

Pedro Escaleira

JUNIOR RESEARCHER AT INSTITUTO DE TELECOMUNICAÇÕES

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Personal Profile

Pedro Escaleira is a Ph.D. student at the University of Aveiro. He obtained his Bachelor's degree in Informatics Engineering in 2020 and his Master's degree in Cybersecurity in 2022, both from the same university. Currently, he works as a researcher at the Instituto de Telecomunicações (IT), where he has contributed to several projects related to 5G, including Route 25, NETEDGE, and AUGMANITY.

In 2022, Pedro received the "ETSI OSM Release Twelve Outstanding Technical Contributor" award for his significant contributions to the ETSI OSM during its release twelve cycle. In 2023, his Master's dissertation was honored with three awards: the APDC Best Thesis Award (BTA) in the telecommunications category, the AP2SI Merit Award for Masters in Information Security, and the IEEE Portugal Outstanding MSc Thesis Award. He has also been a member of the Technical Steering Committee for the ETSI OSM project since early 2024.

While continuing to explore 5G technologies such as Network Functions Virtualization (NFV) and Multi-access Edge Computing (MEC), Pedro is currently focused on studying how to secure Serverless Computing environments, which is the central theme of his Ph.D. research. His research interests include Serverless and Cloud Computing, Cybersecurity, MEC, and NFV.

Education

University of Aveiro

Aveiro, Portugal

Doctorate in Computer Engineering

September 2023 - Present (Ongoing)

- **Thesis:** Dynamic Protection of Serverless Applications
 - **Scientific contribution:** This PhD research aims to develop dynamic and transparent protection mechanisms for serverless applications at multiple layers — including functions, workflows, and the overall application orchestration. The objective is to design reactive and adaptive security primitives that can detect and mitigate threats during application execution, without requiring modifications to user-defined code or disrupting cloud-native operation. The research follows a structured plan that includes a systematic review of existing protection strategies, architecture definition for multi-layered defense mechanisms, and the implementation and evaluation of proof-of-concept systems. Emphasis is placed on runtime responsiveness, security-policy enforcement across workflows, and preserving serverless scalability and performance.
 - **Current Contributions:**
 - ★ Proposed a Moving Target Defense (MTD) and N-Version Programming (NVP)-based framework for function-level protection through version hopping. This system includes a feedback loop powered by a Large Language Model (LLM) to assist developers in automatically generating semantically equivalent function variants for increased diversity and resilience.
 - ★ Preliminary design and implementation of a runtime protection framework that applies lightweight Machine Learning (ML) techniques—specifically Hidden Markov Models (HMMs)—to model normal execution behavior of serverless functions and detect anomalies during real-time operation in production environments.

University of Aveiro

Aveiro, Portugal

Master's in Cybersecurity

September 2020 - December 2022

- **Thesis:** Securing Real World 5G MEC Deployments
 - **Scientific contribution:** Proposal of an enhanced Multi-access Edge Computing (MEC) architecture based on Network Functions Virtualization (NFV) with support for containerization. This architecture was later used to support a Moving Target Defense (MTD) mechanism, designed to protect MEC Applications. Furthermore, this defense system was idealized to protect any provider's MEC Applications, meaning that any Telecommunications Operator could offer it as a security product to its customers. This conceptualization led to it being coined MTD as a Service (MTDaaS).
 - <http://hdl.handle.net/10773/38905>
 - **Grade:** 20/20
- **Final grade:** 19/20

University of Aveiro

Aveiro, Portugal

Bachelor's in Informatics Engineering

September 2017 - June 2020

- **Final grade:** 18/20

Work Experience

Instituto de Telecomunicações

Aveiro, Portugal

Junior Researcher

February 2022 - Present

Currently, as part of his Ph.D. research at Instituto de Telecomunicações, he is exploring the field of Serverless Computing, focusing on its security challenges. Simultaneously, he is involved in the Route 25¹ and ATE² projects, where he continues to advance research in Multi-access Edge Computing (MEC). His key contributions to Route 25 include mentoring Master's students in MEC research and designing and developing a proof of concept for orchestrating and migrating digital twins-related MEC applications within edge environments. In the ATE project, he is also participating in the activities to orchestrate virtual Intelligent Electronic Devices (IEDs) at the edge.

Previously, he worked on the NETEDGE project³, where he proposed a Multi-access Edge Computing as a Service (MECaaS) methodology to meet the needs of a telecommunications operator with a complex Business-to-Business-to-Consumer (B2B2C) model. His work included studying standards from the European Telecommunications Standards Institute (ETSI) related to MEC and Network Functions Virtualization (NFV) and contributing to ETSI's Open Source MANO (OSM) project. Additionally, he researched and proposed a Moving Target Defense (MTD) methodology to protect MEC applications and Virtual Network Functions (VNFs).

University of Aveiro

Aveiro, Portugal

Research Grant

March 2021 - February 2022

Worked on the AUGMANITY project⁴ to evaluate the Intel Smart Edge Open⁵ platform and its alignment with the ETSI MEC references. It was his first interaction with the ETSI references, particularly the ones related to MEC.

University of Aveiro

Aveiro, Portugal

Research Initiation Grant

April 2020 - October 2020

Worked under the EHDEN project⁶ scope. The main focus of this grant was to assess how the overall research group could use Kubernetes and Kafka.

Publications

JOURNAL ARTICLES

Enhancing Serverless Function Resilience Against Vulnerabilities with MoFaaS

Pedro Escaleira, Vitor A. Cunha, João P. Barraca, Diogo Gomes, Rui L. Aguiar

Journal of Network and Systems Management 34.3 (2026). 2026, doi: 10.1007/s10922-026-10054-5

A systematic review on security mechanisms for serverless computing

Pedro Escaleira, Vitor A. Cunha, João P. Barraca, Diogo Gomes, Rui L. Aguiar

Cluster Computing 28.7 (2025) p. 465. 2025, doi: 10.1007/s10586-025-05371-4

Moving Target Defense for the cloud/edge Telco environments

Pedro Escaleira, Vitor A. Cunha, Diogo Gomes, João P. Barraca, Rui L. Aguiar

Internet of Things 24 (2023) p. 100916. 2023, doi: 10.1016/j.iot.2023.100916

CONFERENCE PROCEEDINGS

Tenant-First MEC Orchestration with Serverless Abstractions and Container Checkpoint/Restore

Pedro Coutinho, **Pedro Escaleira**, David Rocha, João Almeida, Diogo Gomes, Rui L. Aguiar

2026 22nd International Conference on Network and Service Management (CNSM), 2026

FADO: Detecting Anomalies in Serverless Functions via eBPF System Call Tracing

Pedro Durval, **Pedro Escaleira**, Vitor A. Cunha, Diogo Gomes, Rui L. Aguiar

NOMS 2026-2026 IEEE Network Operations and Management Symposium, 2026

PoliFlow: Inferring Control-Flow Policies from Serverless Workflows

Pedro Escaleira, Vitor A. Cunha, João P. Barraca, Diogo Gomes, Rui L. Aguiar

2026 IEEE 26th International Symposium on Cluster, Cloud and Internet Computing (CCGrid), 2026, doi: 10.1109/CCGrid68966.2026.00078

Federation-Aware MEC Architecture for Dynamic Service Migration

Diogo Magalhães, Miguel Matos, **Pedro Escaleira**, David Santos, Daniel Corujo, Diogo Gomes, Rui Aguiar

2025 IEEE Conference on Network Function Virtualization and Software-Defined Networking (NFV-SDN), 2025, doi: 10.1109/NFV-SDN66355.2025.11349550

MoFaaS: A Moving Target Defense Approach to Fortify Functions as a Service

Pedro Escaleira, Vitor A. Cunha, João P. Barraca, Diogo Gomes, Rui L. Aguiar

2024 IEEE Symposium on Computers and Communications (ISCC), 2024, doi: 10.1109/ISCC61673.2024.10733628

Exploring Multi-access Edge Computing Federation for V2X scenarios in the Route 25 project

João Fonseca, David Santos, Emanuel Vieira, João Silva, **Pedro Escaleira**, Ricardo Rodriguez, João Almeida, José Quevedo, Pedro Rito, Bruno Parreira, Daniel Corujo, Joaquim Ferreira, Marco Araújo, Susana Sargento

2024 IEEE 22nd Mediterranean Electrotechnical Conference (MELECON), 2024, doi: 10.1109/MELECON56669.2024.10608613

Automatic Service Migration in a MEC-NFV Environment

Pedro Pereira, **Pedro Escaleira**, Diogo Gomes, Rui Aguiar
2024 IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN), 2024, doi: 10.1109/NFV-SDN61811.2024.10807471

Automatic Service Migration in a MEC-NFV Environment for a User Mobility Scenario
Pedro Pereira, Pedro Ferreira, Francisco Cardita, Afonso Castanheta, Henrique Cruz, Luís Oliveira, Samuel Teixeira, **Pedro Escaleira**, Diogo Gomes, Rui Aguiar
2024 IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN), 2024, doi: 10.1109/NFV-SDN61811.2024.10978952

Multi-access Edge Computing as a Service
Pedro Escaleira, Miguel Mota, Diogo Gomes, João P. Barraca, Rui L. Aguiar
2022 18th International Conference on Network and Service Management (CNSM), 2022, doi: 10.23919/CNSM55787.2022.9964650

Collaboration on Master’s Theses

Optimising MEC through Lightweight Orchestration and Automation
Pedro Coutinho
University of Aveiro, Started in 2025, but not yet finished.

Reactive Defense for Serverless Functions via System Call Monitoring
Carlos Ferreira
University of Aveiro, 2026

Detecting Anomalous Behavior in Serverless Functions with System Call Monitoring
Pedro Durval
University of Aveiro, 2025

Multi-cluster Migration of MEC Applications
Diogo Magalhães
University of Aveiro, 2025

Open Source MEC Platform
Pedro Pereira
University of Aveiro, 2024, URL: <http://hdl.handle.net/10773/45364>

Secure Lifecycle for MEC NetApps
Sofia Vaz
University of Aveiro, 2024, URL: <http://hdl.handle.net/10773/42910>

Extending MANO to the Edge
Diogo Vicente
University of Aveiro, 2023, URL: <http://hdl.handle.net/10773/41718>

Collaboration on Informatics Engineering Final Projects

OSM-MEC
Afonso Castanheta, Francisco Cardita, Henrique Cruz, Luís Oliveira, Pedro Ferreira, Samuel Teixeira
University of Aveiro, 2024, URL: <https://pedrodsferreira.github.io/osm-mec/>

Interventions in the Scientific Community

2024-26	Technical Steering Committee Member , ETSI Open Source MANO (OSM) A position held since February 2024. Its related activities involve making decisions with the other TSC members on how the project should evolve	Europe
2026	Technical Program Committee , IEEE 103rd Vehicular Technology Conference (VTC2026-Spring) Track: Emerging Technologies, 6G and Beyond	Nice, France
2026	Technical Program Committee , 31st IEEE Symposium on Computers and Communications (ISCC)	Vilamoura, Portugal
2026	Technical Program Committee , 32nd International Conference on Telecommunications (ICT)	Thessaloniki, Greece
2025	Technical Program Committee , IEEE 102nd Vehicular Technology Conference (VTC2025-Fall) Track: Emerging Technologies, 6G and Beyond	Chengdu, China
2025	Technical Program Committee , 30th IEEE Symposium on Computers and Communications (ISCC)	Bologna, Italy
2025	Technical Program Committee , IEEE 101st Vehicular Technology Conference (VTC2025-Spring) Track: Emerging Technologies, 6G and Beyond	Oslo, Norway
2024	Technical Program Committee , 29th IEEE Symposium on Computers and Communications (ISCC)	Paris, France
2024	Technical Program Committee , 4th International Workshop “From Cloud to Things” (Cloud2Things)	Biarritz, France

Teaching activities

2024	Information And Organisational Security	University of Aveiro
Have been giving weakly 2 slots of 2-hour practical classes (a total of 4 hours per week) in the first semester of the 2024/2025 curricular year. Apart from giving classes, the main contributions to the subject were as follows:		
• Updated and created multiple slides used to support the practical class. • Updated the 3 practical guides for the “XSS Vulnerabilities and CORS,” “Certificate Validation,” and “Security in Linux” classes. • Graded 8 groups of students in the three practical project components they had that semester.		
2023	Information And Organisational Security	University of Aveiro
Gave weakly 2-hour practical classes alongside another professor of the curricular unit in the first semester of the 2023/2024 curricular year. These activities were part of the first year of the doctoral program curriculum, where students needed to give weekly classes in a curricular unit. Apart from giving classes, the main contributions to the subject were as follows:		
• Updated and created multiple slides used to support the practical class. • Created one practical guide from the ground up for the “Containers” class. Furthermore, updated another practical guide for the “Security in Linux” class. • Graded 6 groups of students in the two practical projects they had that semester.		
Ultimately, Pedro Escalera was graded 20/20 in the curricular unit related to giving classes, a grade the Information And Organisational Security subject supervisor decided.		

Achievements

2023	Outstanding MSc Thesis Award, IEEE Portugal	Portugal
This is a prize awarded by the IEEE Portugal Section to recognize exceptional Master’s thesis in the technical areas under the scope of IEEE.		
2023	Merit Award for Masters in Information Security, AP2SI	Portugal
This is a prize awarded by AP2SI each year to an outstanding Master’s thesis in the area of Cybersecurity in Portugal. The award has an associated monetary contribution of 1000€.		
2023	Best Thesis Award — Telecommunications, APDC	Portugal
The APDC Best Thesis Award (BTA) is an annual award that aims to reward the merit of master’s dissertations by students from schools belonging to the Consortium of Engineering Schools (Consórcio das Escolas de Engenharia in Portuguese), having an associated monetary contribution of 1500€. This award was given to Pedro Escalera’s master’s thesis entitled “Securing Real World 5G MEC Deployments”, completed in 2022, in the telecommunications modality.		
2022	ETSI OSM Release Twelve Outstanding Technical Contributor Award, ETSI OSM	Europe
“In recognition of his excellent and dedicated work within ETSI OSM during its Release TWELVE cycle, for progressing various technical areas with high-quality contributions and expertise, bringing enthusiasm and team spirit to the OSM community.”		
2021	Cyber Perseu 2021 — CTF (Capture the Flag) Competition, Portuguese Army	Portugal
In combination with the CTF team, composed mostly of the Master’s in Cybersecurity students, won the Ciber Perseu’s CTF Competition. Ciber Perseu is an annual exercise organized by the Portuguese Army, open to Universities, other international armies, and the private sector, to raise awareness regarding cyber threats and incident handling.		
2021	Think Twice 3rd Edition — High Difficulty Project, Think Twice	Portugal
In conjunction with two other colleagues, won the Think Twice’s 3rd Edition competition in the High Difficulty Project modality. This project involved creating a secure web application, which the other competing teams would assess at the end.		
2019	Seeds for the Future, Huawei	Portugal/China
One of the ten Portuguese students selected for Huawei’s Seeds for the Future initiative. For two weeks, this program allowed students in the STEM fields to integrate a training program at Huawei’s headquarters in Shenzhen, China.		
2019	Academic Merit Scholarship, University of Aveiro	Portugal
Scholarship equivalent to the annual tuition fees awarded to students that continued to have an average grade equal to or higher than 17.5.		
2018	Academic Merit Scholarship, University of Aveiro	Portugal
Scholarship equivalent to the annual tuition fees awarded to students that chosen the University of Aveiro as their first choice with an average grade equal to or higher than 17.5.		

Open Source Contributions

2026	Knative Extensions — Security-Guard - Disclosed Issues: https://github.com/knative-extensions/security-guard/issues?q=is:issue+author:oEscal. - Pull Requests: https://github.com/knative-extensions/security-guard/pulls?q=is:pr+author:oEscal.
2025-26	Apache SonataFlow - Disclosed Issues: https://github.com/apache/incubator-kie-kogito-runtimes/issues?q=is:issue+author:oEscal. - Pull Requests: https://github.com/apache/incubator-kie-kogito-runtimes/pulls?q=is:pr+author:oEscal.
2025	Python SDK for Serverless Workflow - Disclosed Issues: https://github.com/serverlessworkflow/sdk-python/issues?q=is:issue+author:oEscal. - Merged Pull Requests: https://github.com/serverlessworkflow/sdk-python/pulls?q=is:pr+is:closed+author:oEscal.
2022-25	Open Source MANO (OSM) - Merged Patches: https://osm.etsi.org/gerrit/q/owner:escaleira@av.it.pt+status:merged. - Proposed Features: https://osm.etsi.org/gitlab/osm/features/issues?author_username=escaleira.
2023	Apache OpenWhisk Composer Python - Disclosed Issues: https://github.com/apache/openwhisk-composer-python/issues?q=is:issue+author:oEscal. - Merged Pull Requests: https://github.com/apache/openwhisk-composer-python/pulls?q=is:pr+is:closed+author:oEscal.
2023	(Unofficial) University of Aveiro Thesis Template Merged Pull Requests: https://github.com/detiuaveiro/ua-thesis-template/pulls?q=is:pr+is:closed+author:oEscal.
2022	Python library for the Juju API - Disclosed Issues: https://github.com/juju/python-libjuju/issues?q=is:issue+author:oEscal. - Merged Pull Requests: https://github.com/juju/python-libjuju/pulls?q=is:pr+is:closed+author:oEscal.

Disclosed Vulnerabilities

2022	CVE-2022-35503 ETSI OSM - CVE Record: https://www.cve.org/CVERecord?id=CVE-2022-35503. - Public Disclosure: https://osm.etsi.org/news-events/blog/83-cve-2022-35503-disclosure.
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Peer Reviews

JOURNALS	
2026	
Cluster Computing	1
The Journal of Supercomputing	1
Scientific Reports	1
IEEE Transactions on Cloud Computing	1
2025	
ACM Transactions on Privacy and Security	1
Computer Communications	1
IEEE Communications Standards Magazine	1
2024	
Internet Technology Letters	1
Cluster Computing	1
2023	
Internet Technology Letters	3
IEEE Communications Magazine	1

CONFERENCE PROCEEDINGS	
2026	
IEEE Symposium on Computers and Communications (ISCC)	4
INFORUM - Simpósio de Informática	2
International Conference on Telecommunications	2
IEEE Industrial Electronics and Applications Conference	1
ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems	1
2025	

IEEE Symposium on Computers and Communications (ISCC)	3
ACM international joint conference on Pervasive and Ubiquitous Computing (UbiComp) and ACM International Symposium on Wearable Computing (ISWC)	2
IEEE Global Communications Conference	2
IEEE Vehicular Technology Conference	1
2024	
IEEE Symposium on Computers and Communications (ISCC)	3
International Conference on Internet of Things, Big Data and Security	1
IEEE Middle East and North Africa Communications Conference	1
International Conference on Intelligent Systems for Cybersecurity	1
IEEE Annual Congress on Artificial Intelligence of Things (IEEE AIoT)	1
IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)	1
IEEE International Conference on Pervasive Computing and Communications	1
2023	
IEEE Conference on Standards for Communications and Networking (CSCN)	1

Workshops

2023	ETSI OSM 15 Hackfest, Mentor	<i>Barcelona, Spain</i>
	- Participated both as a Mentor and an Expert at the OSM 15 Hackfest. As a Mentor, created a challenge for participants to fix a vulnerability (CVE-2022-35503) on OSM. As an Expert, helped participants throughout the overall event. Event Page: https://osm.etsi.org/wikipub/index.php/OSM15_Hackfest.	

Public Presentations

2023	MEC Practical Realization using OSM, ETSI OSM 15 Ecosystem Day	<i>Barcelona, Spain</i>
	Event Page: https://osm.etsi.org/wikipub/index.php/OSM15_Ecosystem_Day.	
2023	Alumni Testimonials, Guidelines for Higher Education in Cybersecurity	<i>University of Aveiro, Portugal</i>
	News Article: https://www.ua.pt/en/noticias/4/80006.	
2022	Demonstration of a MEC Infrastructure deployment with OSM, 32nd RTCM Seminar	<i>University of Coimbra, Portugal</i>
	Event Page: https://rtcm.inesctec.pt/eventos/32o-seminario.	
2022	Demonstration of a MEC Infrastructure deployment with OSM, ETSI OSM 13 Ecosystem Day	<i>Europe</i>
	Event Page: https://osm.etsi.org/wikipub/index.php/OSM13_Ecosystem_Day. Presentation Recording: https://www.youtube.com/watch?v=1YmqAmFHp_I.	

Volunteering

2023	Volunteer, IEEE 9th World Forum on Internet of Things	<i>Aveiro, Portugal</i>
	Conference Page: https://wfiot2023.iot.ieee.org/.	
2019/20	Chairman of the Tax Council, AETTUA	<i>University of Aveiro, Portugal</i>
	Association Page: https://aettua.pt/. - Was also the Platform's Team Leader of the DETI4devs 2nd edition event: https://deti4devs.aettua.pt.	
2020	External Volunteer of the Global Game Jam Aveiro, Global Game Jam, University of Aveiro's Jam Site	<i>University of Aveiro, Portugal</i>
	News Article: https://www.ua.pt/en/noticias/4/62341.	
2019	External Volunteer of Sunset Hackathon's 3rd edition, Sunset Hackathon, Hardware City	<i>Ílhavo, Portugal</i>
	News Article: https://www.ua.pt/en/noticias/0/59749.	
2018/19	Rapporteur for the Tax Council, AETTUA	<i>University of Aveiro, Portugal</i>
	Association Page: https://aettua.pt/. - Was also the Platform's Team Leader of the DETI4devs 1st edition event: https://deti4devs.aettua.pt.	

Languages

English Upper intermediate proficiency
Portuguese Native proficiency

Notes

¹ <https://route-25.com/>

² <https://aate.pt/en/>

³ <https://netedge.pt/>

⁴ <https://www.augmanity.pt/>

⁵ <https://smart-edge-open.github.io/>

⁶ <https://www.ehden.eu/>