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6GSNS

SUPERIOT

D5.2 Public demonstration and workshop

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Project name	**Truly Sustainable Printed Electronics-based IoT Combining Optical and Radio Wireless Technologies**
Project acronym	**SUPERIOT**
Call	**HORIZON-JU-SNS-2022**
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Deliverable Name	**Public demonstration and workshop**
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Lead beneficiary	**UOULU**
Authors	Tuomas Paso (editor), UOULU
Reviewer:	Bruce Napier, VIVID

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Executive Summary

This document summarizes the event *2nd Workshop on Energy Neutral and Sustainable IoT Devices and Infrastructure* (*EN-IoT 2025*) organized on 22nd of September 2025 in conjunction with the 22nd International Conference on Embedded Wireless Systems and Networks (EWSN) in Leuven, Belgium. In the context of the Smart Networks and Services Joint Undertaking (SNS JU) project SUPERIOT, the EN-IoT 2025 acted as the contractual event defined in the DoA as D5.2 Public demonstration and workshop.

The EN-IoT 2025 workshop comprised of a keynote presentation "Fostering sustainability in IoT solutions: the need for science-based ecodesign and for a holistic efficiency-sufficiency approach" by Prof. David Bol (UCLouvain) followed by three regular paper presentations:

- Aymen Hamrouni: "*Context-Aware Hybrid Radio-Optical IoT Networks"*
- Mateen Ashraf: "*Evaluating Task Execution Performance Under Energy Measurement Overhead"*
- Muhammad Danyal Khattak: "*Testbed and Empirical Current Consumption of 5G Reduced Capability Devices"*

Furthermore, the following public demonstrations were given the showcase the technology developed in the SUPERIOT project:

- Dr. Juha Häkkinen (UOULU): Energy harvesting demonstration
- Marcin Drzewiecki (MPICOSYS): Basic SUPERIOT system demonstration

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Editions

Version	Date	Modified by	Modification
0.1	2025-12-16	Tuomas Paso, UOULU	Draft for internal review
1.0	2025-12-19	Tuomas Paso, UOULU	Final version for submission

1 Acronyms

DoA	Description of the Action
EN-IoT	Energy Neutral and Sustainable IoT Devices and Infrastructure
EWSN	Embedded Wireless Systems and Networks
IoT	Internet of Things
OPC	Organic Photovoltaic
Si	Silicon
SNS	Smart Networks and Services
SNS JU	Smart Networks and Services Joint Undertaking
SUPERIOT	Truly Sustainable Printed Electronics-based IoT Combining Optical and Radio Wireless Technologies

2 Introduction

This document summarizes the event *2nd Workshop on Energy Neutral and Sustainable IoT Devices and Infrastructure* (*EN-IoT 2025*) organized on 22nd of September 2025 in conjunction with the 22nd International Conference on Embedded Wireless Systems and Networks in Leuven, Belgium. In the context of the SUPERIOT project, the EN-IoT 2025 acted as the contractual event defined in the DoA [1] as D5.2 Public demonstration and workshop.

The workshop brought together experts in IoT (Internet of Things) and sustainability to discuss the latest developments and innovations in energy-neutral and sustainable IoT devices and infrastructure. It comprised of a keynote presentation and three regular paper presentations followed by two public demonstrations from the SUPERIOT project. A detailed agenda of the workshop is presented in Annex 1.

The event was co-organized in collaboration with the following projects:

- SUPERIOT
- Hexa-X-II
- AMBIENT-6G
- INTERACT
- 6G Flagship

The following persons formed the event's organizing committee:

- Konstantin Mikhaylov (University of Oulu, Finland; SUPERIOT, INTERACT & 6G Flagship)
- Onel L. Alcaraz López (University of Oulu, Finland; HEXA-X-II, AMBIENT-6G & 6G Flagship)
- Ritesh Kumar Singh (University of Antwerp & IMEC, Belgium; HEXA-X-II & AMBIENT-6G)
- Jeroen Famaey (University of Antwerp & IMEC, Belgium; HEXA-X-II & AMBIENT-6G)

3 Presentations

Prof. Konstantin Mikhaylov (Figure 1). opened the workshop by presenting an overview of the agenda (Appendix 1) and by giving a brief introduction on the topics of the workshop.

Figure 1. Prof. Konstantin Mikhaylov (UOULU) opening the workshop.

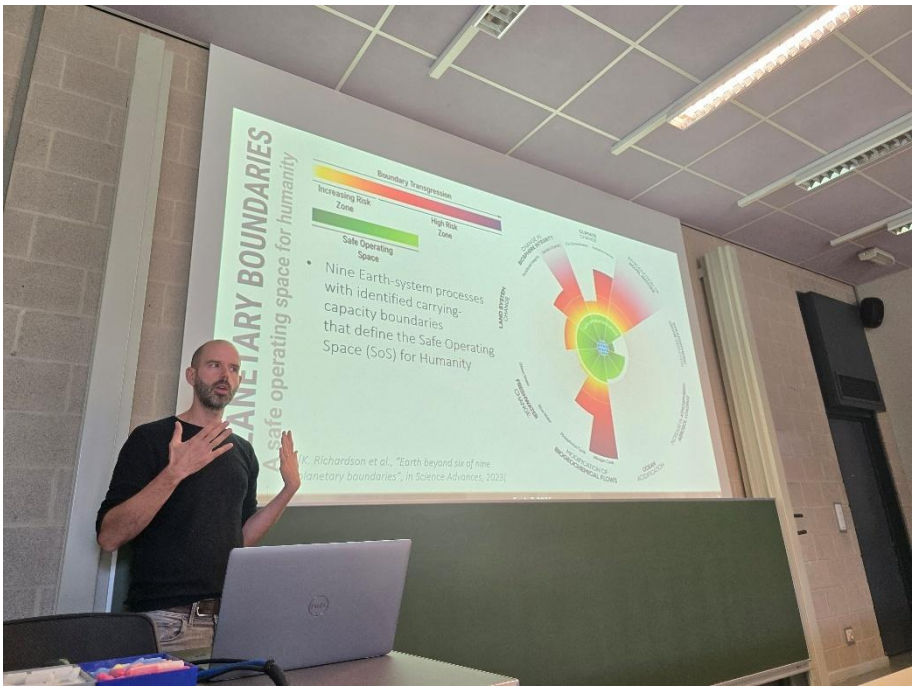

Figure 2. Prof. David Bol (UCLouvain) giving a keynote presentation.

The first presentation was a keynote "Fostering sustainability in IoT solutions: the need for science-based ecodesign and for a holistic efficiency-sufficiency approach" given by Prof. David Bol (UCLouvain) (Figure 2). In his keynote, he emphasized that IoT solutions can enhance automation and efficiency across sectors, but their widespread deployment poses significant environmental challenges throughout their life cycle. To mitigate these impacts, eco-innovation must be grounded in life-cycle assessment and consider both positive and negative indirect

effects, avoiding pitfalls like burden shifting and rebound mechanisms through a holistic approach combining efficiency and sufficiency.

The keynote was followed by presentations of three regular papers by Aymen Hamrouni (Figure 3), Mateen Ashraf (Figure 4), and Muhammad Danyal Khattak (Figure 5).

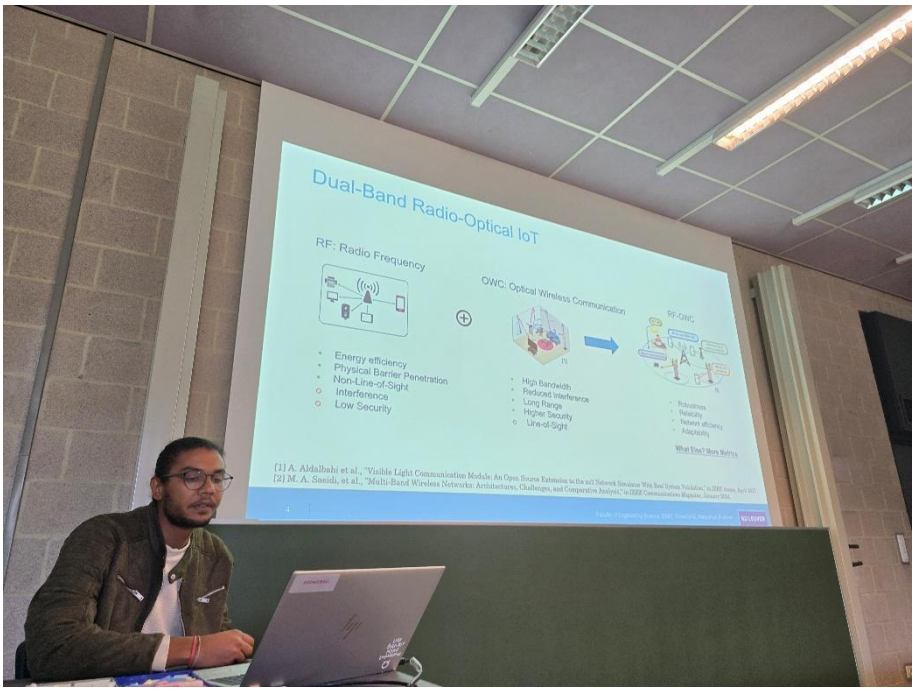

Figure 3. Aymen Hamrouni presenting his paper "*Context-Aware Hybrid Radio-Optical IoT Networks".*

Figure 4. Mateen Ashraf presenting his paper "Evaluating Task Execution Performance Under Energy Measurement Overhead".

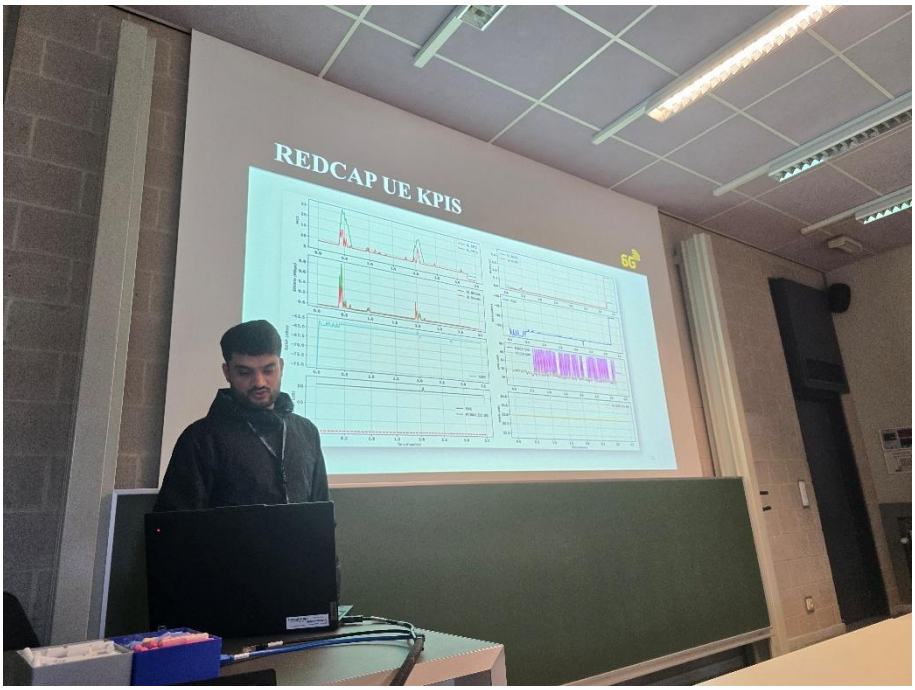

Figure 5. Muhammad Danyal Khattak presenting his paper "Testbed and Empirical Current Consumption of 5G Reduced Capability Devices".

4 Demonstrations

The workshop included two demonstrations from the SUPERIOT project: an energy harvesting demonstration by Dr. Juha Häkkinen (UOULU) and a basic SUPERIOT system demonstration by Marcin Drzewiecki (MPICOSYS).

4.1 Energy harvesting demonstration

This demonstration (please see Figure 6) presents the capability to run continuous sensing with the hybrid node on harvested energy. It utilizes silicon (Si) based solar cells and a flat super capacitor. The demonstration is ready for printed OPVs (organic photovoltaics) super capacitors.

Figure 6. Dr. Juha Häkkinen (UOULU) presenting the energy harvesting demonstration.

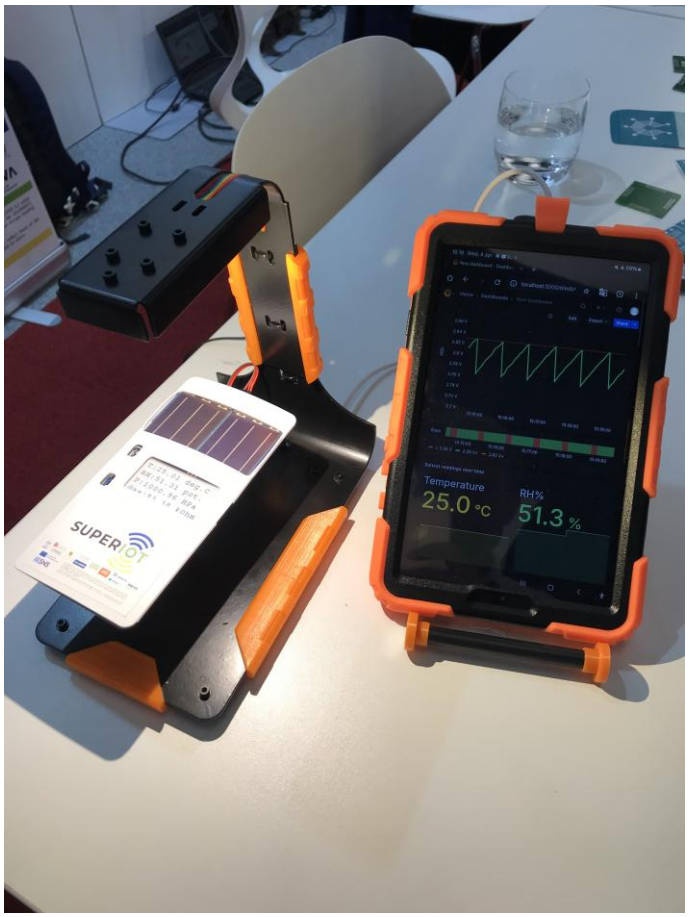

Figure 7. Equipment of energy harvesting demonstration (photo taken at EuCNC'25 conference).

4.2 Basic SUPERIOT system demonstration

The basic SUPERIOT system demonstration (Figures 8-12) has the following features and functionalities:

- Bidirectional multimode optical-radio communication
- DL and UL by light and RF
- Optical-radio reconfigurability
- Positioning with the light to the room-level accuracy
- Sensing
- Temperature, pressure, humidity, gas
- Actuating (e-paper)
- **-> Reconfigurability**
- **-> Sustainability by design**

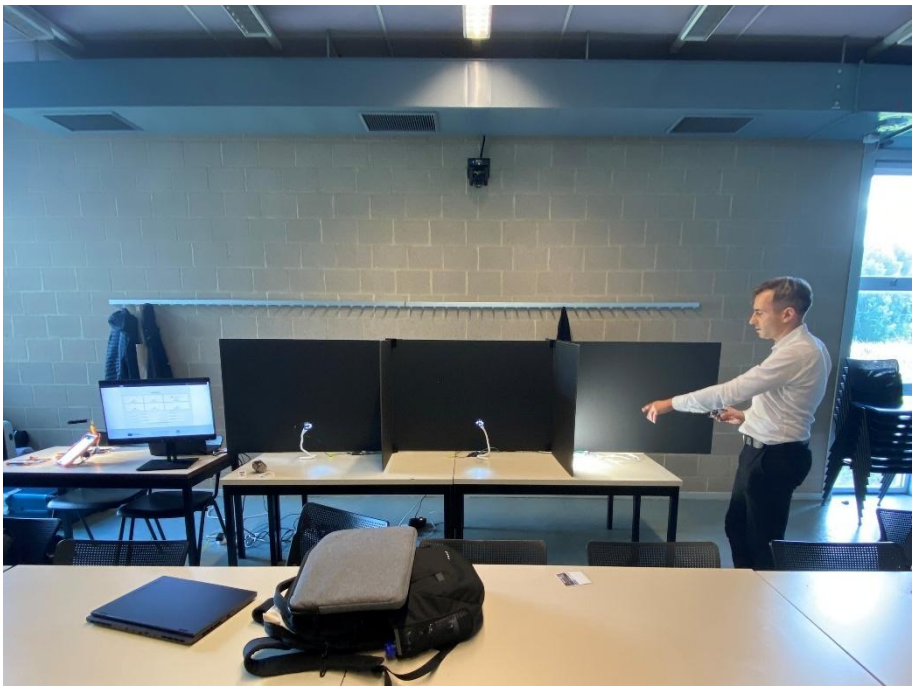

Figure 8. Marcin Drzewiecki (MPICOSYS) presenting the basic SUPERIOT system demonstration.

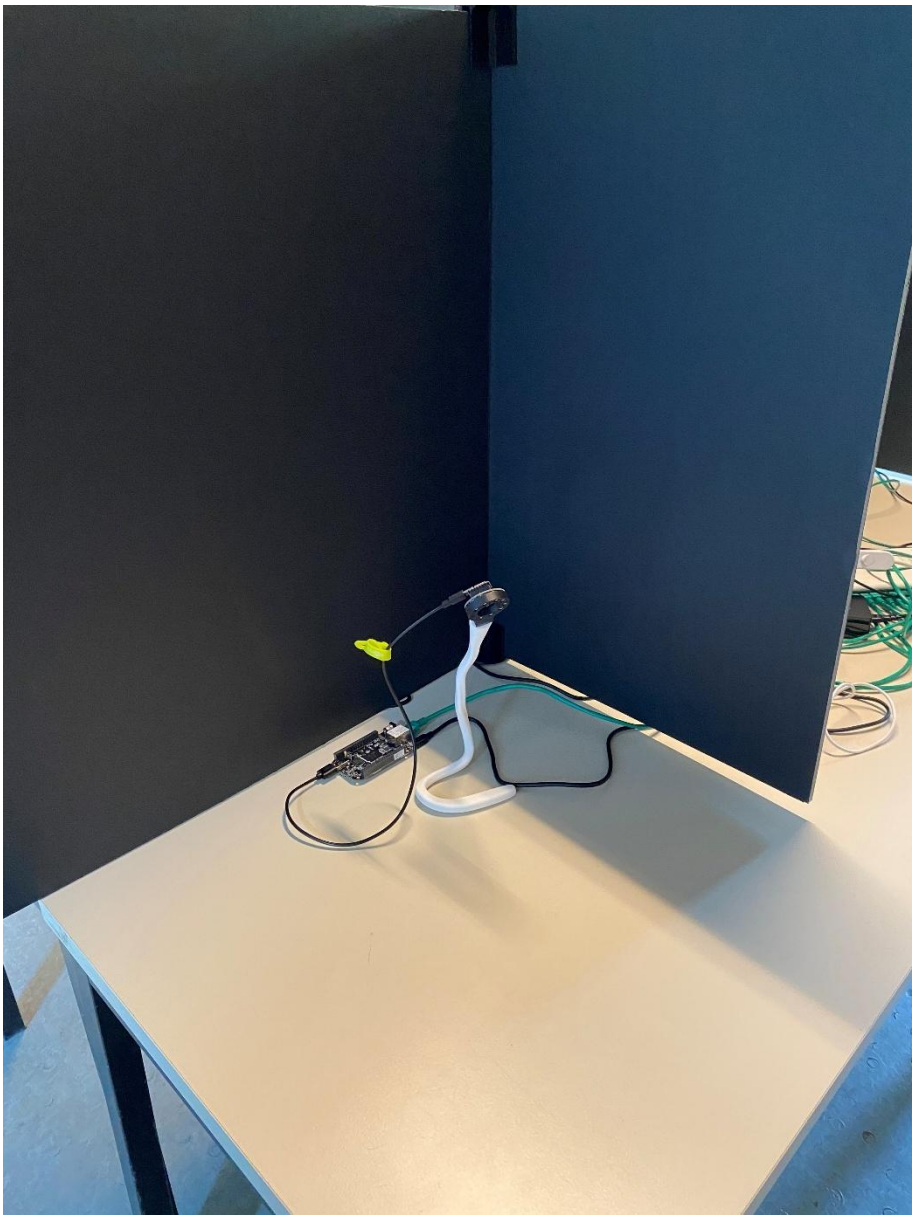

Figure 9. Basic SUPERIOT system demonstration equipment.

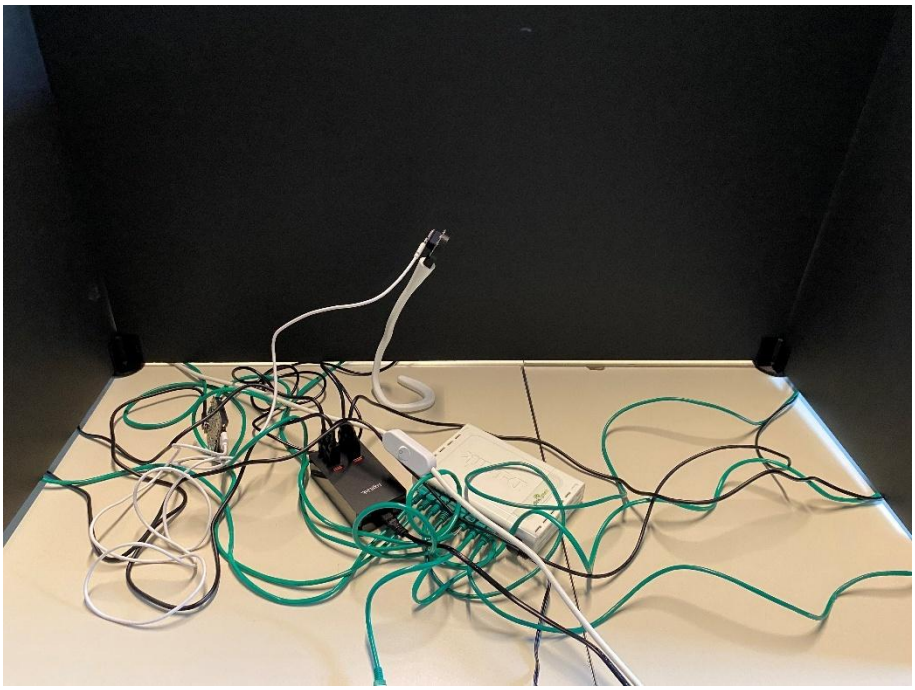

Figure 10. Basic SUPERIOT system demonstration equipment (2).

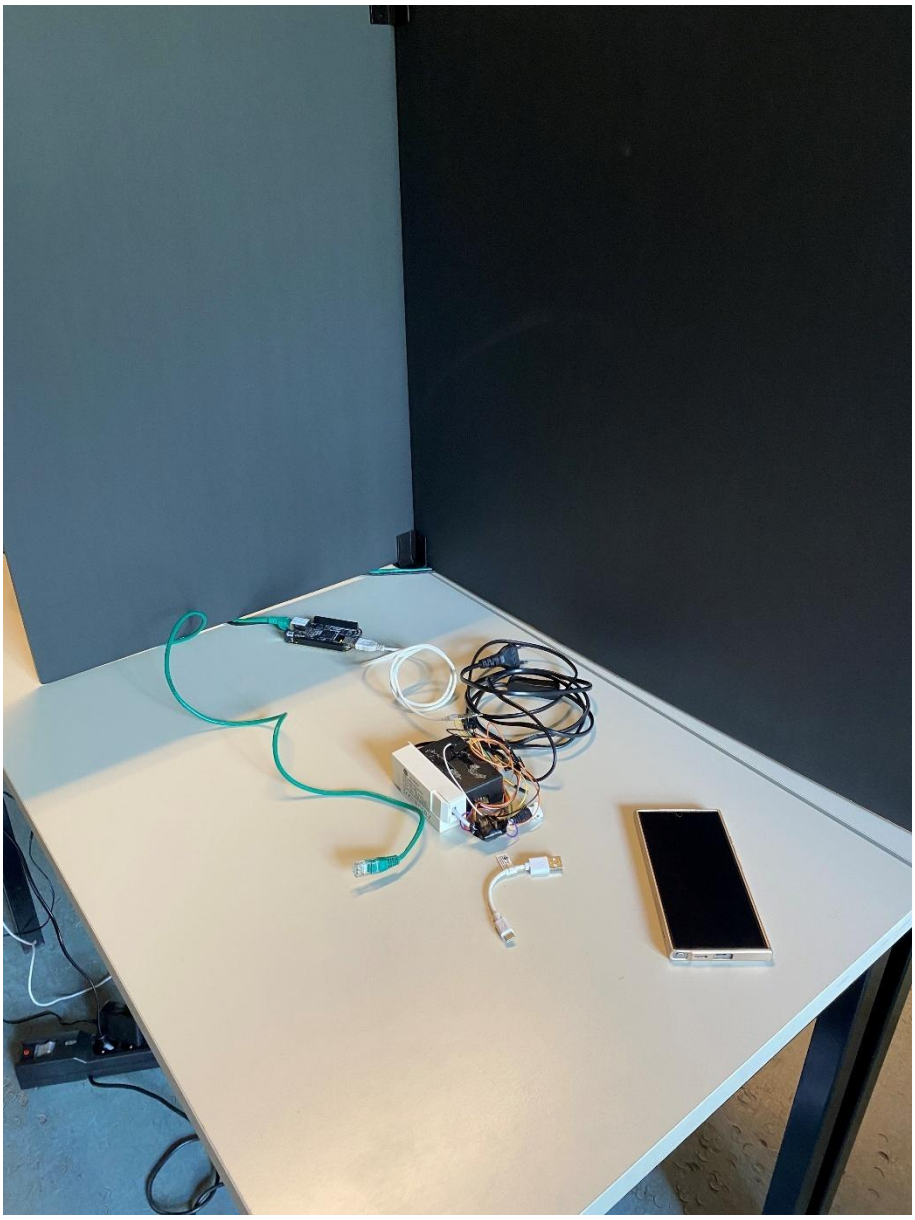

Figure 11. Basic SUPERIOT system demonstration equipment (3).

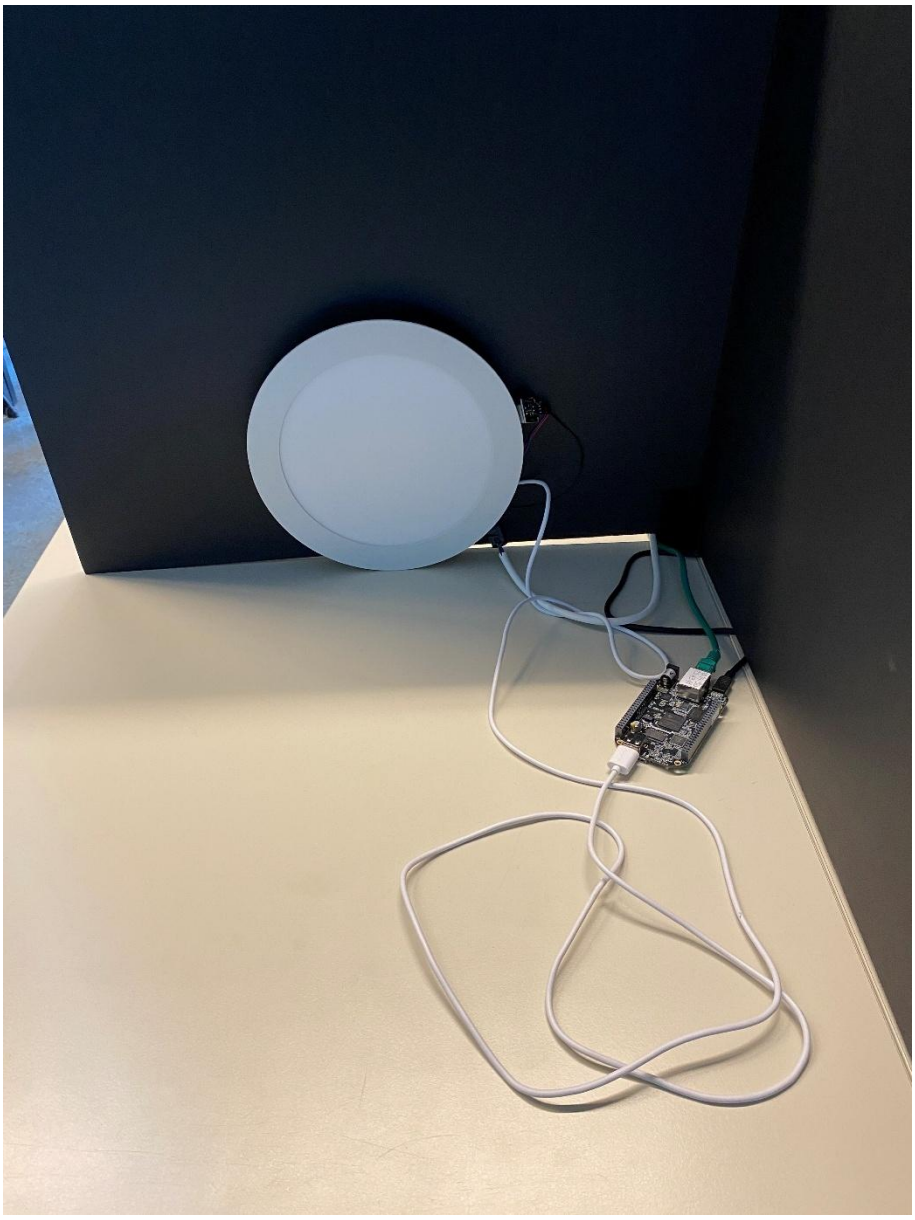

Figure 12. Basic SUPERIOT system demonstration equipment (4).

5 Bibliography

[1] SUPERIOT HORIZON-JU-SNS-2022 project no 101096021, "Grant Agreement," v1.0, 18 November 2022.

6 List of figures

7 List of contributors

Contributors	Short name	Country
OULUN YLIOPISTO	UOULU	Finland

8 Appendix 1: Agenda

13:30 Workshop Opening

13:35 Keynote: Prof. David Bol, UCLouvain, *"Fostering sustainability in IoT solutions: the need for science-based ecodesign and for a holistic efficiency-sufficiency approach"*

14:35 Aymen Hamrouni, *"Context-Aware Hybrid Radio-Optical IoT Networks"*

15:00 Coffee Break

15:20 Mateen Ashraf, *"Evaluating Task Execution Performance Under Energy Measurement Overhead"*

15:45 Muhammad Danyal Khattak, *"Testbed and Empirical Current Consumption of 5G Reduced Capability Devices"*

16:10 Public Technology Demonstration by the SUPERIOT Horizon Europe project and Open Networking

16:40 Workshop close