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

`Fault-Tolerant Subsystem for Monitoring, Fault Diagnosis, and AI-based Failure Prediction 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

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Secondment/Collaboration Opportunity:

Up to eight months: Dependable Software Engineering research group. Mälardalen University (Sweden) - Prof. Sasikumar Punnekkat

Description

Project Title: Fault-Tolerant Subsystem for Monitoring, Fault Diagnosis, and AI-based Failure Prediction of TSN-Based Critical Real-Time Distributed Control Systems

Research Context & Motivation

The modernization of the electrical grid through Smart Microgrids (SMGs) demands ultra-reliable Automation Systems, typically implemented as Critical Real-time Distributed Control Systems (CRDCs). As CRDCs transition to the use of **Time-Sensitive Networking**

(TSN)—which is poised to become the global communication standard for deterministic Ethernet within the **Industry 4.0** framework—a prime opportunity arises to pioneer a reliable infrastructure for monitoring the CRDCs status, as well as for diagnosing and predicting faults of the CRDCs themselves. Such an infrastructure is vital for real-time monitoring and fault diagnosis, with the added benefit of enabling **proactive fault prediction** to anticipate and mitigate potential breakdowns before they impact the SMG stability.

The management of these TSN networks is carried out via an entity called the **Centralized Network Configuration (CNC)**, which relies on data models such as YANG and protocols like NETCONF to represent and acquire data about the status of the network. However, current data acquisition solutions often lack the necessary resilience. If data acquisition fails, the CRDC loses its "eyes," rendering monitoring, fault diagnosis, and proactive maintenance impossible. Most existing data acquisition approaches do not address the reliability of data acquisition itself, nor do they integrate AI-based fault prediction capabilities.

To ensure the continuity of critical SMGs (e.g., in hospitals and power plants), it is imperative to develop a **data acquisition subsystem** that is as resilient as the control traffic it observes. This requires implementing robust redundancy mechanisms for the monitoring-, diagnostic-, and prediction-related traffic flowing between bridges, end-nodes, and the CNC, ensuring that status data reach the management entity (the CNC) even under adverse network conditions. Only through this dependable feedback loop can the **CNC effectively monitor, diagnose faults, and perform AI-based fault prediction**.

Goal & Objectives

The primary ambition of this project is to develop and validate a **Fault-Tolerant Data Acquisition Subsystem (FT-DAS)** for TSN-based CRDCs. This subsystem will provide the necessary reliability for the monitoring, diagnostic, and prediction-related data plane.

- **Objective 1:** To design a fault-tolerant data acquisition architecture based on YANG / NETCONF that guarantees the delivery of critical data from bridges and end-nodes to the CNC by implementing integrated spatial (path) and temporal (retransmission) redundancy for the acquisition channel.
- **Objective 2:** To develop an AI-based engine, integrated within the Centralized Network Configuration (CNC) entity, capable of diagnosing faults and predicting early signs of degradation in TSN components using the continuous streams of status data provided by the resilient acquisition channel.
- **Objective 3:** To implement and validate a prototype of the FT-DAS within the UIB's experimental TSN testbed, demonstrating its capacity to maintain the feedback loop's integrity and meet real-time constraints without interfering with primary control traffic, even under failure scenarios.

Research Method

This project follows the three-stage paradigm (specification, design, and evaluation). Initially, the research will focus on the **specification of a joint fault model** that considers both the CRDC and the monitoring subsystem. During the **design phase**, we will decide on **YANG data models** tailored for fault-tolerant telemetry and define how faults affecting the status data traffic (NETCONF messages) should be tolerated. In particular, we will decide how to use **space and time redundancy** channel redundancy to ensure that no single point of failure (SPOF) exists between the end-nodes, bridges, and the CNC. For the **evaluation phase**, we will use the UIB's experimental infrastructure to perform Hardware-in-the-Loop (HiL) testing. Using

FPGA-based fault injection, we will inject link and node failures in complex topologies to measure key performance indicators such as the "Time to Diagnose" and the accuracy of AI-based fault predictions under degraded network states. The project will adhere to **Open Science** and FAIR data standards, publishing results in Open Access venues and sharing datasets via Zenodo.

Technology & Infrastructure

The fellow will have full access to:

- **Experimental TSN Testbed:** A high-fidelity Hardware-in-the-Loop (HiL) infrastructure comprising a complex topology of interconnected industrial-grade TSN switches and peripheral devices for medium or large scale validation.
- **Advanced Validation Tools:** Full access to FPGA-based fault injection platforms, real-time Ethernet network analyzers, and timing analysis software to ensure strict real-time compliance.
- **Dedicated Research Resources:** High-performance computing workstations for modeling, training and simulation.
- **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 a Q1 journal** (e.g., *IEEE Transactions on Industrial Informatics*) and presentations at flagship conferences such as **RTSS** or **ETFA**. Beyond academic output, the project aims to produce a **proof-of-concept prototype** of status data acquisition Fault-Tolerant subsystem, and of a Monitoring Agent integrated into a CNC, which could lead to technology transfer opportunities with industrial partners such as **TTTech** or **SOC-E**.

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. For heavy computational workloads, such as training AI failure-prediction models or simulating TSN communications, the **UIB's Center for Information Technology (CTI)** provides high-performance computing (HPC) resources. Additionally, the **SRV Laboratory** offers a dedicated workspace for (1) daily research and professional operations, (2) mid-range computing and software development, and (3) specialized **prototyping and testing** on an industrial-grade TSN-based communications infrastructure, including instrumentation tools for injecting faults and validating the monitoring and fault-diagnosis subsystem.
- **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, Telecommunications Engineering**, or related disciplines. The degree must be obtained by Sept 9, 2026, and no earlier than Sept 2018.
- **Prior Knowledge**: While not mandatory, experience with **TSN standards**, **NETCONF/YANG** protocols, and Machine Learning for time series or anomaly detection will be considered an asset. Proficiency in network simulation (OMNeT++) and industrial embedded systems will also be considered an asset.
- **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!