	Acquisition		
	Users	New Users	Sessions
	3,253 % of Total: 100.00% (3,253)	3,243 % of Total: 100.03% (3,242)	3,664 % of Total: 100.00% (3,664)
1. Japan	1,350 (41.42%)	1,346 (41.50%)	1,517 (41.40%)
2. United States	1,055 (32.37%)	1,054 (32.50%)	1,058 (28.88%)
3. Italy	131 (4.02%)	124 (3.82%)	292 (7.97%)
4. China	119 (3.65%)	119 (3.67%)	119 (3.25%)
5. Argentina	69 (2.12%)	69 (2.13%)	69 (1.88%)
6. France	50 (1.53%)	48 (1.48%)	58 (1.58%)
7. India	44 (1.35%)	44 (1.36%)	53 (1.45%)
8. Spain	39 (1.20%)	39 (1.20%)	47 (1.28%)
9. Germany	31 (0.95%)	30 (0.93%)	40 (1.09%)
10. United Kingdom	29 (0.89%)	30 (0.93%)	32 (0.87%)

Figure 16: User locations

The figure below shows pages with the best performing contents. The first most visited sub-page is the Japan Home page while the second-best performing contents have been the “Objectives” and the “Consortium” pages.

Page	Page Views	Unique Page Views	Avg. Time on Page	Entrances	Bounce Rate	% Exit	Page Value
	5,408 % of Total: 100.00% (5,408)	4,413 % of Total: 100.00% (4,413)	00:00:52 Avg for View: 00:00:52 (0.00%)	3,326 % of Total: 100.00% (3,326)	77.40% Avg for View: 77.40% (0.00%)	61.50% Avg for View: 61.50% (0.00%)	US$0.00 % of Total: 0.00% (US$0.00)
1. /	3,393 (62.74%)	2,861 (64.83%)	00:00:46	2,782 (83.64%)	79.40%	78.07%	US$0.00 (0.00%)
2. /index.php/japan-home/	443 (8.19%)	299 (6.78%)	00:00:49	215 (6.46%)	50.70%	35.89%	US$0.00 (0.00%)
3. /index.php/objectives/	216 (3.99%)	166 (3.76%)	00:00:33	20 (0.60%)	70.00%	21.30%	US$0.00 (0.00%)
4. /index.php/consortium/	182 (3.37%)	140 (3.17%)	00:00:18	6 (0.18%)	50.00%	20.88%	US$0.00 (0.00%)
5. /index.php/deliverables/	169 (3.12%)	118 (2.67%)	00:04:21	55 (1.65%)	66.67%	43.79%	US$0.00 (0.00%)
6. /index.php/pubblications/	154 (2.85%)	132 (2.99%)	00:01:20	25 (0.75%)	84.62%	48.05%	US$0.00 (0.00%)
7. /index.php/results/	126 (2.33%)	96 (2.18%)	00:00:04	12 (0.36%)	58.33%	11.90%	US$0.00 (0.00%)
8. /index.php/japan-home/results/	124 (2.29%)	65 (1.47%)	00:00:18	7 (0.21%)	28.57%	5.65%	US$0.00 (0.00%)
9. /index.php/publications/	89 (1.65%)	76 (1.72%)	00:01:24	29 (0.87%)	68.97%	41.57%	US$0.00 (0.00%)
10. /index.php/standardization/	83 (1.53%)	74 (1.68%)	00:00:50	24 (0.72%)	79.17%	45.78%	US$0.00 (0.00%)

Figure 17: Best performing contents

2.2.3 GitHub

The VirIoT platform is being developed as an open-source project to best improve collaboration and sharing of the project. Partners can share and build their own code directly to the GitHub repository. In this way, since the code is publicly available online, anyone can support and make suggestions to better develop the platform. Essentially, it makes a lot easier for a team to use Git for version control and collaboration. In addition, GitHub's interface is very user-friendly, so anyone can take advantage of Git. As a key component in the making of the platform, it has shortened the gap between collaborators, improving speed and flawlessly integrate new add-ons to better shape the final version of VirIoT.

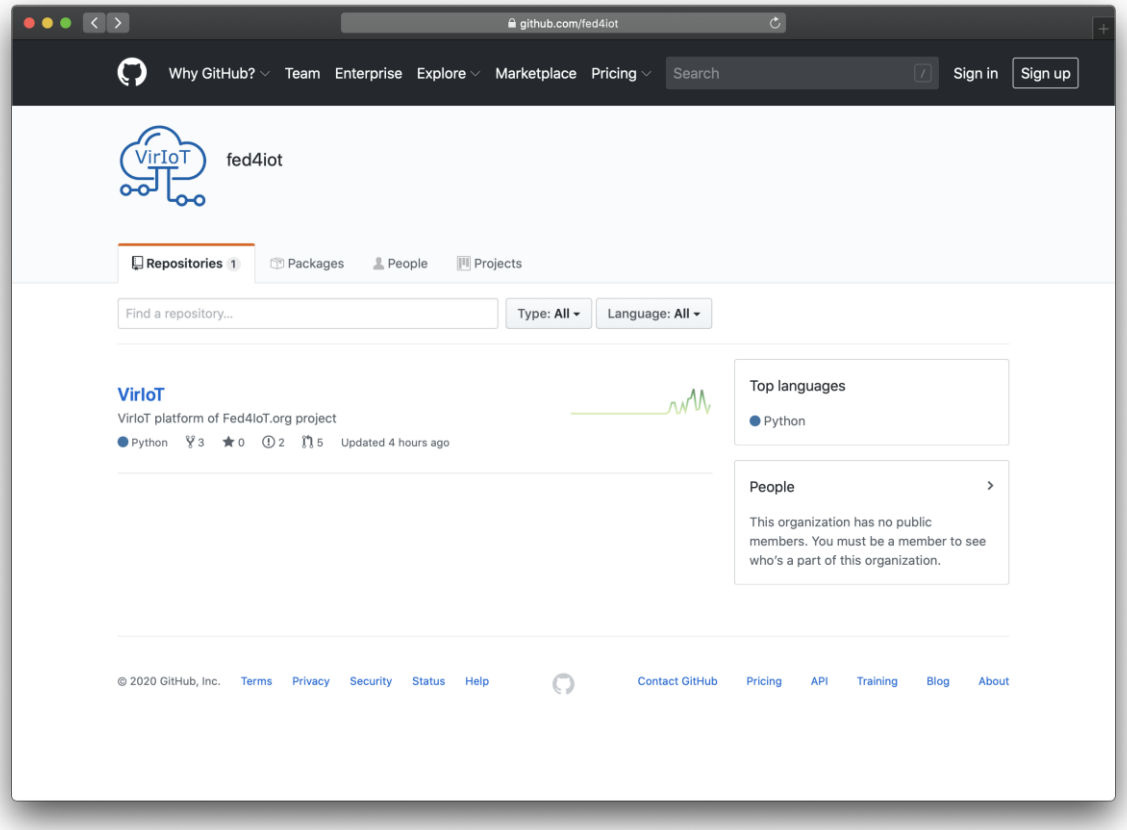


Figure 18: Fed4IoT GitHub organization

To reduce as much as possible any friction in the developing process, we are using Fed4IoT as an *organization* account instead of a regular user, so that owners and administrators can manage member access to the platform's data. We can see the organization GitHub page directly in Figure 18 with listed the VirIoT repository.

The VirIoT repository embraces the idea of modularity that comes over the developing of the platform. It has an organized structure, as we can see from Figure 19 below, each folder represents a main topic for developing purposes:

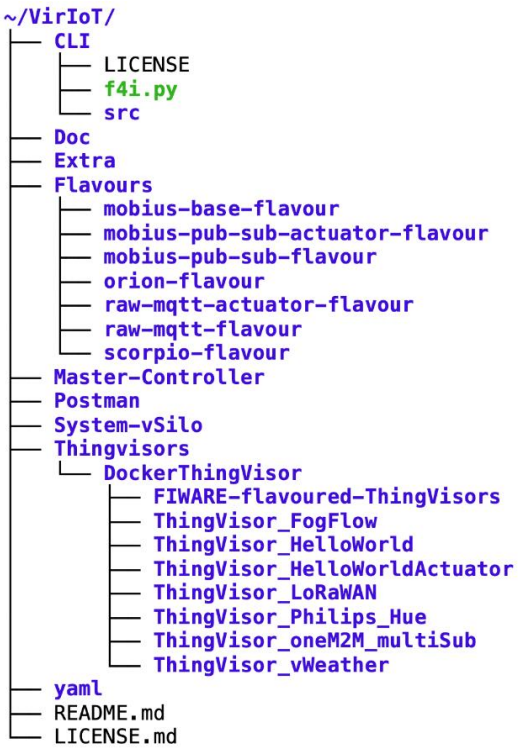


Figure 19: VirIoT GitHub repository structure

- CLI: The Command Line Interface directory
- Doc: contains documentation useful for the reader to give a better understating of the repository, e. g. deliverables, additional README files
- Extra: contains miscellaneous files
- Flavours: is the directory for developing of the vSilos flavours
- Master-Controller: for the developing of the Master-Controller
- Postman: contains the Postman collection
- System-vSilo: for the system vSilo developing
- ThingVisors: for the developing of the ThingVisors
- yaml: contains all the useful YAML files for the Kubernetes deployment

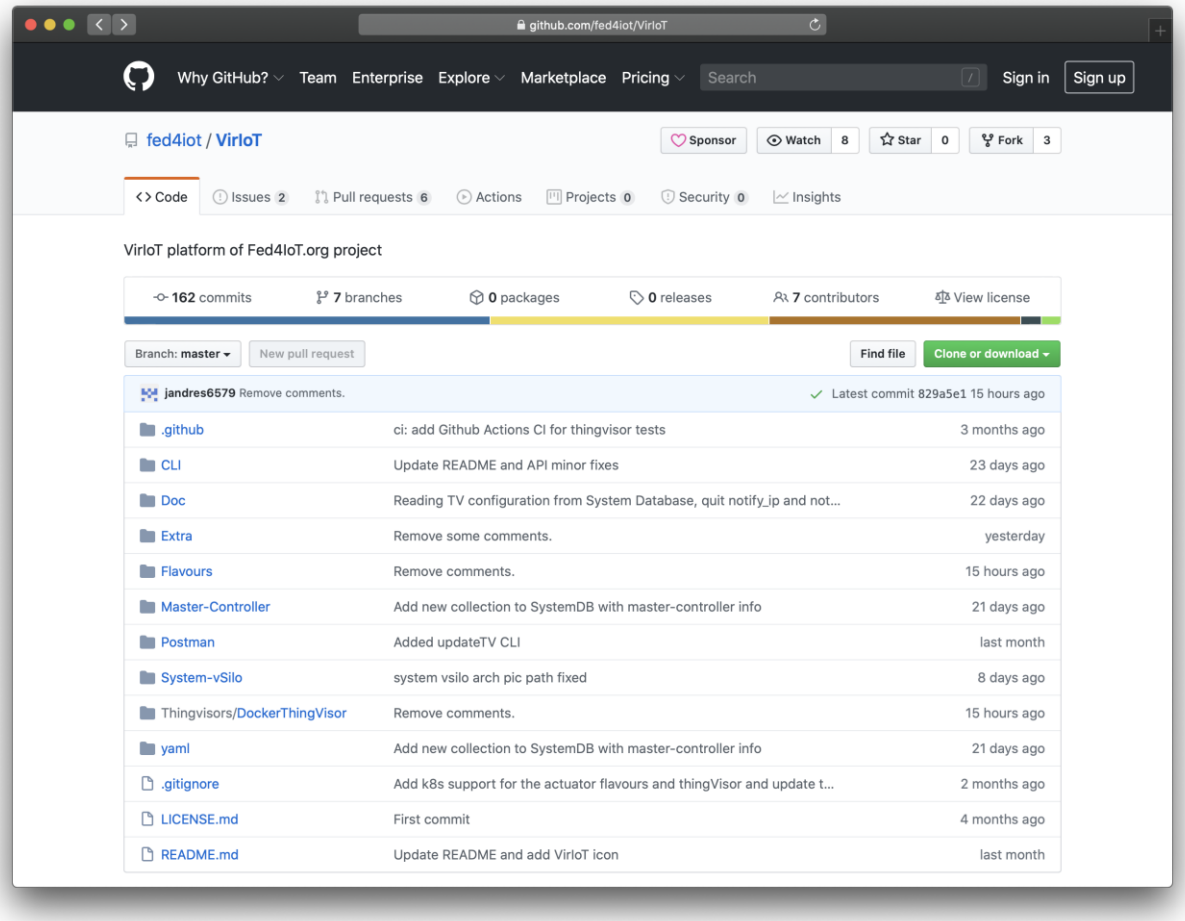


Figure 20: VirIoT GitHub repository

The first document that comes to the attention of the reader is the *README.md*, as we can see in Figure 22: VirIoT GitHub repository README. It consists in a concise and to the point description of the platform along with its logo. At the beginning of the document, we can see two GitHub badges: *k8s CI* and *Docker CI*. The badges help increasing the readability of the README file, they show whether a workflow is currently failing or passing. GitHub Actions makes it easy to automate the software workflows, following a GitHub event, like the push of the latest commit on the master branch. In this case they help both the developer as well as the readers, to get a clear idea of the validity of the latest commit, as a matter of fact, in just a glance, it can be checked if the Kubernetes or the Docker tests have been successfully passed the preliminary tests.

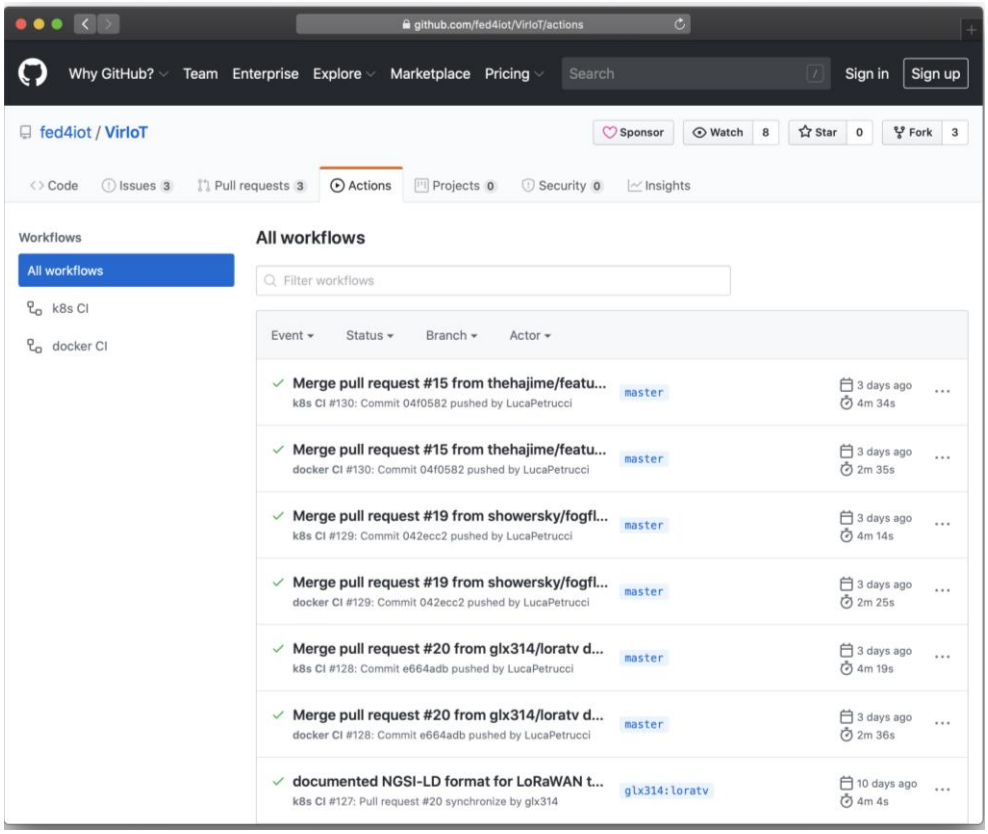


Figure 21: GitHub Action: Kubernetes CI and Docker CI

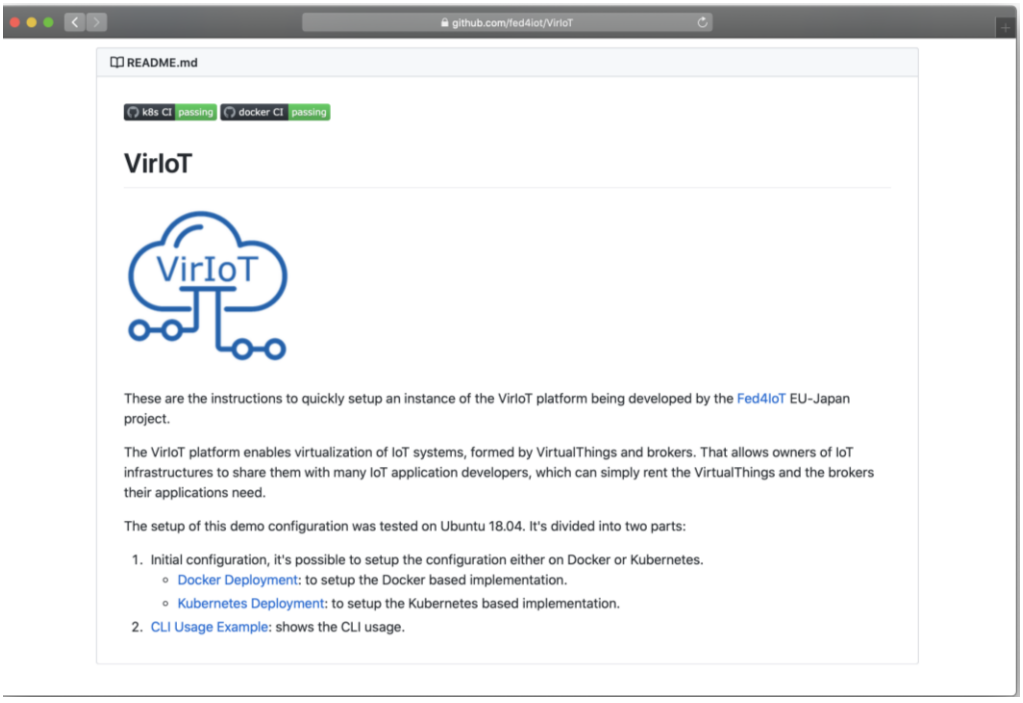


Figure 22: VirIoT GitHub repository README

The README has the purpose of a guide, an introduction to the platform for the reader. As a matter of facts, it describes, step by step, the key commands for putting the deployment up and running. In particular, it can be performed following one of the two ways: Docker or Kubernetes, as we can see in Figure 23: Two different ways for the deployment of the VirIoT platform: Docker (left) and Kubernetes (right).

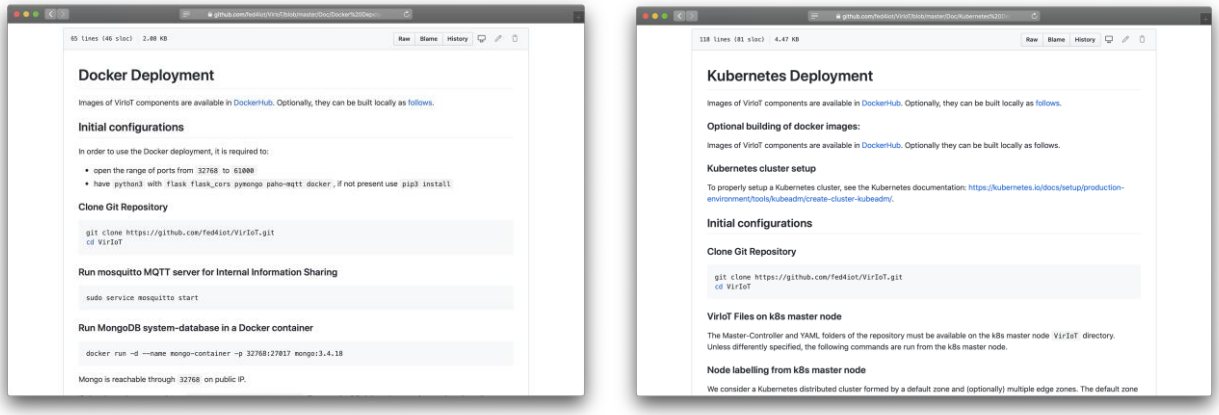


Figure 23: Two different ways for the deployment of the VirIoT platform: Docker (left) and Kubernetes (right)

After the initial configuration is completed, the reader can now use the Command Line Interface to interact with the VirIoT platform, either if the implementation is on Docker or Kubernetes. Figure 24: README of Command Line Interface shows the CLI page.

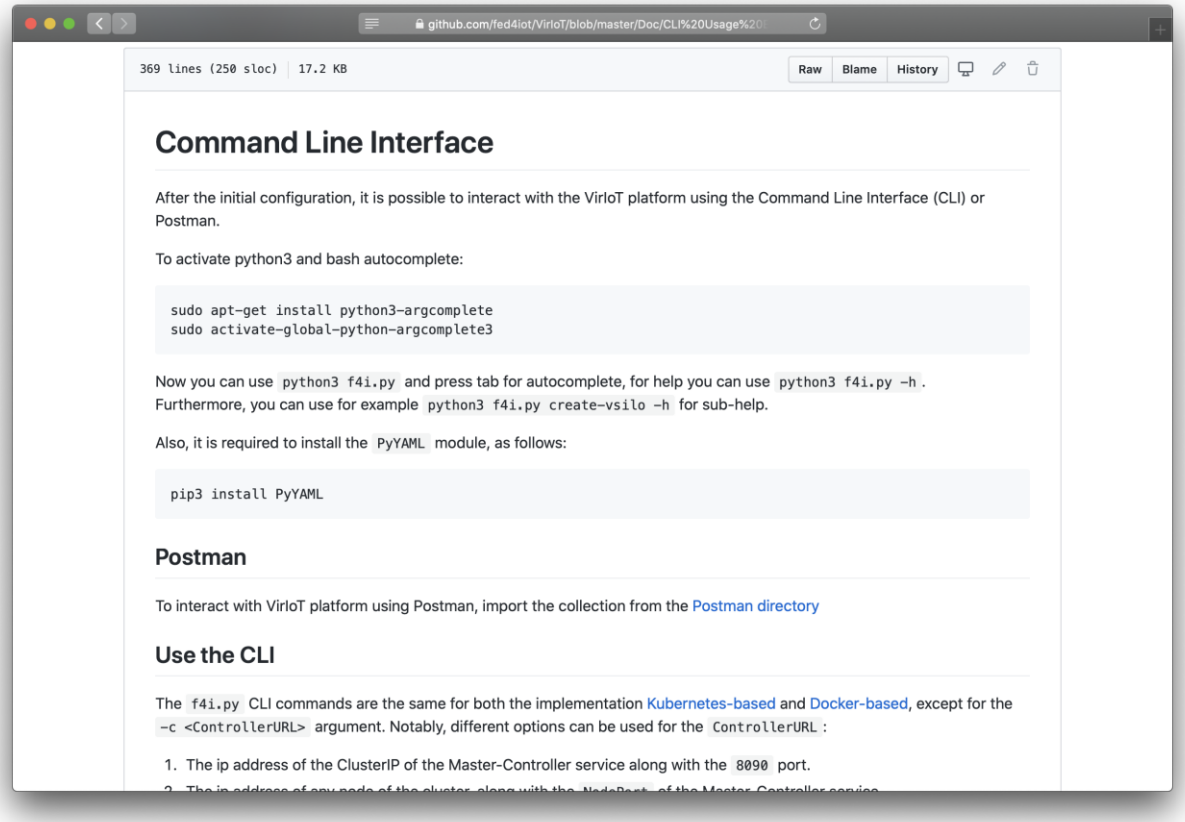


Figure 24: README of Command Line Interface

Each module that can be containerized, has its own README located in its directory. The latter has a similar structure for all the alike components. This is to give an easier understating and self-explanatory instructions across the whole repository. An example is given in Figure 25: README of the Weather ThingVisor for the *Weather* ThingVisor as well as Figure 26: README of the Raw MQTT Actuator vSilo for the *Raw MQTT Actuator* vSilo. The structure is the following: a *brief introduction* of the tool, a *How to run* section for the deployment: Docker or Kubernetes, an *NGSI-LD data model* section for clarifications on the structure of the information used by the tool itself.

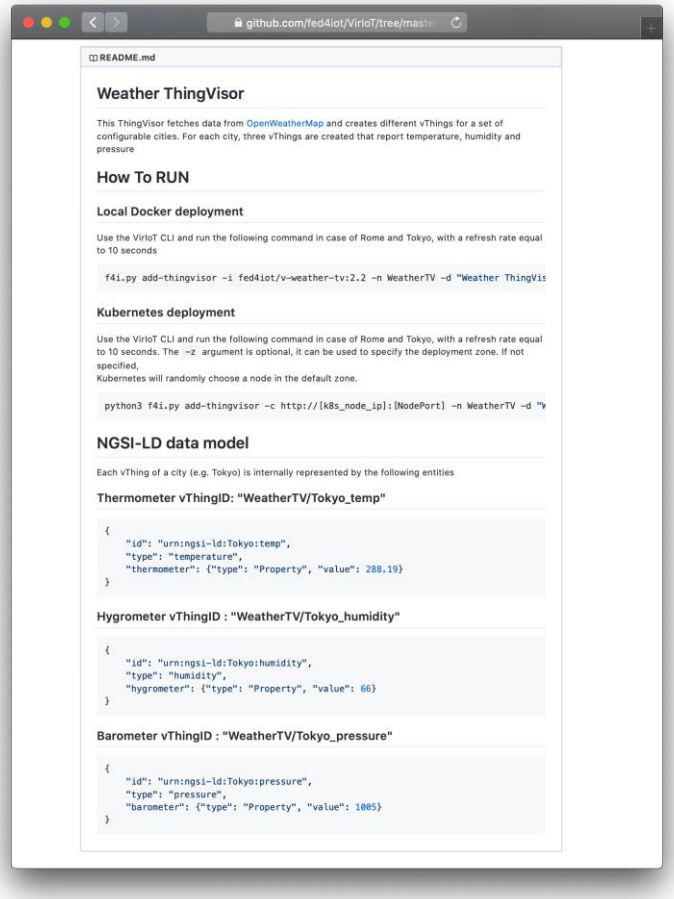


Figure 25: README of the Weather ThingVisor

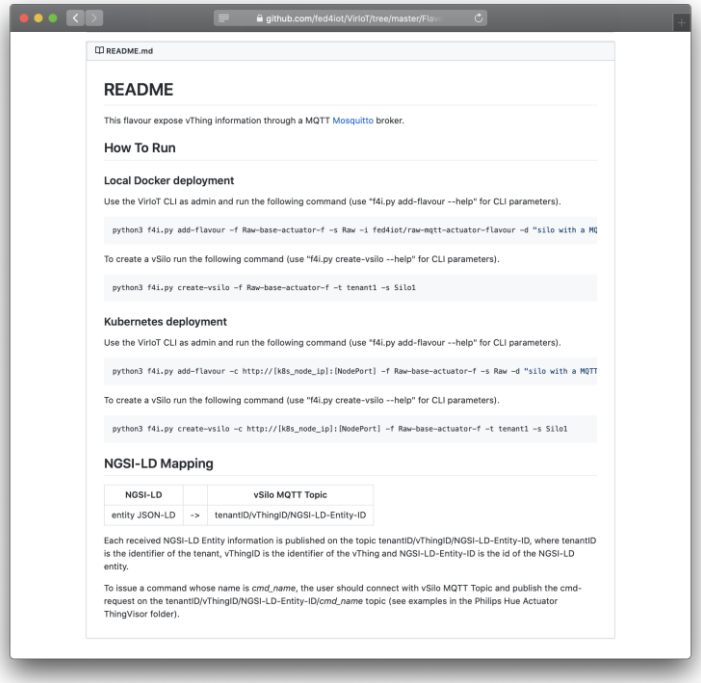


Figure 26: README of the Raw MQTT Actuator vSilo

2.2.4 Project publications

Fed4IoT partners carried out, since the beginning of the project, 39 publications listed in the following table. Details on each publication are provided in Annex 1.

Table 3: Synthesis of project publications

Type	Conference Journal Book Chapter	Title	Partners	Publication Date
Journals / Magazines	New Breeze	Smart city interoperability -- Fed4IoT Japan-Europe joint research --	WAS	04/2020
	Sensors	Evaluation of the Use of Compressed Sensing in Data Harvesting for Vehicular Sensor Networks	OdinS	03/2020
	Sensors	Secure Authentication and Credential Establishment in Narrowband IoT and 5G	OdinS	02/2020
	Sensors	Lightweight Data-Security Ontology for IoT	OdinS	02/2020

	IEEE Access	Exploiting Information-Centric Networking to Federate Spatial Databases	CNIT	11/2019
	IEEE Transactions on Network and Service Management	Sub-linear Scalability of MQTT Clusters in Topic-based Publish-subscribe Applications	CNIT	06/2020
Conference Papers / Reports	2020 IEEE CQR	Real-world implementation of function chaining in Named Data Networking for IoT environment	WAS	05/2020
	IEICE Technical Report	ICN-based service function chaining for workflows	WAS	03/2020
	IEICE Technical Report	ThingVisor Factory for Things as a Service and IP and ICN-based Things sharing architecture	WAS	02/2020
	IEICE Technical Report	End.to-end response time evaluations in centralized and distributed IoT data sharing model	WAS	02/2020
	2019 IEEE ISM	Performance evaluations of viewport movement prediction and rate adaptation for tile-based 360-degree video delivery	WAS	05/2019
	IEICE Technical Report	Optimal service function allocation method for IoT device virtualization	WAS	12/2019
	IEICE Technical Report	Design of NDN-FC using virtual environment by Docker	WAS	11/2019
	IEICE Technical Report	Research development of Fed4IoT platform for Things as a Service.	WAS, KIT, PAN	10/2019
	IEICE Technical Report	Clustering-based service function scheduling algorithm for service function chaining.	WAS	09/2019
	2019 IEICE Society Conference	Applicability of ICN protocol for interoperability of smart cities	WAS, PAN, KIT	09/2019
	2019 IEICE Society Conference	Performance evaluations of rate adaptation methods for tile-based 360-degree video delivery	WAS	09/2019

	2019 IEICE Society Conference	Performance evaluations of daily moving behavior by using biometric sensors	WAS	09/2019
	2019 IEICE Society Conference	End-to-end delay evaluations of micro service in various IoT resource environments	WAS	09/2019
	IEEE CLOUD 2019	A function clustering algorithm for resource utilization in service function chaining	WAS	07/2019
	2019 Global IoT Summit (GIoTS)	Review of Standard Ontologies for the Web of Things	EGM, CNIT	06/2019
	The 44th IEEE Conference on Local Computer Networks (LCN'19), demo paper	Intent-based Fog Computing with FogFlow	NEC	10/2019
	he 4th International Symposium on Mobile Internet Security (MobiSec'19) ,	EAP-based bootstrapping for secondary service authentication to integrate IoT into 5G networks	OdinS	10/2019
	2019 IEEE Global Communications Conference (GLOBECOM)	MEC-assisted End-to-end 5G-Slicing for IoT	OdinS	12/2019
	IEICE Technical Report	Development of a Root Data Domain Gateway to Provide Interoperability of IoT Data	KIT, WAS	07/2020
	IEICE Technical Report	MQTT distributed broker architecture for IoT services	KIT	07/2020
	IEICE Technical Report	Development of IoT end device using PLC to realize various functions	KIT	02/2020

	IEICE Technical Report	Target counter with direction tracking	KIT	02/2020
	IEICE Technical Report	IoT devices management for outdoor wireless sensor networks	KIT	02/2020
	IEICE Technical Report	IoT Networks using MQTT for Wildlife Monitoring System	KIT	07/2019
	IEICE Technical Report	Concept for and Application to Wildlife Monitoring to Contribute Sustainable Development Goals	KIT	07/2019
	IEICE General Conf.	Development of IoT end device using PLC	KIT	03/2020
	IPSJ National Convention	A study on privacy protection in IoT	KIT	03/2020
	12nd Int. Conf. on Future Computer and Communication (ICFCC)	Concept for and Application to Wildlife Monitoring to Contribute Sustainable Development Goals	KIT, WAS	02/2020
	IoT Enabling Sensing/Network/AI and Photonic conference (IoT-SNAP 2020)	Development of a Root data Domain Gateway to provide interoperability of IoT Data	KIT, WAS	04/2020 (Although paper was accepted, the conference was cancelled because of COVID-19)
	The 34th Int. Conf. on Information Networking (ICOIN 2020)	Proposal of MQTT distributed broker control mechanism	KIT	01/2020
	International Japan-Africa Conf. on Electronics, Communications and Computer	An ICN system focusing on distributed MQTT Brokers for IoT service	KIT	12/2019

	(JAC-ECC 2019)			
	The 2019 Int. Conf. on Internet of Things and Intelligent System (IEEE IoTais 2019)	Implementation of IoT Networks based on MQTT for Wildlife Monitoring System	KIT	11/2019
	2019 Int. Conf. on Innovation and Intelligence for Informatics, Computing, and Tech.(3ICT)	Concept for and Implementation of Wildlife Monitoring to Contribute Sustainable Development Goals	KIT	09/2019

2.2.5 Events

This section presents the participation of Fed4IoT partners in various events during the second year of the project. The Table 4 provides a synthetic view of the events whereas details are provided in the forthcoming sections.

Table 4. Participation in events.

Category	Event	Partner	Venue	Date
Big scale community Event	Exhibition booth in Smart IoT Acceleration Forum, IoT International Symposium 2020	WAS		27/3/2020 (Event cancelled due to COVID-19)
	Exhibition booth and tutorial talks on FogFlow at FIWARE Summit	NEC	Berlin, Germany	23~24, October, 2019
	Invited talk at IEEE World Forum on The Internet of Things (WF-IoT 2020)	NEC	New Orleans, USA	5-9 April 2020 (Event cancelled due to COVID-19)

	3rd Workshop on Internet of Things Security and Privacy (WISP) (in conjunction with Global IoT Summit 2020)	OdinS	Online	2nd June, 2020
	Presentation on Fed4IoT at FIWARE Summit	CNIT	Berlin, Germany	23~24, October, 2019
Small scale focused events	Meeting with territorial officers from Département des Pyrennées Orientales	EGM	Montpellier, France	22/01/2020
	Italian Networking Workshop	CNIT	Cavalese, Italy	29-31, January, 2020

2.2.5.1 **FIWARE Summit**

CNIT and NEC participated to the FIWARE summit in Berlin 23~24, October 2019. Andrea Detti (CNIT) presented the concepts of IoT Virtualization and VirIoT architecture of Fed4IoT.

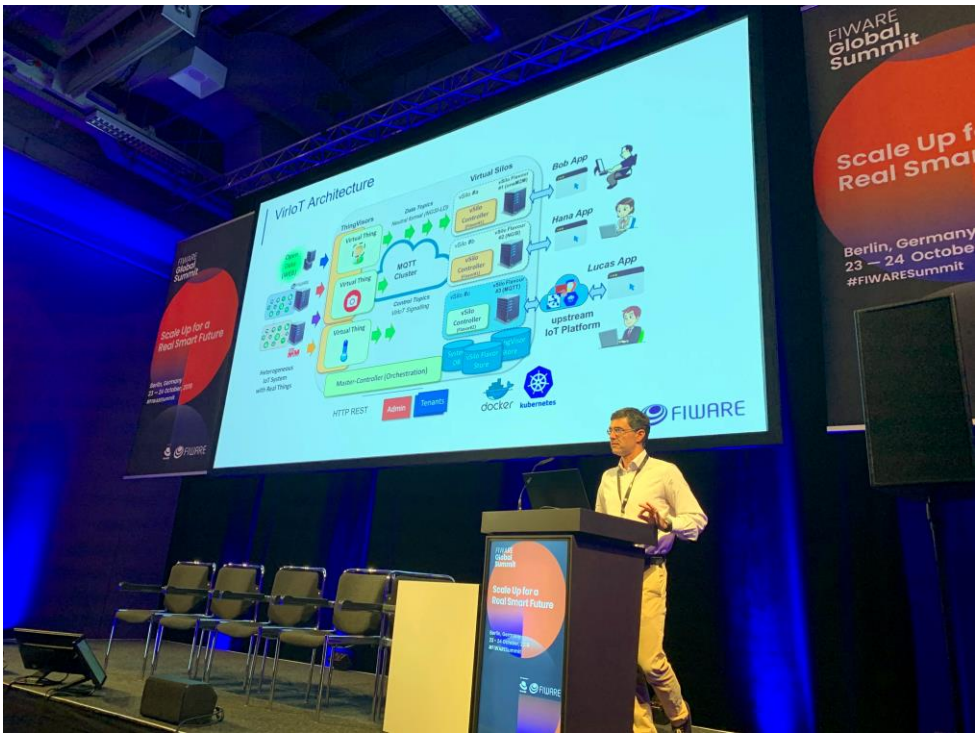


Figure 27: Andrea Detti presentation at FIWARE summit

NEC presented FogFLow as a poster at their FIWARE booth (see Figure 28: FogFlow Poster at NEC booth) and Bin Cheng gave a presentation on *FogFlow: Intent Based Edge Programming* in the FIWARE developer track, showing how to use intent-based edge programming, which is at the centre of realising the FogFlow-based ThingVisor in Fed4IoT.

Figure 28: FogFlow Poster at NEC booth

2.2.5.2 **WISP**

OdinS, has participated in the organizing comittee of the 3rdWorkshop on Internet of Things Security and Privacy (WISP) in conjunction with Global IoT Summit 2020 with the support of the Fed4IoT project among others. It has been presented in an online manner.

Figure 29: WISP workshop announcement

2.2.5.3 **Département des Pyrénées Orientales**

EGM met some local government officers, in charge of the roads and transportations of the "Département des Pyrénées Orientales". In particular, the smart camera with illegal waste deposit detections and carpooling parking monitoring use cases were presented. The contact is firmly established to deploy one of these use cases on a site they own.

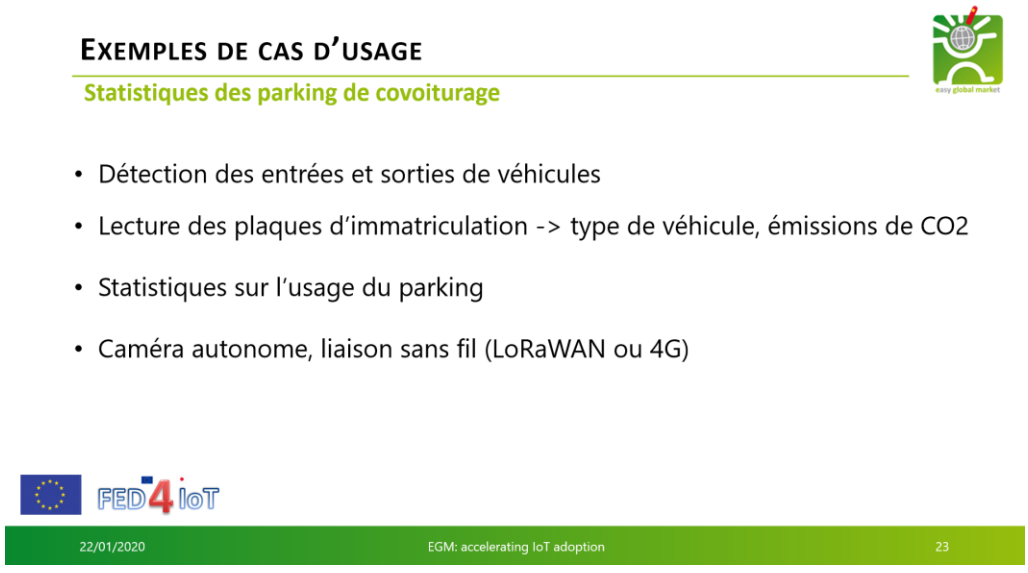


Figure 30: One slide of the presentation done for "Département des Pyrénées Orientales"

2.2.5.4 Italian Networking Workshop 2020

Andrea Detti participated to the Italian Networking Workshop (INW2020), an annual workshop that provides a forum to present recent and original work in various areas of telecommunication networks, mainly attended by Italia researcher. During the workshop, Andrea Detti presented the concept IoT system-as-a-service and the Fed4IoT VirIoT architecture that implements it.

Figure 31: First slide of Andrea Detti presentation at INW2020

2.2.6 Education and Academic dissemination activities

2.2.6.1 Smart SE consortium

On 26th June 2019, Kenji Kanai attended the Kick-off symposium of Smart SE consortium. Smart SE consortium is the education program for fostering innovative professional engineers about Smart Systems and Services and established by Waseda University. In the Kick-off symposium, Kenji Kanai provided a poster and a presentation about introducing the Fed4IoT project. About 120 people from Academia and Industry participated.

Figure 32 : Poster of Fed4IoT project in Smart SE consortium.

2.2.6.2 **Best Lesson**

Andrea Detti has been invited to have a lesson on IoT for BEST, Board of European Students of Technology a non-profit and non-political organisation providing communication, co-operation, and exchange possibilities for students all over Europe. Andrea Detti presented IoT technology from physical layer up to the cloud and eventually introduced the concept of IoT Virtualization of Fed4IoT.

Figure 33 : First slide of Andrea Detti BEST lesson

2.2.6.3 **Workshop proposals**

A workshop proposal has been submitted and accepted to ACM SenSys 2020, which will be held in Yokohama, Japan in November 16-19, 2020. This proposal is shown on Figure 34.

ACM SensSys 2020 Workshop Proposal: Cloud Continuum Services for Smart IoT Systems

1 Scope and Topics

Internet of Things (IoT) is one of the hottest topic in the field of communications and computing. Many cloud providers offers cloud/edge services for IoT, to handle big data, to apply AI technologies, to support massive IoT devices, and to provide low-latency control. At the same time 5G cellular networks have Massive IoT as reference scenario, for which a huge number of smart sensors/actuators must be connected with low latency. Cloud and edge computing on the one and 5G on the other hand push for an IoT cloud continuum aimed at simplifying the integration, development and delivery processes of future, cloud-native, IoT applications, also considering related security and privacy issues.

There are many alternatives for cloud and networking services and technologies in forming cloud continuum for IoT. The objectives of this workshop are to create a forum for researchers and practitioners to discuss issues in applying cloud/edge computing and AI technologies to IoT systems, in networking IoT devices and federating IoT systems, and in development of IoT services exploiting the computing and networking capabilities of IoT systems, and to set a direction in forming a cloud continuum where IoT systems work together towards well-being of humankind.

The topics include, but are not limited to:

- Cloud/edge computing platforms and services for IoT applications
- Continuum computing and IoT
- Cloud-native IoT applications
- Performance evaluation of IoT cloud and networking platforms
- Light virtualization technologies for constrained devices
- Application of machine learning and AI in cloud-native IoT systems
- Testbeds, prototypes, and field trials of smart IoT systems, including smart city, agriculture, metering, safety, health, etc.
- IoT security and privacy of IoT devices and services
- Security protocols for IoT in 5G
- Blockchain-based IoT applications
- 5G Networks, IoT and Tactile Internet
- Network services for massive IoT
- Application of Information Centric Networking in IoT applications

2 Workshop Organizers

- **Name:** Antonio Skarmeta
  Affiliation: University Murcia/OdinS
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  3-14-9 Ohkubo, Shinjyuku-ku, Tokyo 169-0072, Japan

Figure 34: Text of the ACM SenSys workshop proposal

3 Standardization activities

During its second year of activity, Fed4IoT has strongly contributed to standardization activities within ETSI and ITU-T.

3.1 Overall strategy

The applied strategy adopted this year is the same as the one applied before, which was extensively described in deliverable D1.2. We continued to base our research on the concept of a standard and open sourced platform architecture. We still commit to have our requirements, concepts, and frameworks in *de jure* standards (ISO, ITU, ETSI, …) to try to maximise outreach and worldwide impact of Fed4IoT while continuing to use conventional *de facto* standards to fetch out technical ideas, solutions, and technologies in order to complement what we do in Fed4IoT.

In the following sections we describe our contributions to standardisation activities for ETSI (section 3.2) and ITU-T (section 3.3).

3.2 ETSI contribution

Fed4IoT, through several partners of the consortium (NEC, CNIT, EGM, OdinS), is part of the ETSI Industry Specification Group for cross-cutting Context Information Management (ETSI ISG CIM).

ETSI ISG CIM (visit page here) is a group of more than 30 different organizations that is publishing the NGSI-LD Specification, an open API and data model for applications to publish, discover, update and access context information for smart cities and other areas, which evolves FIWARE's NGSIv2.

Fed4IoT exploits NGSI-LD as a "neutral format", able to capture the structure and semantics of all other data formats used within the project's Root Data Domain. Furthermore NGSI-LD Brokers developed by NEC and EGM are used in Fed4IoT's platform, both as NGSI-LD vSilos and as System vSilos. Of course, we also promote usage of NGSI-LD systems directly in the Root Data Domain, so as to easily implement ThingVisors that seamlessly make information available in our IoT Virtualization Platform, without intermediate translations, producing data in the "neutral format", directly.

In the following we list all major CIM Work Items, and what active contribution we are bringing in, or working on.

ETSI GS CIM-009 v1.2.2 – NGSI-LD API (published February 2020, [download here])

This is the NGSI-LD API specification work item. Overall, this API evolves the former OMA NGSI 9 and 10 interfaces, and FIWARE NGSIv2, to incorporate the latest advances from Linked Data. CNIT is now the new Rapporteur of this Work Item, and next version v1.3.1 of the standard is going to

be published in the second half of 2020. Several novel features have been brought into this upcoming version:

- Capability to list what entity types and attributes are currently available in the system
- POST-based querying
- Notifications via MQTT
- Array-based representation of Multi-Attributes
- Multi-tenancy support
- Support of full GeoJSON results
- Temporal aggregation functions
- Allow for additional Headers (Authorization, Bearer) in notifications
- More flexible query syntax

Moreover, Fed4IoT is taking an active part in driving the process of publication, and in scheduling the roadmap of new versions of the standard.

ETSI GS CIM-006 – Information Model (published July 2019, [download here])

This is the Information Model specification work item. It defines a cross-domain data model compatible with the NGSI-LD API. We contributed to the definition of the "system composition" concepts.

ETSI GR CIM-008 – NGSI-LD Primer v1.1.1 (published March 2020, [download here])

This is the NGSI-LD Primer report work item. It explains, through examples, the usage of the NGSI-LD information model and API, essentially giving a more easily accessible introduction to NGSI-LD for developers. NEC is Rapporteur for this Work Item, and we have extensively revised it. We are now working on adding more advanced functionality examples.

ETSI GR CIM-007 – Security and Privacy (still working draft)

This is the Security and Privacy report Work Item. It deals with security and privacy issues concerning the API, the platforms, and the context data items themselves. OdinS is Rapporteur for this Work Item. We are focusing on how to address security and privacy aspects when using NGSI-LD in different deployment settings. In this regard, we have considered different sorts of scenarios, ranging from single-domain ones, up to distributed or federated ones. Since security is a very wide research area, we have identified precise topics relevant to the scope of NGSI-LD. We have considered authentication and access control, which are very common, but we have also considered other aspects such as confidentiality and even identity management, incorporating contributions about that in the current working draft. Furthermore, we have introduced several new use cases and a use-case matrix to synthesise the relevant requirements. Finally, we have started to look into existing standardization initiatives that support the idea of capturing in machine-readable format the regulatory policies and restrictions coming from the GDPR, such as the Open Digital Rights Language (ODRL) with its ODRL Regulatory Compliance Profile, and the

W3C Data Privacy Vocabulary Draft Community Group Report and the DPVCG GDPR Legal Basis Vocabulary. Our goal is to investigate the various strategies for expressing consent to processing of personal data, and for matching of said consent against data available in the IoT brokers.

New Work Items and Additional Activities

Further, a new Work Item named GR CIM-010 has been opened with the support, among others, of all Fed4IoT partners that participate ETSI CIM, i.e. CNIT, EGM, NEC, OdinS. This WI is devoted to NGSI-LD interworking, including with oneM2M, W3C WoT, and other systems. We will focus on the interworking with oneM2M, and CIM has already held a joint workshop with ETSI TC Smart M2M, showing a NGSI-LD Federation Demo based on Scorpio and fostering discussion about use of SAREF together with NGSI-LD.

Additionally, we have supported the creation of a TTF (Testing Task Force) on NGSI-LD testing in ETSI. The TTF reserves some funding for a group of experts to specify test cases and a testing environment for the API, because ETSI ISG CIM wants executable test cases to serve the open source ecosystem. The call for experts went through in March 2020, and activity of this TTF has officially started in May 2020, and it is led by EGM. ISG CIM has structured the TTF activity into several Work Items, as follows:

- NGSI-LD Testing Framework
- NGSI-LD Test Suite Structure
- NGSI-LD Test Purposes Specification
- NGSI-LD Test Suite
- NGSI-LD Testing Environment Validation

Also, a novel Work Item on Digital Twins has been started, which Fed4IoT partners in ISG CIM fully support. EGM is going to be Rapporteur for this Work Item. The WI is officially registered as GR CIM-017 [download here], the ToC of is fully agreed, and it identifies the various characteristics of Digital Twins in areas of representing human actions, or in health/biological areas, for smart manufacturing, etc, and it considers the usage of the NGSI-LD information model and API for realising such systems. Fed4IoT will contribute to this document during the second half of 2020.

Finally, a Whitepaper on best-practices for using NGSI-LD when modelling real-life data is under active development, and lessons learned in our project are transferred to it, wherever they are relevant to the goal of the whitepaper.

3.3 ITU-T contribution

Concerning service function chaining framework studied in SG13, project partners have made the following contributions, in addition to the two contributions reported in the previous Deliverable D1.2:

- Clarification of Y.FnChain, to finalize the document for consent, SG13-C0559, (March 11, 2019 – ITU-T SG13). We proposed clarification and missing definitions to finalize the draft Recommendation Y.ICN-FnChain.
- Additional use cases to complete Y.ICN-FnChain for consent, 17289-C156 (190617), (June 24, 2019 – ITU-T SG13). We have added use cases to help understanding the sensor-initiated communication model where the service function chaining is applied.

The last contribution above finalized the draft standard, and the following standard is approved by ITU-T SG13.

- Recommendation ITU-T Y.3073 (2019), Framework of service function chaining in information centric networking.

In June 2019, we proposed to initiate a new work item "Framework on Inter-Networking of heterogeneous application domain connected objects through information-centric networking in IMT-2020" in ITU-T SG13. This work item is now under discussion as a draft Recommendation ITU-T Y.ICN-interworking. To contribute to the above draft Recommendation, we so far contributed the following two contributions.

- Proposal of initial text for Clause 8 of Y.ICN-interworking, SG13-C676-R1, (October 21, 2019 – ITU-T SG13). We defined functional components in information-centric-networking-based interworking systems. We also proposed a message format and the communication sequence.
- Proposal to separate descriptions for control messages from data messages in clause 8 in draft Recommendation Y.ICN-interworking, 17741-C177 (200302), (March 9, 2020 – ITU-T SG13). We proposed to separate description on control plane and data plane.

Concerning FG on DPM, project partners made three contributions out of the use cases of the project, which were reported in the previous Deliverable D1.2. In FG on DPM, project partners submitted two contributions, indicated as DPM-I-247 and 248. The contributions were adopted, and descriptions of the use cases made into specifications defined in the following Technical Specification:

- ITU-T Technical Specification, Technical Specification D1.1: Use case analysis and requirements for Data Processing and Management to support IoT and Smart Cities and Communities, 19 July 2019.

4 Conclusion

During this second year of activity, the Fed4IoT project carried on its communication, dissemination and standardisation activities, which led to an on-line presence via the web site and a GitHub organisation, to a relevant number of publications (39), to the organisation and participation to events (6), as well as to a strong presence in the standardisation area in relation with smart city platforms, IoT interoperability, security, data and privacy protection.

This effort will be pursued and enhanced during the third and last year of the project where actual implementations and deployments will provide further ground for dissemination.

5 Annex 1 – Detailed list of publications

Publication information	
DOI	10.1109/CQR47547.2020.9101396
Type of publication	Publication in conference
Repository Link	https://ieeexplore.ieee.org
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KumNak2020Real-World.pdf
Title	Real-world implementation of function chaining in Named Data Networking for IoT environment
Authors	Yohei Kumamoto and Hidenori Nakazato
Abstract	In this paper, we discuss how to implement function chaining in Named Data Networking (NDN), an incarnation of information centric networking technology, for real-world IoT environments. We explain our new architecture, called NDN-FC, for function chaining over NDN, and how to extend existing NDN software to support function chaining. The key features discussed in this paper are Interest and Data packet structure, forwarding methods, and segmentation and reassembly methods of a content. Even in IoT environments, it is possible that most content, such as image and video, does not fit into a single Data packet. Segmentation and reassembly of a content is therefore crucial. The feasibility of our proposed protocol for segmentation and reassembly is displayed through a prototype implementation. In order to support lightweight operation of functions, the implementation is extended to use Docker container technology to run functions. The performance of Docker implementation and virtual machine implementation are compared.
Title of the Journal/ Proceedings/Books	2020 IEEE ComSoc International Communications Quality and Reliability Workshop (CQR)
Number, date or frequency of the Journal/Proceedings/Book	May 2020
Relevant Pages	Not available

ISBN	978-1-7281-6627-8
Publisher	IEEE
Place of publication	Stevenson, WA, USA
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Journal article
Repository Link	https://www.ituaj.jp/?newbreeze=new-breeze-2020-spring
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/nb32-2_1-1.pdf
Title	Smart city interoperability -- Fed4IoT Japan-Europe joint research --
Authors	Hidenori Nakazato
Abstract	This article introduces Fed4IoT project. Its goal, federating IoT systems, is presented and the concept to achieve the goal which includes virtual IoT device, ThingVisor, and Virtual Silo are discussed.
Title of the Journal/ Proceedings/Books	New Breeze
Number, date or frequency of the Journal/Proceedings/Book	vol.32, no.2, April 2020
Relevant Pages	1-4
ISBN	Not available
Publisher:	The ITU Association of Japan
Place of publication:	Tokyo, Japan

Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KanHanKan2020ICN-Based.pdf
Title	ICN-based service function chaining for workflows
Authors	Hidehiro KANEMITSU, Masaki HANADA, Kenji KANAI, and Hidenori NAKAZATO
Abstract	With spreading of network virtualization technologies in the world, each network function is processed in cooperation with others to achieve Service Function Chaining (SFC). A generalized structure of such a chain is a work.ow, that can be more critical structure when a complex-type structured application must be processed. Thus, how each service function should be processed efficiently is one important issue for practical work.ow SFC. In this paper, we propose two variants of INC-SFC for work.ow. The one is that a work.ow SFC is supposed to be processed according to a static SF scheduling algorithm. The other is that each computational resource has its own neighbors in FIB, to which the target for the interest packet is sent. We also present the comparison results among them by an actual environment. Key words NFV, Function Chaining, ICN, SFC, Clustering, Scheduling, Workflow.

Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 461, March 2020
Relevant Pages	249-254
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KanNakKan2020ThingVisor.pdf
Title	ThingVisor Factory for Things as a Service and IP and ICN-based Things sharing architecture
Authors	Kenji Kanai, Hidenori Nakazato, and Hirohide Kanemitsu
Abstract	In this paper, we propose “Thing Visor FactoryFactory” platform to realize “Things as a Service Service,” and this platform provides users the functionalities of designing, creating, deploying and sharing their own IoT service services. Since t the plat form adopts service function chaining

	technology to define the IoT service as a virtual IoT service (or Virtual Thing), the platform can efficiently manage network and computing resources . In addition, to share the Virtual Thing Things over different communication protocols , such as IP and Information Centric Networking, we propose IP and ICN-based Things Sharing Architecture that gives a functionality of IP and ICN protocol binding.
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 424, February 2020
Relevant Pages	19-24
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/TakNakKan2020End-to-End.pdf
Title	End.to-end response time evaluations in centralized and distributed IoT data sharing model

Authors	Keisuke TAKAHASHI, Hidenori NAKAZATO, and Kenji KANAI
Abstract	In this paper, we model the current standardized IoT platform as a centralized architecture and a distributed architecture to analyze end-to-end IoT data retrieval time by constructing a simple numerical model. In our definition, the centralized/distributed architecture represents IoT data sharing by one/distributed IoT broker(s) that located on the cloud/edge servers. Based on the numerical model, we evaluate end-to-end IoT data retrieval time of these two architectures under various parameters, such as the latency between IoT device and edge server, the latency between edge and cloud servers, number of IoT data entry in the IoT broker(s) and access load of the IoT broker(s).
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 424, February 2020
Relevant Pages	13-18
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	10.1109/ISM46123.2019.00055
Type of publication	Publication in conference
Repository Link	https://ieeexplore.ieee.org

Link to the publication	https://www.katto.comm.waseda.ac.jp/kanai/papers/2019/iee_ism_2019_shinohara.pdf
Title	Performance evaluations of viewport movement prediction and rate adaptation for tile-based 360-degree video delivery
Authors	Yuya Shinohara, Kenji Kanai, and Jiro Katto
Abstract	Recently, the demand for high quality 360-degree video delivery is increasing, however, 360-degree videos require extremely high bitrate and large network capacity. Therefore, an efficient (i.e., higher quality and lower traffic) 360-degree video delivery is mandatory. To address this fact, this paper introduces and evaluates a tile-based 360-degree video delivery system that equips viewport movement prediction and rate adaptation.
Title of the Journal/ Proceedings/Books	Proc. of 2019 IEEE International Symposium on Multimedia (ISM)
Number, date or frequency of the Journal/Proceedings/Book	Not available
Relevant Pages	241-242
ISBN	978-1-7281-5606-4
Publisher	IEEE
Place of publication	San Diego, CA, USA
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)

Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/SekKanKan2019Optimal.pdf
Title	Optimal service function allocation method for IoT device virtualization
Authors	Hibiki SEKINE, Kenji KANAI, Hidehiro KANEMITSU, Jiro KATTO, and Hidenori NAKAZATO
Abstract	Authors proposed IoT device virtualization technology using edge computing. In IoT device virtualization, IoT service is divided into multiple micro service functions, and these functions are allocated to computing resources that are located in the networks. In this paper, we study an optimal service function allocation method that minimizes application end-to-end latency. Through computer simulations, we confirm an effectiveness of the optimal allocation method.
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol.119, no.323, December 2019
Relevant Pages	23-27
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KumNak2019Design.pdf
Title	Design of NDN-FC using virtual environment by docker
Authors	Yohei KUMAMOTO and Hidenori NAKAZATO
Abstract	In recent years, the number of IoT devices has increased rapidly, resulting in the development of IoT applications and services. Examples include factory automation and automated driving, and these require low latency. Therefore, a method called NDN-FC that combines Named Data Networking (NDN) and Service Function Chaining (SFC) has been proposed as a means of creating a more efficient IoT network. In this study, we examined a method for implementing NDN-FC that is lighter and easier to manage using Docker, which realizes container-type virtualization technology.
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 256, November 2019
Relevant Pages	33-38
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No

Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KanYosKan2019Research.pdf
Title	Research development of Fed4IoT platform for Things as a Service.
Authors	Kenji KANAI, Eisei YOSHIDA, Hidehiro KANEMITSU and Hidenori NAKAZATO, Tetsuya YOKOTANI, Hiroaki MUKAI, Kenichi NAKAMURA, and Mitsuru UESUGI
Abstract	In this paper, we propose virtual IoT system that provides “Things as a Service”. This proposal is a part of our research activity called Federating IoT and cloud infrastructures to provide scalable and interoperable Smart Cities applications, by introducing novel IoT virtualization technologies. This paper introduces an 1st version of architecture of proposed virtual IoT system and explain static and dynamic instantiation methods of virtual IoT device.
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 256, October 2019
Relevant Pages	39-44
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019

Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in workshop (in Japanese)
Repository Link	https://www.ieice.org/ken/user/index.php?cmd=techreparchive&lang=eng
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KanKanKat2019Clustering-Based.pdf
Title	Clustering-based service function scheduling algorithm for service function chaining.
Authors	Hidehiro KANEMITSU, Kenji KANAI, Jiro KATTO, and Hidenori NAKAZATO
Abstract	Virtualized service and network functions are deployed on virtual machines (VMs) to realize essential processing to realize service function chaining (SFC). Issues on SFC is SF allocation to a VM and to minimize the response time and number of function instances. In this paper, we propose an SF clustering-based scheduling algorithm, called “SF-clustering for utilizing virtual CPUs” (SF-CUV), to solve the SF allocation and SF selection problems simultaneously. Experimental results show that SF-CUV can utilize vCPUs to minimize the response time.
Title of the Journal/ Proceedings/Books	IEICE Technical Report
Number, date or frequency of the Journal/Proceedings/Book	vol. 119, no. 196, September 2019
Relevant Pages	1-4

ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in conference (in Japanese)
Repository Link	https://www.ieice.org/publications/conference-DVDs/2019S/_pdf/bt_01_002.pdf
Link to the publication	http://www.nz.comm.waseda.ac.jp/papers/KanKanNak2019Applicability.pdf
Title	Applicability of ICN protocol for interoperability of smart cities
Authors	Kenji Kanai, Hidehiro Kanemitsu, Hidenori Nakazato, Kenichi Nakamura, Mitsuru Uesugi, Tetsuya Yokotani, and Hiroaki Mukai
Abstract	This article introduces Fed4IoT project and applicability of Information-Centric Networking technology to Fed4IoT is discussed.
Title of the Journal/ Proceedings/Books	Proc. of the 2019 IEICE Society Conference
Number, date or frequency of the Journal/Proceedings/Book	September 2019
Relevant Pages	BT-1-2
ISBN	Not available
Publisher	IEICE

Place of publication	Tokyo, Japan
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in conference (in Japanese)
Repository Link	https://www.ieice.org/publications/conference-DVDs/2019S/_pdf/b_11_029.pdf
Link to the publication	https://www.katto.comm.waseda.ac.jp/kanai/papers/2019/ieice_society_201909_shinohara.pdf
Title	Performance evaluations of rate adaptation methods for tile-based 360-degree video delivery
Authors	Yuya Shinohara, Kenji Kanai, and Jiro Katto
Abstract	This article demonstrates performance evaluations of rate adaptation methods for tile-based 360-degree video delivery.
Title of the Journal/ Proceedings/Books	Proc. of the 2019 IEICE Society Conference
Number, date or frequency of the Journal/Proceedings/Book	September 2019
Relevant Pages	B-11-29
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019

Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in conference (in Japanese)
Repository Link	https://www.ieice.org/publications/conference-DVDs/2019S/_pdf/b_15_031.pdf
Link to the publication	https://www.katto.comm.waseda.ac.jp/kanai/papers/2019/ieice_society_201909_shirasaki.pdf
Title	Performance evaluations of daily moving behavior by using biometric sensors
Authors	Satomi Shirasaki, Kenji Kanai, and Jiro Katto
Abstract	This article presents erformance evaluations of daily moving behavior by using biometric sensors.
Title of the Journal/ Proceedings/Books	Proc. of the 2019 IEICE Society Conference
Number, date or frequency of the Journal/Proceedings/Book	September 2019
Relevant Pages	B-15-31
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019

Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	Not available
Type of publication	Publication in conference (in Japanese)
Repository Link	https://www.ieice.org/publications/conference-DVDs/2019S/_pdf/b_08_033.pdf
Link to the publication	https://www.katto.comm.waseda.ac.jp/kanai/papers/2019/ieice_society_201909_sekine.pdf
Title	End-to-end delay evaluations of micro service in various IoT resource environments
Authors	Hibiki Sekine, Kenji Kanai, and Jiro Katto
Abstract	This article reports end-to-end delay evaluations of micro service in various IoT resource environments for efficient IoT virtualization.
Title of the Journal/ Proceedings/Books	Proc. of the 2019 IEICE Society Conference
Number, date or frequency of the Journal/Proceedings/Book	September 2019
Relevant Pages	B-8-33
ISBN	Not available
Publisher	IEICE
Place of publication	Tokyo, Japan
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes

Is this a peer-reviewed publication?	No
Is this a joint public/private publication?	Yes

Publication information	
DOI	10.1109/CLOUD.2019.00041
Type of publication	Publication in conference
Repository Link	https://ieeeeplore.ieee.org
Link to the publication	http://133.9.67.233/papers/KanKanKat2019A-Function.pdf
Title	A function clustering algorithm for resource utilization in service function chaining
Authors	Hidehiro Kanemitsu, Kenji Kanai, Jiro Katto, and Hidenori Nakazato
Abstract	Virtualized service and network functions are de- ployed on virtual machines (VMs) to realize essential processing to realize service function chaining (SFC). Issues on SFC is SF allocation to a VM and to minimize the response time and number of function instances. In this paper, we propose an SF clustering-based scheduling algorithm, called "SF-clustering for utilizing virtual CPUs" (SF- CUV), to solve the SF allocation and SF selection problems simultaneously. Experimental results show that SF-CUV can utilize vCPUs to minimize the response time.
Title of the Journal/ Proceedings/Books	Proceedings of IEEE International Conference on Cloud Computing (IEEE CLOUD 2019)
Number, date or frequency of the Journal/Proceedings/Book	July 2019
Relevant Pages	193-195
ISBN	978-1-7281-2705-7
Publisher	IEEE
Place of publication	Milan, Italy
Year of publication	2019

Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes

Publication information	
DOI	https://doi.org/10.3390/s20051434
Type of publication	Article in journal
Repository Link	https://www.mdpi.com/1424-8220/20/5
Link to the publication	https://www.mdpi.com/1424-8220/20/5/1434
Title	Evaluation of the Use of Compressed Sensing in Data Harvesting for Vehicular Sensor Networks
Authors	Juan Antonio Martinez, Pedro Miguel Ruiz and Antonio F. Skarmeta
Abstract	We propose a new harvesting approach for Vehicular Sensor Networks based on compressed sensing (CS) technology called Compressed Sensing-based Vehicular Data Harvesting (CS-VDH). This compression technology allows for the reduction of the information volume that nodes must send back to the fusion center and also an accurate recovery of the original data, even in absence of several original measurements. Our proposed method, thanks to a proper design of a delay function, orders the transmission of these measurements, being the nodes farther from the fusion center, the ones starting this transmission. This way, intermediate nodes are more likely to introduce their measurements in a packet traversing the network and to apply the CS technology. This way the contribution is twofold, adding different measurements to traversing packets, we reduce the total overload of the network, and also reducing the size of the packets thanks to the applied compression technology. We evaluate our solution by using ns-2 simulations in a realistic vehicular environment generated by SUMO, a well-known traffic simulator tool in the Vehicular Network domain. Our simulations show that CS-VDH outperforms Delay-Bounded Vehicular Data Gathering (DB-VDG), a well-known protocol for data gathering in vehicular sensor networks which

	considers a specific delay bound. We also evaluated the proper design of our delay function, as well as the accuracy in the reconstruction of the original data. Regarding this latter topic, our experiments proved that our proposed solution can recover sampled data with little error while still reducing the amount of information traveling through the vehicular network.
Title of the Journal/ Proceedings/Books	Sensors
Number, date or frequency of the Journal/Proceedings/Book	Volume 20, Issue 5, March 2020
Relevant Pages	
ISBN	ISSN: 1424-8220
Publisher	MDPI
Place of publication	
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/privateprivate publication?	Yes

Publication information	
DOI	https://doi.org/10.3390/s20030882
Type of publication	Article in journal
Repository Link	https://www.mdpi.com/1424-8220/20/3
Link to the publication	https://www.mdpi.com/1424-8220/20/3/882
Title	Secure Authentication and Credential Establishment in Narrowband IoT and 5G

Authors	Jesus Sanchez-Gomez, Dan Garcia-Carrillo, Rafael Marin-Perez, and Antonio F. Skarmeta
Abstract	Security is critical in the deployment and maintenance of novel IoT and 5G networks. The process of bootstrapping is required to establish a secure data exchange between IoT devices and data-driven platforms. It entails, among other steps, authentication, authorization, and credential management. Nevertheless, there are few efforts dedicated to providing service access authentication in the area of constrained IoT devices connected to recent wireless networks such as narrowband IoT (NB-IoT) and 5G. Therefore, this paper presents the adaptation of bootstrapping protocols to be compliant with the 3GPP specifications in order to enable the 5G feature of secondary authentication for constrained IoT devices. To allow the secondary authentication and key establishment in NB-IoT and 4G/5G environments, we have adapted two Extensible Authentication Protocol (EAP) lower layers, i.e., PANATIKI and LO-CoAP-EAP. In fact, this approach presents the evaluation of both aforementioned EAP lower layers, showing the contrast between a current EAP lower layer standard, i.e., PANA, and one specifically designed with the constraints of IoT, thus providing high flexibility and scalability in the bootstrapping process in 5G networks. The proposed solution is evaluated to prove its efficiency and feasibility, being one of the first efforts to support secure service authentication and key establishment for constrained IoT devices in 5G environments.
Title of the Journal/ Proceedings/Books	Sensors
Number, date or frequency of the Journal/Proceedings/Book	Volume 20, Issue 3, February 2020
Relevant Pages	
ISBN	ISSN: 1424-8220
Publisher	MDPI
Place of publication	
Year of publication	2020

Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/privateprivate publication?	Yes

Publication information	
DOI	https://doi.org/10.3390/s20030801
Type of publication	Article of journal
Repository Link	https://www.mdpi.com/1424-8220/20/3
Link to the publication	https://www.mdpi.com/1424-8220/20/3/801
Title	Lightweigh Data-Security Ontology for IoT"
Authors	Pedro Gonzalez-Gil, Juan A. Martinez, and Antonio F. Skarmeta
Abstract	Although current estimates depict steady growth in Internet of Things (IoT), many works portray an as yet immature technology in terms of security. Attacks using low performance devices, the application of new technologies and data analysis to infer private data, lack of development in some aspects of security offer a wide field for improvement. The advent of Semantic Technologies for IoT offers a new set of possibilities and challenges, like data markets, aggregators, processors and search engines, which rise the need for security. New regulations, such as GDPR, also call for novel approaches on data-security, covering personal data. In this work, we present DS4IoT, a data-security ontology for IoT, which covers the representation of data-security concepts with the novel approach of doing so from the perspective of data and introducing some new concepts such as regulations, certifications and provenance, to classical concepts such as access control methods and authentication mechanisms. In the process we followed ontological methodologies, as well as semantic web best practices, resulting in an ontology to serve as a common vocabulary for data

	annotation that not only distinguishes itself from previous works by its bottom-up approach, but covers new, current and interesting concepts of data-security, favouring implicit over explicit knowledge representation. Finally, this work is validated by proof of concept, by mapping the DS4IoT ontology to the NGSI-LD data model, in the frame of the IoTCrawler EU project.
Title of the Journal/ Proceedings/Books	Sensors
Number, date or frequency of the Journal/Proceedings/Book	Volume 20, Issue 3, February 2020
Relevant Pages	
ISBN	ISSN: 1424-8220
Publisher	MDPI
Place of publication	
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/privateprivate publication?	Yes

Publication information	
DOI	Not available
Type of publication	Article in Conference
Repository Link	Not available
Link to the publication	Not available
Title	EAP-based bootstrapping for secondary service authentication to integrate IoT into 5G networks

Authors	Dan Garcia-Carrillo, Jesus Sanchez-Gomez, Rafael Marin-Perez and Antonio Skarmeta
Abstract	Security aspects must be considered in the next generation of IoT and 5G networks. As core aspects, authentication and key management operations are essential to establish security associations between end-devices and data services. However, little effort has been put so far into providing a network-independent solution for service access authentication in the field of constrained devices based on IoT such as LoRaWAN, Narrow Band IoT (NB-IoT) and LTE-M in 5G networks. Therefore, this paper proposes a novel architecture based on EAP bootstrapping and AAA infrastructure for IoT and 5G networks to manage service authentication and security association in order to enable secure end-to-end communication. In this work, we propose the use of an improved bootstrapping mechanism for secondary authentication adapted to be compliant with the 3GPP specifications for integrating IoT technologies in 5G networks. We propose the adaptation of LO-COAP-EAP (Low-Overhead CoAP-EAP) as an EAP lower layer for enabling the secondary service authentication with high flexibility, scalability and networks independence.
Title of the Journal/ Proceedings/Books	The 4th International Symposium on Mobile Internet Security (MobiSec'19)
Number, date or frequency of the Journal/Proceedings/Book	October 17-19, 2019, Taichung, Taiwan, Article No. 7,
Relevant Pages	1-8
ISBN	5.1.1.1.1.1 2383-9201
Publisher	Innovative Information Science & Technology Research Group (ISYOU)
Place of publication	Taichung, Taiwan
Year of publication	2019
Is this publication available in Open-Access,	Yes

or will it be made available?	
Is this a peer-reviewed publication?	Yes
Is this a joint public/privateprivate publication?	Yes

Publication information	
DOI	https://doi.org/10.1109/GLOBECOM38437.2019.9013623
Type of publication	Article in conference
Repository Link	https://ieeexplore.ieee.org
Link to the publication	https://ieeexplore.ieee.org/abstract/document/9013623
Title	MEC-assisted End-to-end 5G-Slicing for IoT
Authors	Ramon Shancez-Iborra, Stefan Covaci, José Santa, Jesús Sanchez-Gomez, Jorge Gallego-Madrid, Antonio F. Skarmeta
Abstract	The Internet of Things (IoT) has emerged as a key horizontal technology enabler within the 5G ecosystem, characterized by supporting the heterogeneity of end-devices, radio-access technologies, and services. Network slicing techniques allow to configure dedicated networks with assured resources to specific users or applications over a common physical infrastructure. This paper describes a novel end- to-end network slicing framework for IoT services in 5G systems, based on a Multi-Access Edge Computing (MEC) and central cloud architecture that permits the flexible and dynamic placement of micro-services encapsulated as Virtualized Network Functions (VNFs) along the end-to-end path. The critical analysis of the validation results highlights the performance and flexibility gains of our proposal. It allows deploying end-to-end slices over a number of participating domains in a very short time, it is able to isolate slices with guaranteed Quality of Service (QoS) parameters, and shows great scalability in terms of number of connected end-devices and application services.

Title of the Journal/ Proceedings/Books	2019 IEEE Global Communications Conference (GLOBECOM)
Number, date or frequency of the Journal/Proceedings/Book	9-13 Dec. 2019
Relevant Pages	1-6
ISBN	978-1-7281-0962-6
Publisher	IEEE
Place of publication	Waikoloa, USA
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/privateprivate publication?	Yes

Publication information	
DOI	10.1109/ACCESS.2019.2953043
Type of publication	Article of journal
Repository Link	https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8896842
Link to the publication	https://ieeexplore.ieee.org/document/8896842
Title	Exploiting Information-Centric Networking to Federate Spatial Databases
Authors	A. Detti, G. Rossi and N. B. Melazzi
Abstract	This paper explores the methodologies, challenges, and expected advantages related to the use of the information-centric network (ICN) technology for federating spatial databases. ICN services allow simplifying the design of federation procedures, improving their

	performance, and providing so-called data-centric security. In this work, we present an architecture that is able to federate spatial databases and evaluate its performance using a real data set coming from OpenStreetMap within a heterogeneous federation formed by MongoDB and CouchBase spatial database systems.
Title of the Journal/ Proceedings/Books	IEEE Access
Number, date or frequency of the Journal/Proceedings/Book	Volume: 7
Relevant Pages	165248 - 165261
ISBN	Not available
Publisher	IEEE
Place of publication	None
Year of publication	2019
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/private publication?	No

Publication information	
DOI	10.1109/TNSM.2020.3003535
Type of publication	Article of journal
Repository Link	https://ieeexplore.ieee.org/document/9120278
Link to the publication	https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9120278

Title	Sub-linear Scalability of MQTT Clusters in Topic-based Publish-subscribe Applications
Authors	A. Detti, L. Funari and N. B. Melazzi
Abstract	Message Queuing Telemetry Transport (MQTT) is a widespread protocol for topic-based publish-subscribe architectures supporting IoT and social networks applications. MQTT brokers are logical entities that couple publishers and subscribers and play a critical role in such architectures. MQTT brokers can be implemented either as standalone servers or in a cluster configuration. Clusters of brokers increase reliability, availability and overall performance, since operations can be highly parallelized among the brokers that form the cluster. The load-balancing strategy in a cluster usually consists in connecting an incoming client to a randomly selected broker. This random-attach strategy, it is very simple, but generates a significant amount of inter-broker traffic, as we demonstrate through theoretical and experimental evaluations. Inter-broker traffic is an overhead for the system and it increases the CPU load of the brokers, compromising the scaling behaviour of the whole cluster. Indeed, we found that a linear increase of the number of brokers forming a cluster does not necessarily provide an equivalent linear gain in performance, and such a scaling penalty can be surprisingly significant, in the order of 40%. To solve this issue and improve performance, we propose a novel load-balancing strategy that envisages the use of multiple MQTT sessions per client to reduce inter-broker traffic and that can be implemented by means of a greedy algorithm. We show feasibility and effectiveness of our strategy for IoT and social-network applications by means of simulations and real measurements. The resulting scaling penalty is reduced to 10%.
Title of the Journal/ Proceedings/Books	IEEE Transactions on Network and Service Management
Number, date or frequency of the Journal/Proceedings/Book	Early Access
Relevant Pages	Not available
ISBN	Not available

Publisher	IEEE
Place of publication	Not available
Year of publication	2020
Is this publication available in Open-Access, or will it be made available?	Yes
Is this a peer-reviewed publication?	Yes
Is this a joint public/private publication?	No

Publication information	
DOI	Not available
Type of publication	Demo paper
Repository Link	Not available
Link to the publication	https://www.ieeelcn.org/prior/LCN44/Program_demos.html
Title	**Intent-based Fog Computing with FogFlow**
Authors	Bin Cheng, Gürkan Solmaz, and Flavio Cirillo
Abstract	IoT devices are connected and often with limited computation and battery lifetime. To extend their capability and make them smarter, some kinds of edge intelligence is required. Fog computing has been advertised as a new paradigm to host such edge intelligence as IoT services by making computation and storage resources close to IoT devices. However, this introduces lots of complexities and new challenges for programming and managing those IoT services in a shared and geo-distributed infrastructure. To ease the design and management of IoT services, we propose an intent-based fog computing framework called FogFlow, which is an open source fog computing framework with user-friendly interface. So far, FogFlow has been widely used by many research projects and also industrial

	proof-of-concept systems. In this demo, we are going to showcase its latest programming model with two implemented use cases.
Title of the Journal/ Proceedings/Books	The 44th IEEE Conference on Local Computer Networks (LCN)
Number, date or frequency of the Journal/Proceedings/Book	Not available
Relevant Pages	Not available
ISBN	Not available
Publisher	Not available
Place of publication	Not available
Year of publication	Not available
Is this publication available in Open-Access, or will it be made available?	Not available, since all demo papers are not included in the proceedings of this conference and only the on-site demo has been shown.
Is this a peer-reviewed publication?	Yes
Is this a joint public/private publication?	No