PUBLISHABLE SUMMARY

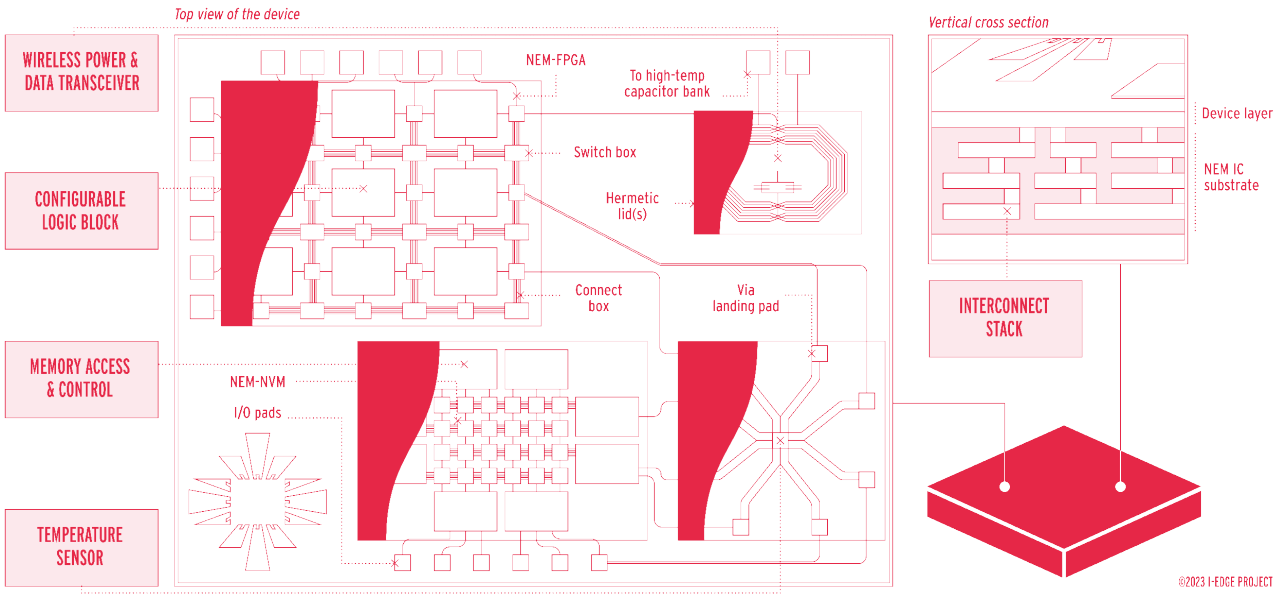
January 2023 – June 2024

1. Context and overall objectives of the project

Many Internet of Things (IoT) applications in various sectors like manufacturing (circular economy), automotive, aerospace, and power generation operate in challenging environments. These environments, often involving high temperatures and/or high radiation levels, pose significant limitations for conventional electronics.

The i-EDGE project introduces a groundbreaking nanoelectromechanical (NEM) switch technology platform specifically designed for IoT edge devices operating under demanding conditions. This technology offers key advantages:

- High-Temperature Tolerance: i-EDGE devices can function effectively under high temperatures up to 300°C.
- Radiation Resistance: They are resistant to high radiation levels up to 1 Mrad.
- Zero Standby Power Consumption: These devices eliminate standby power consumption, improving overall efficiency.



Schematic representation of the i-EDGE device

The project will develop a proof-of-concept demonstrator showcasing a System-on-Chip (SoC) IoT node built with NEM technology. This node will include:

- Field-Programmable Gate Array (FPGA): The FPGA fabric itself will be based on NEM switches, enabling digital logic functionality.
- Non-Volatile Memory Array: The SoC will integrate non-volatile memory for data storage.
- Analog Utility Blocks: These blocks will handle wireless power transfer, data communication, and sensor data readout, facilitating interaction with the FPGA and memory.
- High-Temperature Capacitor Bank: This bank will provide power to the IoT node.
- Wireless Power Receiver: The receiver will enable trickle charging of the capacitor bank.
- Simple Data Transceiver and Sensor Readout: These components will ensure efficient data transmission and sensor interaction.

The project also aims to create a dedicated NEM physical design kit (PDK). This kit will empower application engineers by providing tools for design and circuit simulation, simplifying the development process.

The i-EDGE technology will be demonstrated through a practical condition monitoring application designed for industrial IoT processes. This builds upon previous EU and national projects that have already advanced to Technology Readiness Level (TRL) 3. Through i-EDGE, the technology will be further developed to TRL 5.

The i-EDGE consortium possesses the comprehensive expertise required to establish a complete supply chain. This chain will encompass everything from designing basic logic and memory cells to creating full Systems-on-Chip. Additionally, the project will explore a path towards pilot manufacturing of NEM technology within Europe. This initiative aligns perfectly with the vision of the EU Chips Act, which aims to strengthen Europe's position in chip design and manufacturing. By achieving these goals, i-EDGE will empower the development of a new generation of resilient and efficient IoT devices capable of operating in previously inaccessible environments.

2. Work performed and main achievements

In the first 18 months of the project, we have:

- Created initial system specifications.
- Designed key components: NEM switches, non-volatile memory, FPGA, and utility circuits for wireless power, sensor data, and communication.
- Developed a toolkit for designing and simulating circuits. This tool will be accessible to others even without deep NEMS knowledge, promoting future use of the technology.
- Fabricated and tested various NEM switches (3, 4, and 7 terminals).
- Initiated work on integrating NEM switches into existing manufacturing processes.
- Exploring options for small-scale manufacturing.
- Established a Business Interest Group (BIG) to explore future uses and commercialisation of the i- EDGE technology.

For additional information, please visit our project's website https://www.i-edge-project.eu/, where you will find an introductory video at https://vimeo.com/900829825?fl=pl&fe=vl and a flyer and media kit available for download.

3. Progress beyond the state of the art

Scientific Impact:

The i-EDGE project has already laid the groundwork for several publications in prestigious peer-reviewed journals. This demonstrates the project's significant contribution to the scientific and technological advancement of NEM switch electronics. These publications showcase the project's innovative approach and its potential to push the boundaries of this field.

Beyond Academia:

While still in its early stages, i-EDGE has a bold vision that goes beyond pure academic research. The project aims not only to develop the underlying NEM switch technology but also to pave the way for its commercialisation. This includes identifying initial 'incubator applications' – specific practical uses for the technology that can be developed and brought to market early on. By focusing on these initial applications, i-EDGE can demonstrate the real-world value of the technology and attract potential commercial partners. This dual focus on scientific advancement and commercialisation positions i-EDGE as a leader in the field, poised to bridge the gap between cutting-edge research and practical applications

Policy relevant evidence of your project

The i-EDGE project directly supports several key EU initiatives:

- EU Chips Act: i-EDGE strengthens Europe's position in the Internet of Things (IoT) device market by developing a technology independent of foreign sources. This aligns perfectly with the EU Chips Act's aim of boosting European competitiveness and autonomy in the semiconductor industry.
- Green Deal and Climate Neutrality: i-EDGE's low-power technology enables energy-efficient edge computing. Furthermore, its ability to operate in harsh environments opens doors for sensor data collection and real-time computation in areas like industrial settings (bakery ovens), aerospace (airplane engines) and many other fields. This data can be used to optimize processes and reduce energy consumption, supporting the European Green Deal and the EU's push towards climate neutrality.

Partners involved in i-EDGE

AMO	**Gesellschaft für Angewandte Mikro- und Optoelektronik mbH**
KTH	**Kungliga Tekniska högskolan**
TUWIEN	**Technische Universitaet Wien**
Microchip-FR	**Microchip Technology Nantes**
CSEM	**Centre Suisse d'Electronique et de Microtechnique SA – Recherche et Développement**
SCIPROM	**SCIPROM Sàrl**
UNIVBRIS	**University of Bristol**
Microchip-UK	**Microchip Technology Caldicot Limited**

UK Research and Innovation

Schweizerische Eidgenossenschaft
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www.i-edge-project.eu