1. General Information

Name of the position	**Enabling distributed computing in swarms of cyber-physical systems**
Foreseen enrolment date	January 2025
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • École Nationale de l'Aviation Civile (ENAC) • The University of Adelaide (UoA)
Research Host	École Nationale de l'Aviation Civile (ENAC)
PhD awarding institutions	École Nationale de l'Aviation Civile & The University of Adelaide
Locations	Primary: Toulouse, France Secondary: Adelaide, Australia
Supervisors	Guthemberg Silvestre (ENAC) Rini Akmeliawati (UoA)
Group of discipline	Computer science, Robotics, Electronics, Embedded systems

2. Research topics (only one of these projects will be funded)

Project 1: *Exploring the Design of Distributed, Fault-Tolerant Computing for Nanosat Constellations*
The recent deployment of an increasing number of nanosatellites in low-earth orbit (LEO) presents new opportunities for space applications. Built atop small-sized yet powerful blocks, known as CubeSats or simply nanosats, nanosats constellations emerge as promising platforms for massive sensing and large-scale distributed computing. Indeed, they represent a cheaper, competitive alternative for traditional satellite systems for a wide range of application domains such as earth observation and defence. However, the design of distributed, intelligent systems based on nanosats is particularly challenging: nanosats have more stringent physical limitations with respect to processing/networking capability, energy supply, and connectivity among nanosats. Therefore, this project aims at investigating distributed systems problems and propose specific solutions for

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dynamic reconfiguration mechanisms, consensus algorithms, and data replication schemes on nanosats systems.

This project will be supervised by researchers from both ENAC and UoA, and it will be conducted in close cooperation with SpaceLocker company that will contribute with its invaluable experience in nanosat systems.

Supervisors: Guthemberg Silvestre (ENAC), Rini Akmeliawati (UoA) and Baptiste Fournier(SpaceLocker)

Research Fields: Distributed Systems, Computer Networks, Control Systems Design, System Modelling and Identification

Project 2: *Designing Fault-Tolerant Middleware Services in Swarms of Cyber-Physical Systems*

Cyber-Physical Systems (CPS) enable complex applications to solve real-world problems, and as a research field, they are rapidly evolving. The architecture of a CPS strongly relies on the tight coupling between the cyber components (i.e., hardware, software, including control models) and the interactions with the physical environment (basically through actuators and sensors). In contrast to traditional computer systems, the efficiency and reliability of cyber components depend not only on the platform and the inter-process communication, but on the intrinsically unpredictable interactions with the environment, as well.

This doctoral project aims to provide distributed, fault-tolerant computing techniques to foster the design of reliable applications for emerging CPS platforms. In order to face the important challenges to build such techniques properly, this project adopts a data-centric approach to design middleware services with both correctness and performance guarantees, focusing on key features including fault tolerance, Interoperability and flexibility.

This project will be supervised by researchers from both ENAC and UoA, and it will be conducted in close cooperation with SpaceLocker company that will contribute with its invaluable experience in nanosat systems.

Supervisors: Guthemberg Silvestre (ENAC), Rini Akmeliawati (UoA) and Baptiste Fournier(SpaceLocker)

Research Fields: Distributed Systems, Computer Networks, Control Systems Design, System Modelling and Identification

Project 3: *Towards Reliable Distributed Coordination for Mobile Edge Computing*

Recent years have seen rapid technological evolution in embedded systems, that have become easier yet cheaper to design and deploy. As a result, new, larger embedded platforms and experimental facilities are emerging, in particular atop swarms of Unmanned Aerial Vehicle (UAV) and constellations of small satellites. These advances brings new opportunities for the design of novel services, such as accurate natural disaster forecast from huge amounts of Earth observation data or multi-tasking robotic testbed for lunar scientific missions.

To successfully reach the aforementioned ambitious design goals, these platforms should be capable of operating reliably, at scale and, eventually, meeting real-time constraints. Yet the lack of suitable distributed protocols for coordinated, concurrent task execution is likely to hamper the efficiency of these powerful platforms, leading to undesirable waste of resources, costly operations and unpredictable performance guarantees.

Therefore, we argue that novel reliable protocols, based on shared memory, reliable communication and replication state machine (RSM), will play a key role in emerging embedded systems. For instance, we believe that RSM is a promising technique to provide challenging functionalities of new control system for robotic platforms, including autonomous, reliable multi-task execution with transparent fault tolerance.

Our goal in this doctoral project is twofold. First, we aim to study the fault tolerant techniques for reliable distributed coordination of multiple autonomous robots. Second, we aim to investigate the opportunities to

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improve the reliability of multi-task planning and control of emerging robot platforms, in particular swarms of drones and constellations of nano-satellites.
Supervisors: Guthemberg Silvestre (ENAC), Rini Akmeliawati (UoA) and Baptiste Fournier(SpaceLocker)
Research Fields: Distributed Systems, Computer Networks, Control Systems Design, System Modelling and Identification

3. Employment Benefits and Conditions

The École Nationale de l'Aviation Civile (ENAC) offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). There is a 2-month probation period and the total working hours per week is 35h.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of 29,604 EUR. Of this amount, the estimated net salary to be perceived by the Researcher is 1,982 EUR per month (before income tax). However, the definite amount to be received by the Researcher is subject to national tax legislation.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be invited to join the Marie Curie Alumni Association.
- Access to all the necessary facilities and laboratories at ENAC (University of Toulouse) and the University of Adelaide as well as the Lab Seminars.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for up to 12 months in Australia.
- Possibility to choose between 2 work cycles.
- Paid holiday leave including extra day off related to statutory reduction in working hours (number depending on the work cycle).
- Sick leave.
- Parental leave.
- Access to on-site social, cultural and sports activities.
- Tuition fee waiver at Université de Toulouse and UoA.

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4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

Applicant should meet the following specific requirements:

- Master of Science degree in Computer Science, Electrical Engineering or Mechanical/Mechatronics Engineering with excellent grades in related courses (e.g. wireless communications, networks, AI/ML, distributed systems).
- Deep understanding in wired/wireless communications and network implementations.
- Strong theoretical and practical knowledge and experience with distributed systems.
- Interest in combining theory and experiments and well-developed analytic skills.
- Excellent communication skills.
- Excellent proficiency in English (CECR : C1; IELTS : 7.0; Cambridge English Scale : 185; or equivalent).

Applicants also need to demonstrate sufficient background and experience in independent supervised research to successfully complete a PhD.

More information on ENAC's requirements

Visit the website: https://www.enac.fr/en/phd-enac-0

More information on The University of Adelaide's requirements

Visit the website: https://www.adelaide.edu.au/degree-finder/2023/hdrdoctor_philosophy.html

Short-listed applicants will need to demonstrate their suitability for entry to the program. More information: https://www.adelaide.edu.au/graduate-research/future-students/how-to-apply#step-4-apply-online

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