Expression of Interest (EoI)

MSCA Postdoctoral Fellowships 2026

Host Institution: University of the Balearic Islands (UIB) — Department of Mathematics and Informatics. SRV-INTER Group

Project

`Machine Learning-Based Reliability Assessment of TSN-Based Critical Real-Time Distributed Control Systems`

Hosting Information: University of the Balearic Islands (UIB)

Offer Deadline: July 10th, 2026
EU Research Framework: Horizon Europe - MSCA Postdoctoral Fellowships 2026
Country: Spain
City: Palma, Balearic Islands

Organisation/Institute

Organisation/Company: Universitat de les Illes Balears (UIB)
Department: Departament de Ciències Matemàtiques i Informàtica (DMI)

Contact Information

Organisation / Company Type: Higher Education Institution
Website: https://www.uib.es
Email: julian.proenza@uib.es, manuel.barranco@uib.es
State/Province: Mallorca, Illes Balears
Postal code: 07121
Street: Cra. de Valldemossa, km 7.5

Secondment/Collaboration Opportunity:

Up to eight months: Department of Engineering and Information Technology. Åbo Akademi University (Finland) - Prof. Sébastien Lafond

Description

Project Title: Machine Learning-Based Reliability Assessment of TSN-Based Critical Real-Time Distributed Control Systems

Research Context & Motivation

The digital transformation of the energy sector, aligned with the **EU Digital Decade**, is driving the deployment of **Smart Microgrids** (SMGs) as a key solution for efficient and sustainable energy management. The autonomous and dependable operation of an SMG is governed by its automation system, which is increasingly implemented through **Critical Real-time Distributed Control Systems** (CRDCs). These systems require communication networks that

guarantee both strict time determinism and ultra-high dependability. While **Time-Sensitive Networking (TSN)** has emerged as the standard for deterministic Ethernet, current reliability assessment methods are insufficient for the increasing complexity of modern CRDCs.

To maintain service continuity in the face of faults or changing demands, these systems require **dynamic reconfiguration**, which must be executed as quickly as possible to avoid instabilities or critical failures in the SMG. However, evaluating the reliability of these new configurations in real-time is a complex challenge involving aspects such as **node and task redundancy, task allocation, channel space redundancy, and message time redundancy**. As CRDCs scale, traditional stochastic analysis tools are not capable of calculating, within a time frame compatible with the urgency of reconfiguration, whether a specific system configuration is safe and reliable.

This research addresses this gap by developing a **Machine Learning-based framework** designed to provide these essential reliability assessments at the speed required by the SMG's operational constraints. By training models to recognize the complex interplay between **node redundancy** and **channel space and time redundancy**, the project aims to replace slow, traditional stochastic methods with a predictive engine. This will allow the system to assess the **reliability** of a new configuration in milliseconds, thereby **facilitating** that CRDCs **supporting** critical infrastructures can adapt to **changes in functional requirements** as well as to **node and channel failures** without compromising stability.

Goal & Objectives

The primary ambition of this project is to develop a **Machine Learning (ML)-driven framework** to provide fast reliability assessments that enable the dynamic reconfiguration of TSN-based CRDCs without compromising SMGs stability.

- **Objective 1:** To characterize the operational space of CRDCs by leveraging **stochastic models previously developed by the research team** to generate a comprehensive, labeled dataset. This dataset will model the impact of **node and task redundancy**, **task allocation**, and **channel space and time redundancy** on system reliability, providing the necessary foundation for training the machine learning models.

- **Objective 2:** To develop and train a predictive ML engine designed to replace slow, traditional stochastic analysis tools. This model will perform near-instantaneous **reliability assessments**—in the order of milliseconds—to verify if a specific configuration can support **changes in functional requirements** and survive concurrent **node and channel failures** within the strict time constraints of the SMG's reconfiguration process.

- **Objective 3:** To validate the ML engine's predictive accuracy by performing a **comparative analysis against a Ground Truth** established through traditional **stochastic models**. This objective focuses on quantifying the model's precision in estimating reliability metrics, ensuring that the high-speed ML inference maintains the mathematical rigor and consistency of formal stochastic methods.

Research Method

The project follows a rigorous **experimental and computational approach** structured around the three-stage paradigm: characterization, development, and validation. Initially, the research will focus on the **generation of a reliability dataset** by leveraging formal **stochastic models previously developed by the research team**. This stage will model the impact of **node and task redundancy, task allocation, and channel space and time redundancy** to provide a robustly labeled foundation for the learning phase. During the **development phase**, these data will be used to train a predictive ML engine designed to replace slow, traditional

analysis tools, enabling **reliability assessments** in the order of milliseconds to support **dynamic reconfiguration**. Finally, the research will perform a **comparative validation** where the ML engine's predictive accuracy is quantified against the **Ground Truth** established by the aforementioned formal stochastic methods. This process ensures that the high-speed computational inference maintains mathematical rigor and consistency. In alignment with **Open Science** practices, all datasets and models will be published in Open Access repositories (e.g., Zenodo), adhering to FAIR data standards.

Technology & Infrastructure

The fellow will have full access to:

- **Dedicated Research Resources:** High-performance computing workstations for intensive ML training.
- **High-Performance Computing (CTI):** Advanced computing resources provided by the **Centre de Tecnologies de la Informació (CTI)** at UIB. This includes access to specialized clusters and GPU-accelerated nodes, which are essential for the large-scale execution of stochastic models and the high-speed training of the proposed Machine Learning framework.
- **Full access to:** the UIB's digital library and specialized IEEE/ACM databases.
- **Workspace:** Dedicated laboratory space within the **Department of Mathematics and Computer Science** at the University of the Balearic Islands (UIB), integrated into the research group's collaborative environment.

Expected Output

The project is expected to yield high-impact results, including at least **one publication in Q1 journals**—targeting top-tier venues such as *IEEE Transactions on Industrial Informatics* or *Expert Systems with Applications* for ML-specific contributions. Additionally, the findings will be presented at flagship conferences, including **RTSS** or **ETFA** for the industrial communication focus, and **IJCAI** (*International Joint Conference on Artificial Intelligence*) or **AAAI** *Conference on Artificial Intelligence* as premier forums for the application of advanced Machine Learning frameworks.

For the fellow, this project provides a unique pathway to **professional independence** by establishing a distinct research line within the UIB's **Systems, Robotics & Vision (SRV) Group**. This will allow the fellow to gain specialized expertise in the critical intersection of Power Systems and TSN-based automation while fostering long-term collaborations with international industry leaders like **ABB**.

Proposing University

The **Universitat de les Illes Balears (UIB)** is a leading research institution. We hold the **HR Excellence in Research** award (HRS4R), ensuring a supportive, transparent, and high-quality environment for the fellow's career development.

- **Institutional Excellence and Rankings:** The **Universitat de les Illes Balears (UIB)** is a leading research institution with a distinguished track record in productivity and impact. In the global **U-Ranking 2025**, the UIB maintains the **73rd position**, while in the **U-Ranking Volume 2025**, it holds an outstanding **18th position** nationwide. Comprehensive ranking and performance data can be accessed at: `https://www.u-ranking.es/universidad/UIB`.
- **Horizon Europe Engagement:** The UIB is deeply integrated into the European Research Area, currently participating in or leading **18 Horizon Europe projects**. This

active involvement demonstrates the institution's competitiveness and its capacity to foster high-impact international collaborations, providing the fellow with a vibrant ecosystem of ongoing research, networking opportunities, and cross-disciplinary innovation.

- **MSCA Hosting Capacity:** The UIB has a proven track record in managing Marie Skłodowska-Curie Actions, having successfully participated in **9 MSCA projects within the last five years**. This extensive experience ensures that the institution provides not only a high-level scientific environment but also a robust administrative and financial support structure, fully aligned with the requirements of the Horizon Europe framework and the European Charter for Researchers.
- **Infrastructure:** The fellow will be supported by a dual-tier technical environment focused on high-performance analytical capabilities. For heavy computational workloads, such as the execution of formal stochastic models to establish the Ground Truth and the intensive training of the ML predictive engine for reliability assessment, the **UIB's Center for Information Technology (CTI)** provides high-performance computing (HPC) clusters and GPU-accelerated nodes. Additionally, the **SRV Laboratory** offers a dedicated workspace for (1) daily research and professional operations, (2) development of the ML-based framework and software tools, and (3) comparative analysis between the ML engine's outputs and formal stochastic results.
- **Mentorship and Research Environment:** The fellow will be integrated into the **Systems, Robotics and Vision (SRV)** group, and will be supervised by senior members of the **Intelligent Embedded Systems and Robotics (SRV-INTER)** unit. The supervisors bring a distinguished track record of leadership in national competitive projects, ensuring top-tier technical guidance. Furthermore, the fellow will be embedded in the broader **SRV-INTER** ecosystem, which possesses extensive experience in European-funded projects. This dual-layer support combines specialized national leadership with the group's collective expertise in the European Research Area, providing an ideal environment for the fellow's career development. Project portfolios are available at `https://srv.uib.es` and `https://www.uib.eu/research/structures/structure/SRV-INTER/`.

Our Support for Your Proposal

We don't just host you; we help you win. Candidates selected for this topic will receive:

- **Support in preparing for the MSCA Postdoctoral Fellowship application**, including individual consultation, proposal review, and guidance from experienced mentors at UIB.

Candidate Requirements

- **Degree:** PhD in **Computer Science, Industrial Engineering**, or related disciplines. The degree must be obtained by Sept 9, 2026, and no earlier than Sept 2018.
- **Prior Knowledge:** While not required, experience in **industrial ethernet communications** (particularly TSN standards), **embedded systems programming**, and **network instrumentation and simulation tools** is desirable. Knowledge of **Artificial Intelligence (AI)** and **intelligent agents** for the development of autonomous configuration modules, as well as prior experience with fault-tolerant architectures or power system automation, will be positively valued.
- **Mobility Rule:** Candidates must not have resided in **Spain** for more than 12 months in the 3 years immediately prior to the call deadline.

Interested?

Interested candidates should send the following to `julian.proenza@uib.es` by **July 10th, 2026**, with subject "MSCA Postdoctoral Fellowships 2026":

1. A brief CV (max 2 pages).
2. A motivation letter (1 page) outlining research alignment.
3. A 1-page summary of your proposed research idea.

More information

We look forward to building a winning proposal with you!