



**PhD in Information Technology and Electrical Engineering**

**Università degli Studi di Napoli Federico II**

**PhD Student: Flavio Cirillo**

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**XXXIII Cycle**

**Training and Research Activities Report – First Year**

**Tutor: Prof. Simon Pietro Romano**

# Training and Research Activities Report – First Year

PhD in Information Technology and Electrical Engineering – XXXIII Cycle

Flavio Cirillo

## 1. Information

**Title:** Flavio Cirillo Master Degree in Computer Engineering from University of Naples “Federico II” in 2014

**Cycle:** Ph.D. student of the XXXIII Cycle of the ITEE Course, at the University of Naples “Federico II”

**Fellowship:** No Fellowship

**Tutor:** Prof. Simon Pietro Romano

## 2. Study and Training Activities

Credits year 1							
	1	2	3	4	5	6	
Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary
<b>Modules</b>	<b>15</b>				6	6	<b>12</b>
<b>Seminars</b>	<b>3</b>	0,6	0,3	0,2	1,6		<b>2,7</b>
<b>Research</b>	<b>42</b>	4	4	10	7	13	<b>46</b>
	<b>60</b>	4,6	4,3	10,2	8,6	19	<b>60,7</b>

### Courses

Master's Degree Course	Lecturer	Date	CFU
Big Data Analytics and Business Intelligence	Prof. Antonio Picariello	II semester 2017/2018	6
Network Security	Prof. Simon Pietro Romano	I semester 2018/2019	6

### Seminars

Seminar	Lecturer	Date	Place	H	CFU
Cyber-Human Partnerships – Towards a resilient ecosystem in Smart Cities	Prof. Dr. Schahram Dustdar, TU Wien, Austria	2018/02/01	NEC Labs Europe, Heidelberg, Germany	1	0.2
How to get published with the IEEE	Eszter Lukacs	2018/02/27	NEC Labs Europe, Heidelberg, Germany	1	0.2
Techniques for effective searching with IEEE Xplore	Eszter Lukacs	2018/02/27	NEC Labs Europe, Heidelberg, Germany	1	0.2
Understanding the World with AI: Reliable & Validated AI via Simulation, ML, and HPC	Prof. Dr. Philipp Slusallek, Saarland University, Saarbrücken,	2018/04/11	NEC Labs Europe, Heidelberg, Germany	1.5	0.3

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	Germany				
Using Big Data to understand Network Slicing	Dr. Marco Gramaglia, University Carlos III of Madrid, Madrid, Spain	2018/05/14	NEC Labs Europe, Heidelberg, Germany	1	0.2
CPU/GPU/Aurora programming seminar and hackathon,	Dr. Nicola Weber, NEC	2018/07/03 and 2018/07/05	NEC Labs Europe, Heidelberg, Germany	8	1.6

### 3. Research Activities

#### De-centralization of IoT platforms

In the past decade the Internet-of-Things concept has overwhelmingly entered all of the fields where data are produced and processed (e.g., health care, industry), resulting in a plethora of IoT platforms, typically cloud-based, which centralize data and services management. This has brought to a multitude of disjoint vertical IoT silos. Significant efforts have been devoted to making interfaces and data models interoperable, recurrently resulting into bigger centralized infrastructures. Such an approach often stumbles upon the reluctance of IoT system owners to lose control over their data.

#### Architecture: Privacy –preserving Federation of IoT Platforms.

As first I have dedicated my research studies to define an architecture where a federation overlay is distributed among parties and the control over the data is delegated to data owners. The system is based on NGSI that is an open standard supported formerly by the Open Mobile Alliance (OMA) and today by ETSI, NGSI has been adopted by the FIWARE Foundation<sup>1</sup> which has established a worldwide community supporting it with open source software. In addition, I have included privacy schemes in the architecture and iterations between actors for protecting data exposure across different IoT domains. The conceived architecture is scalable by design, since it allows iterative formation of multiple levels of domains thanks to the transparent nature of its federation approach, which hides the federation overlay from both data providers and IoT applications. Experiments conducted show that the overhead introduced is minimal when considering wide IoT deployments and in some scenarios the designed platform performs even better than centralized approaches.

#### Collaborations:

- Prof. Simon Pietro Romano, University of Naples “Federico II”
- Dr. Ernoe Kovacs, NEC Laboratories Europe, Germany,

#### Interoperable applications for an open IoT ecosystem

Commercial IoT platforms typically envision an ecosystem of IoT services and data providers that offer their capability in a marketplace. This is feasible in a well-defined environment where the interfaces and the platform are designed by a single entity (e.g. a vendor). In the case of open source platforms the interoperability between services is not always ensured. This is an obstacle to the business development of a solution. That is necessary in order for the platform to reach the critical mass to become self-sustained. For

<sup>1</sup> <https://www.fiware.org/>

that reason I have worked for the specification and design of IoT applications following open standards and compatible with the federation approach where IoT providers keep the control over the data.

In particular, as first, I have worked to semantically define crowd mobility applications using the NGSI standards as data format and a blend of sensors network ontologies (i.e. FIESTA-IoT ontology)<sup>2</sup> as data model. This application has been implemented and deployed in Australia (Gold Coast) and New Zealand (Wellington and Christchurch).

As a second topic, I have worked with eight smart cities (Milan, Santander, Porto, Eindhoven, Antwerp, Helsinki, Manchester and Carouge) in Europe in the context of the Large Scale Pilot EU project named SynchroniCity. The aim of the project is to “synchronize” the IoT platforms between the smart cities for building a pan-European (and beyond) IoT marketplace and incentivizing the cities growth. The smart cities are deploying an overlay IoT platform based on NGSI and FIWARE over the legacy smart cities platforms. Starting from this I have coordinated the co-design of city services (i.e. IoT applications offered to citizens such as a multi-modal transportation app) among cities. The approach was to recognize communality in the requirements and/or architecture of city services from different cities in order to identify basic services to be co-created among cities. Those basic services, namely “atomic services” or “baseline services”<sup>3</sup>, are the building blocks for the final city services.

### Collaborations:

- Dr. Gurkan Solmaz, NEC Laboratories Europe, Germany,
- Dr. Fang-Jing Wu, TU Dortmund, Germany
- Dr. Jorge Lanza, University of Cantabria, Spain
- Prof. Luis Sanchez, University of Cantabria, Spain
- Dr. Luis Diez, University of Cantabria, Spain
- Dr. Ignacio Elicegui Maestro, University of Cantabria, Spain
- Dr. David Gomez Fernandez, ATOS, Spain
- Jose Gato, ATOS, Spain

### IoT Edge Computing

The de-centralization of IoT platforms envisions a multi-tier architecture that relies not only on the cloud but also on the edge to fulfil strict real-time requirements. For that reason I have worked towards the integration of the federated NGSI architecture within the ETSI Multi-access Edge Computing (MEC) interfaces and architecture. ETSI MEC is based on the multi-tenancy and network slicing concepts. An edge infrastructure, composed by one or more MEC instances, owned and managed by either a network provider (e.g. Deutsch Telekom) or big service provider (e.g. an airport) is shared among IoT service providers. The IoT service providers are renting a slice of the resources of the edge architecture in order to have network and power capabilities across the whole edge infrastructure. The federated architecture is designed to work across MEC slices and MEC instances.

### Collaborations:

- Dr. Vincenzo Sciancalepore, NEC Laboratories Europe, Germany,
- Dr. Fabio Giust, Athonet Srl, Italy
- Lanfranco Zanzi, NEC Laboratories Europe, Germany

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<sup>2</sup> R. Agarwal et al., "Unified IoT ontology to enable interoperability and federation of testbeds," 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT), Reston, VA, 2016, pp. 70-75.

doi: 10.1109/WF-IoT.2016.7845470

<sup>3</sup> <https://synchronicity-iot.eu/open-call/framework/data-tools-services-in-core-pilot-cities/>

- Dr. Simone Mangiante, Vodafone Group R&D, UK

## Contribution to the research community

- Serving as reviewer for MDPI Smart Cities journal
- Serving as reviewer for Hindawi Wireless Communications and Mobile Computing journal
- Serving as TPC Reviewer for IEEE WCNC 2019

## 4. Products

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### Publications

#### Published

- [Journal] J. Lanza, L. Sánchez, J. R. Santana, R. Agarwal, N. Kefalakis, P. Grace, T. Elsaleh, M. Zhao, E. Tragos, H. Nguyen, **F. Cirillo**, R. Steinke and J. Soldatos , "*Experimentation as a Service Over Semantically Interoperable Internet of Things Testbeds*," in *IEEE Access*

#### Final Proofreading

- [Journal] G. Solmaz, F-J. Wu, **F. Cirillo**, E. Kovacs, J.R. Santana, L. Sánchez, P. Sotres and L. Munoz. "*Towards Understanding Crowd Mobility in Smart Cities through Internet of Things*". IEEE Communications Magazine.

#### Under minor revision

- [Journal] L. Zanzi, **F. Cirillo**, S. Mangiante, V. Sciancalepore, F. Giust, X Costa-Perez and G. Klas, "*Evolving Multi-Access Edge Computing to support enhanced IoT deployments*", IEEE Communications Standards Magazine
- [Journal] **F. Cirillo**, F-J. Wu, G. Solmaz and E. Kovacs, "*Embracing the Future Internet of Things*", MDPI Sensors Journal

#### Submitted (under review)

- [Journal] **F. Cirillo**, E. L. Berz, G. Solmaz, M. Bauer and E. Kovacs. "*A Standard-based Open Source IoT Platform: FIWARE*", IEEE Internet of Things Magazine (IoTMag)
- [Conference] **F. Cirillo**, N. Capuano, E. Kovacs and S.P. Romano, "*Standard-based Transparent Privacy-safe Federation of Secured IoT Platforms: a Scalable approach*", IEEE International Conference on Communications (ICC) 2019

#### Under preparation

- [Conference] **F. Cirillo**, D. Straeten, D. Gomez Fernandez, J. Gato, I. EliceGUI Maestro, L. Diez, R. Akhavan, "Atomic Services: co-creating smart city services" (tentative), IEEE Global IoT Summit (GloTS) 2019
- [Conference] **F. Cirillo**, N. Capuano, E. Kovacs and S.P. Romano, "IoT Registrar: Privacy-preserving system for IoT discovery" (tentative). (venue to be decided)

## 5. Conferences and Seminars

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### Attended Conferences, Seminars and Events

Event	Date	Place
1st Industrial Data Space Association (IDSA) Summit	2018/03/22-23	Frankfurt, Germany
Hannover Messe 2018	2018/04/24	Hannover Germany
FIWARE Global Summit Porto 2018	2018/05/08-09	Porto, Portugal
IEEE Global IoT Summit (GloTS) 2018. 1 oral presentation of a paper on behalf of collaboration	2018/06/04-27	Bilbao, Spain

### Presentations

Presentation	Event	Date	Place
Presentation on behalf of the original authors: F.-J. Wu, G.Solmaz and E. Kovacs, "Toward the Future World of Internet of Things"	IEEE Global IoT Summit (GloTS) 2018	2018/06/04-27	Bilbao, Spain
IoT for Smart Cities demo	Heidelberg Second „Digital City“ forum	2018/07/25	Heidelberg, Germany
Next Generation Context Management, Poster	NEC Research Platform Technology Exhibition	2018/11/21	Tokyo, Japan

## 6. Activities abroad

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I have spent the whole 2018, corresponding to my first year of PhD, at the NEC Laboratories Europe, Heidelberg Germany.

## 7. Tutorship

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- 32 hours. I have tutored a Master degree student to develop the project for his Master thesis. I have introduced him to the open standards of NGSI and to the FIWARE ecosystem. I have then tutored him about federation of IoT platforms.