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Title: D4.2 Report on the created five joint university-
company labs ruled by an agreement

Lead Organization: UdelaR

Participating Organizations: UNI-KLU, UC3M, UNC, UNS, UNMDP, UCU,
INCUTEX, ALASSIO, ALENET, EYCON, ALLIANSYS
SRL, Santex, TELECOM ARGENTINA S.A,
CONTROLNET S. A., ABM ingeniería y sistemas
S.R.L., UTE, CONAE.

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Disclaimer:

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5	27/11/23	Rosina D'Eboli	UdelaR	Final Revision

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1. Introduction

The NEON project's primary aim is to enhance training and skill development in both academic and public-private sectors, specifically within the field of Internet of Things (IoT) technology. It seeks to establish a Network of Competence (NoC) for IoT among its participating institutions.

The project focuses on fostering collaboration with industries in Argentina and Uruguay, with support and guidance from experienced European partners in Austria and Spain. This collaboration entails updating academic curricula, setting up IoT laboratories, training faculty members, and promoting cooperation between local and regional industries.

In Latin America, particularly in Argentina and Uruguay, there are disparities in opportunities due to a growing population, urbanization, and a reliance on primary industries like agriculture. High-tech sectors, including ICT, are underdeveloped, contributing to high unemployment rates. The IoT field offers potential solutions across various domains, such as agriculture, energy, healthcare, and smart cities.

The European Union's involvement in the project aims to modernize engineering education by integrating IoT knowledge and skills from EU Higher Education Institutions. This collaboration aims to produce highly skilled graduates specializing in IoT, fostering innovation within ICT companies at the EU level. It involves curriculum enhancements, innovative teaching methods, new laboratories, and internships to prepare students for the global job market and increase their mobility.

NEON's emphasis on IoT aligns with the EU's strategy for promoting ICT applications in society and the economy. Achieving these goals necessitates strong collaboration between Latin American and EU HEIs, including the exchange of best practices, mutual recognition of degrees, and industry partnerships. This collaboration benefits Latin American companies by increasing their visibility at the EU level and potentially reducing the emigration of experts while attracting talent from Europe.

In the present deliverable, **D4.2**: "Report on the created five joint university-company labs ruled by an agreement", will detail joint HEI-industry labs, covering their technical and administrative operation throughout and after the project, with a focus on enhancing industry and student capacity. This report takes part of the **WP4**: "Development and implementation of laboratories", which is led by UdelaR. In this work package, Latin American HEIs partners will upgrade the lab infrastructure through the development of novel thematic joint industry-academia labs.

The tasks to be evaluated are listed below and complement the D4.1 Development and implementation of laboratories.

- **T4.2**: Pilot lab development. The purpose is to develop a complete undergraduate or graduate lab with pedagogical/technological tools in the domain of IoT.
- **T4.3**: Pilot lab development. The purpose is to develop a complete undergraduate or graduate lab with pedagogical/technological tools in the domain of IoT, regarding introductory Lab, Smart grids and hardware for IoT.

The author of the report is the lead organization of the WP4: Universidad de la República (UdelaR).

2. Objectives of the Deliverable

This report aims to gather the final characteristics of the laboratories established jointly by HEIs and industries. It will also examine their technical and administrative operation, during and beyond the project lifetime. This report will highlight the commitment to enhancing the capacity building of both

the industries involved and the students engaged in these initiatives. The assessment will focus on the following items:

- Collaborate with selected industrial partners during the lab design and selection phase.
- Ensure ongoing collaboration with industrial partners during the equipment purchase phase.
- Facilitate staff training in coordination with industrial partners.
- Manage lab demonstration and usage both during and after the project's duration.
- Foster a sustainable collaboration with industrial partners beyond the project's lifetime.

3. Joint industry-academia labs

The Latin American university partner develop joint industry-academia labs focused in IoT domain. The five modern industry-academia labs are the following

- Signal Processing for Communications laboratory (UNS) – Modernized lab
- Communications Technology applied to IoT (UNdMP)
- Digital Communications Laboratory (UNC)
- IoT for agribusiness Laboratory (UCU)
- IoT Laboratory (UdelaR)

The five laboratories are already created. The equipment was purchased and installed to reinforce the labs. The UNMDP ha significant difficulties in completing the procurement of equipment but finally they fully completed.

The equipment has been used in different project activities primarily for teaching and training but also for some more advanced research engaging graduate students as planned in the project proposal.

Following a more detailed description of the installation and purpose of each laboratory.

- UNS installed the equipment in two specific laboratory areas designated for both undergraduate and graduate students, focusing on teaching and research.
- UNMDP utilizes the equipment in two designated laboratory spaces, primarily for teaching, within the Department of Electronics and Computing. These areas are specifically allocated for the use of both undergraduate and graduate students.
- UNC deployed the devices in the Laboratory of Digital Communication (LCD) to facilitate practical work for both undergraduate and postgraduate students. The SDR laboratory offers continuous remote access through a VPN and a Jupyter server, enabling students to configure a variety of experiments. An IoT lab is designated for deployment in classrooms, while another IoT network is established at the LCD with local access.
- UCU set up the equipment in the Engineering Department's "Design Lab," exclusively devoted to the development of IoT projects and applications. Additional equipment is positioned in the agribusiness sector, specifically at a "Test Site" operated in collaboration with a company.
- Udelar implemented the equipment in two labs dedicated to undergraduate practice and one for postgraduate research activities. Nevertheless, the majority of the equipment will be utilized by courses that either adopt or have already embraced lab-at-home methodologies. Consequently, electronic kits, devices, and instruments will be furnished to students or student teams throughout the duration of the courses.

Photos of each implemented laboratory are attached in Appendix 7.1.

In the next section, the formal agreements of cooperation established with companies are detailed.

4. Joint Lab Cooperation Agreements

Higher education institutions reached out to industries for insights into the preferred testbeds for training their employees and prospective engineers in the IoT field. Both industries and industry chambers indicated their keen interest in moving forward with this initiative. This initial contact were reported in D4.1.

Higher education institutions (HEIs) and numerous industries have effectively signed Memorandum of Understanding (MoU) agreements, laying the foundation for productive collaboration with a broad focus encompassing not just engineer training but also research and development of IoT projects.

Next, we have listed the Memorandum of Understanding subscribed by our partners with industry entities¹:

- UNMDP:
 - Lyrtron
 - PONCE
 - Digimage Electronica
 - TechInside
- UCU:
 - Alassio S.A.
 - Alenet S.A
 - Batfer Investment S.A
 - Laured S.A.
 - Minegold S.A.
- UNC:
 - Incutex
 - CONAE (Comision Nacional de Actividades Espaciales)
- UNS:
 - Penta
 - Alliansys
- UDELAR:
 - Focus
 - Silvermist
 - Intendencia de Montevideo – Unidad Técnica de Alumbrado Público
 - Liderfox
 - Antel
 - GranjaUtica

Since the last update of the MoUs agreed upon between HEIs and various industries (documented in D4.1), Udelar and UNC have entered into additional agreements.

All the agreements made are shown the following [link](#), and the list of contacts for the companies can be found at this other [link](#).

¹ The partial list of MoU signed up to the last meeting in Klagenfurt in May was presented in D4.1.

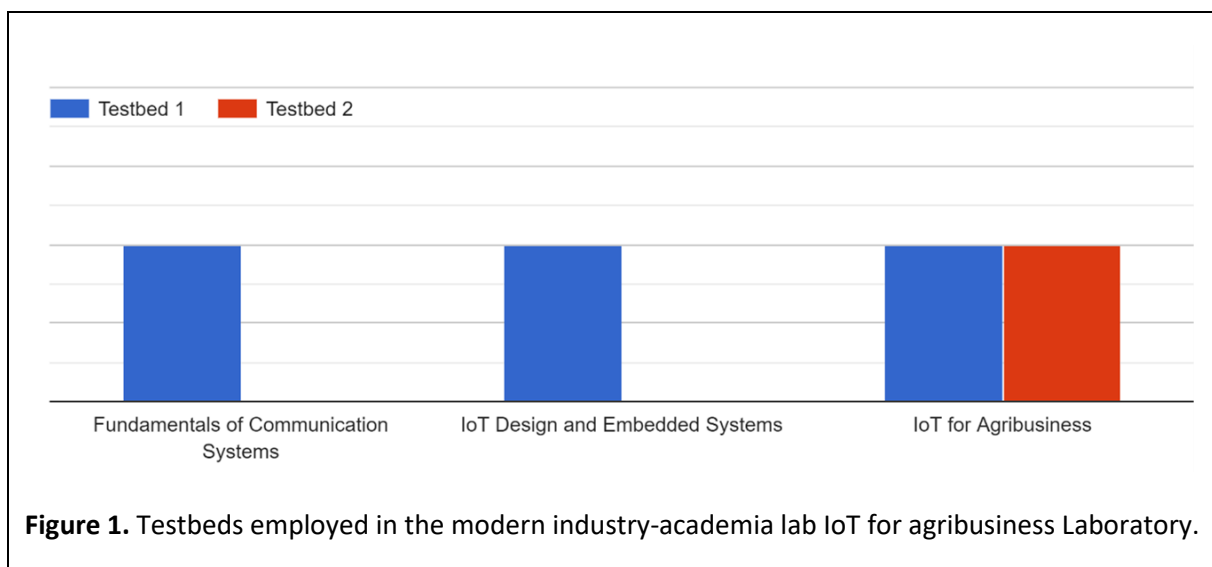
5. Joint Lab utilization in HEIs courses

Additionally, each testbed developed by partners was utilized in their academic courses. In this stage, collaborators were requested to give information about the specific testbeds employed in each course². To provide a deeper understanding, a brief summary of the testbeds presented in [D4.1](#) will be conducted.

As it will be demonstrated in the following sections, at least one was employed in the execution of the courses.

IoT for agribusiness Laboratory – UCU

- **Testbed 1:** Provide the students with development boards, sensors, cameras, geolocation etc for the 'hands-on' development of IoT solutions aimed at the agribusiness industry.
- **Testbed 2:** Work with a nearby rural production site, and install a monitoring (sensors, actuators, camera) and data management system of the property using different state of the art IoT tools.

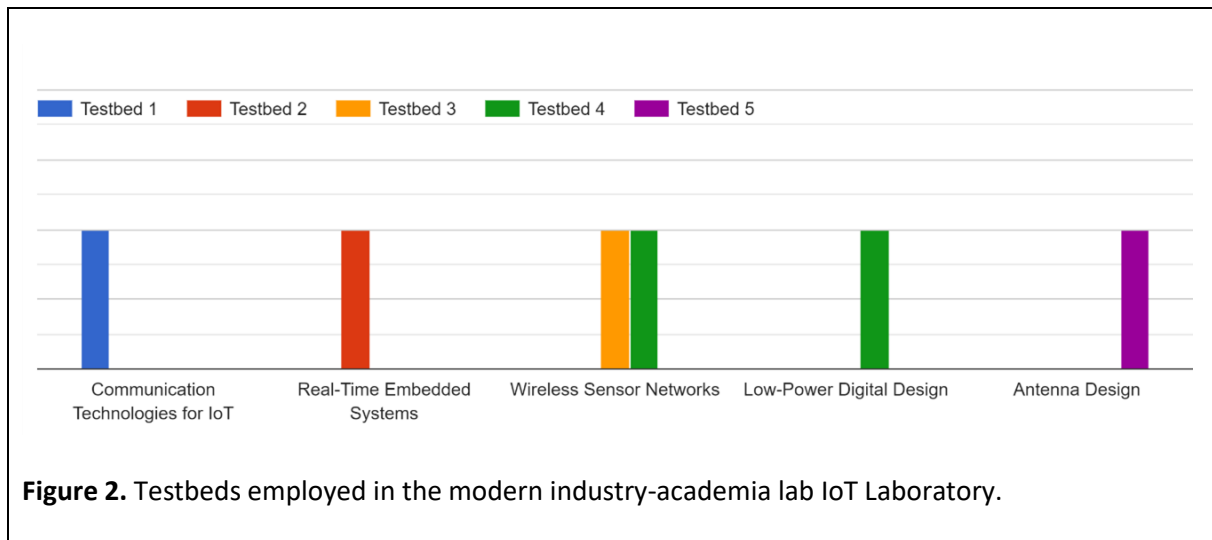


IoT Laboratory – UdelaR

- **Testbed 1 :** Propagation and Antennas: The objective of this testbed is to provide the students with the basic understanding of antenna parameters. Also, theory and techniques for estimating the propagation performance of a communication channel will be presented.
- **Testbed 2 :** Embedded Systems: The objective of this testbed is to study the different hardware and software architectures for embedded systems, learn to design hardware through component integration and to develop software.
- **Testbed 3:** Wireless Sensor Networks: The aim is to understand the basic principles of operation of wireless sensor networks for IoT and to familiarize with the current technologies for their implementation.
- **Testbed 4:** Digital design for low power: The aim is to explore different low-power digital design techniques and methodologies. The students would learn how to characterize power consumption in a digital system and also to incorporate power reduction techniques from early design stages.

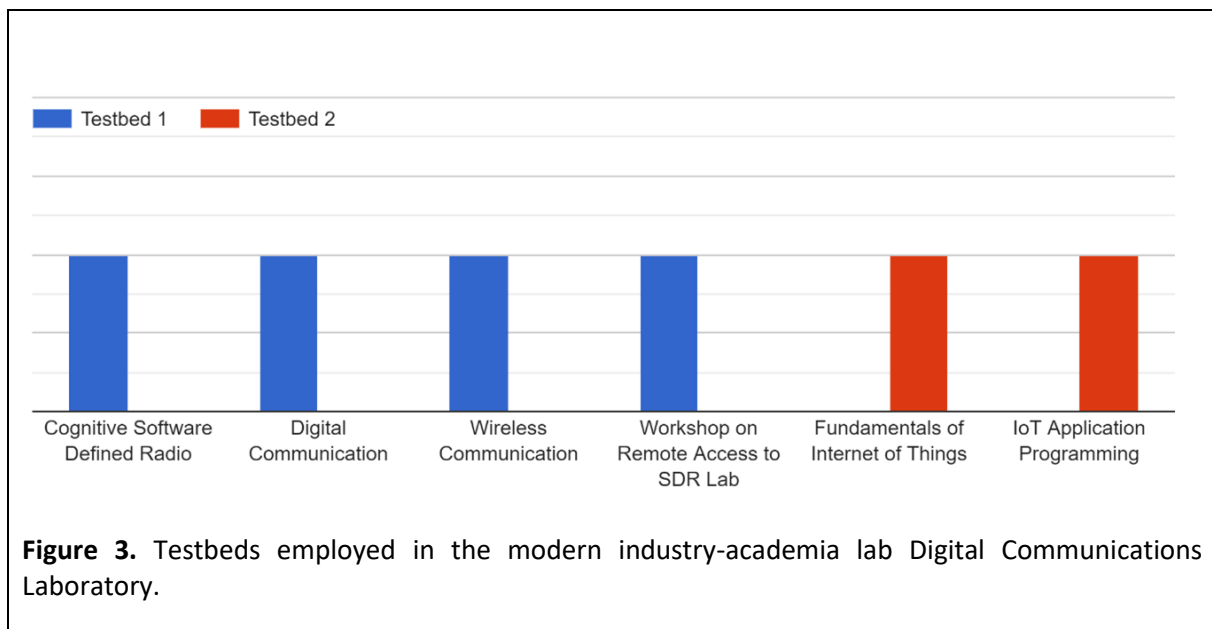
² More information about the courses offered by the universities can be found at the following [link](#).

- **Testbed 5:** Communications technologies for IoT. The objective is to understand the basic characteristics and principles of current communications technologies for IoT.



Digital Communications Laboratory – UNC

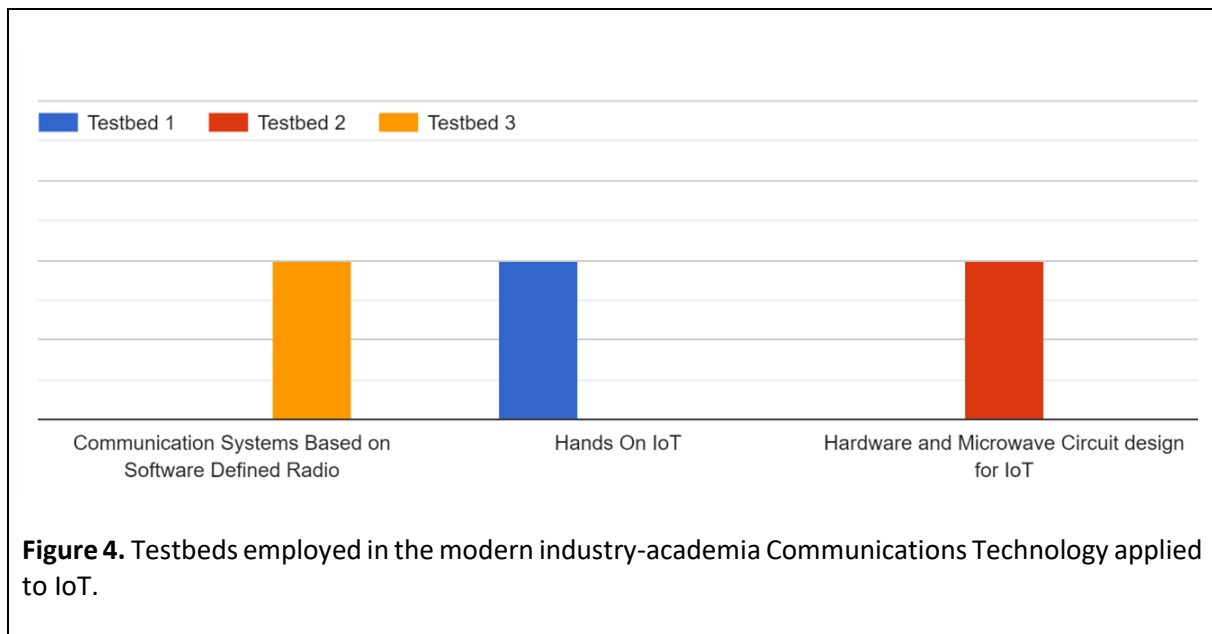
- **Testbed 1:** Internet of Things Lab. Data will be collected from sensors installed in IoT devices spread in the campus. The communications infrastructure between IoT devices will be developed to collect data from sensors.
- **Testbed 2:** Software Defined Radio Lab with Remote Access. The objective is to understand different waveforms applied to wireless communications for IoT. The testbed is intended to develop practical skills supported by Software Defined Radio (SDR) platforms.



Communications Technology applied to IoT – UNdMDP

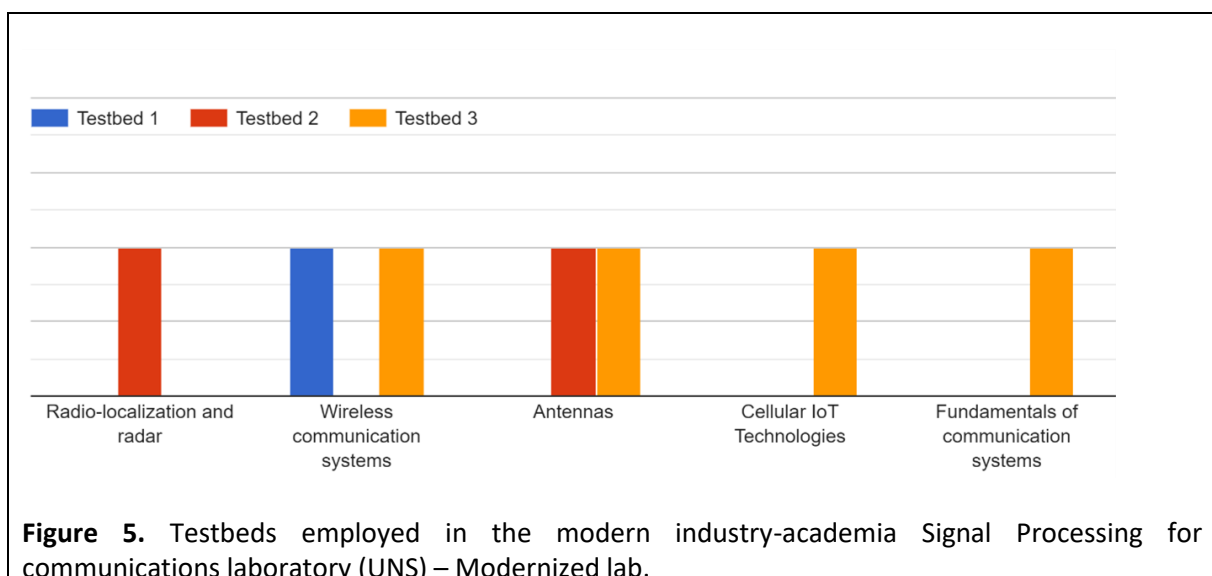
- **Testbed 1:** Introductory testbed on IoT, based on Arduino platforms and different connectivity technologies (LoRa, WIFI, Zigbee, etc.).

- **Testbed 2:** Microwave and Millimeter Wave Design for IoT. Design of main blocks of microwave and millimeter frequency parts of a communication system for IoT.
- **Testbed 3:** Software Defined Radio (SDR) based Communications Systems.



Signal Processing for Communications laboratory – Modernized lab – UNS

- **Testbed 1:** Self-powered IoT node (BSc, MSc and training). Energy harvesting and wireless power transmission. A wireless power transmission setup that includes a transmitter and several harvester nodes will be implemented.
- **Testbed 2:** Measuring small antennas for IoT and harvesting. (BSc, MSc and training). A system to perform antenna measurements using a Gigahertz Transverse Electromagnetic Cell (GTEM) will be implemented.
- **Testbed 3:** First steps on software defined radios (SDR) for IoT (BSc and training). Development of dedicated software platforms (Matlab and C) to explain, in a tutorial form, the main aspects of an IoT in a full communication system.



6. Conclusions

The laboratories were developed successfully and are currently operational.

HEIs worked in collaboration with industries to determine the types of testbeds that would be valuable for training employees and prospective engineers in the IoT field. The collaborative effort between HEIs and industries reflects an approach to aligning academic training with industry needs.

As a result, the developed testbeds proved to be effective tools in generating agreements with industries throughout the entire duration of the NEON project. Furthermore, these testbeds were successfully used in the context of various courses, detailed in WP3.

7. Appendix

7.1 Photos of each implemented laboratory

Signal Processing for Communications laboratory (UNS) – Modernized lab



Figure 6. UNS laboratory



Figure 7. UNS laboratory



Figure 8. UNS laboratory



Figure 9. UNS laboratory

Digital Communications Laboratory (UNC)



Figure 10. UNC laboratory



Figure 11. UNC laboratory

Communications Technology applied to IoT (UNdMP)



Figure 12. UNdMP laboratory



Figure 13. UNdMP laboratory



Figure 14. UNdMP laboratory

IoT for agribusiness Laboratory (UCU)



Figure 15. UCU laboratory



Figure 16. UCU laboratory

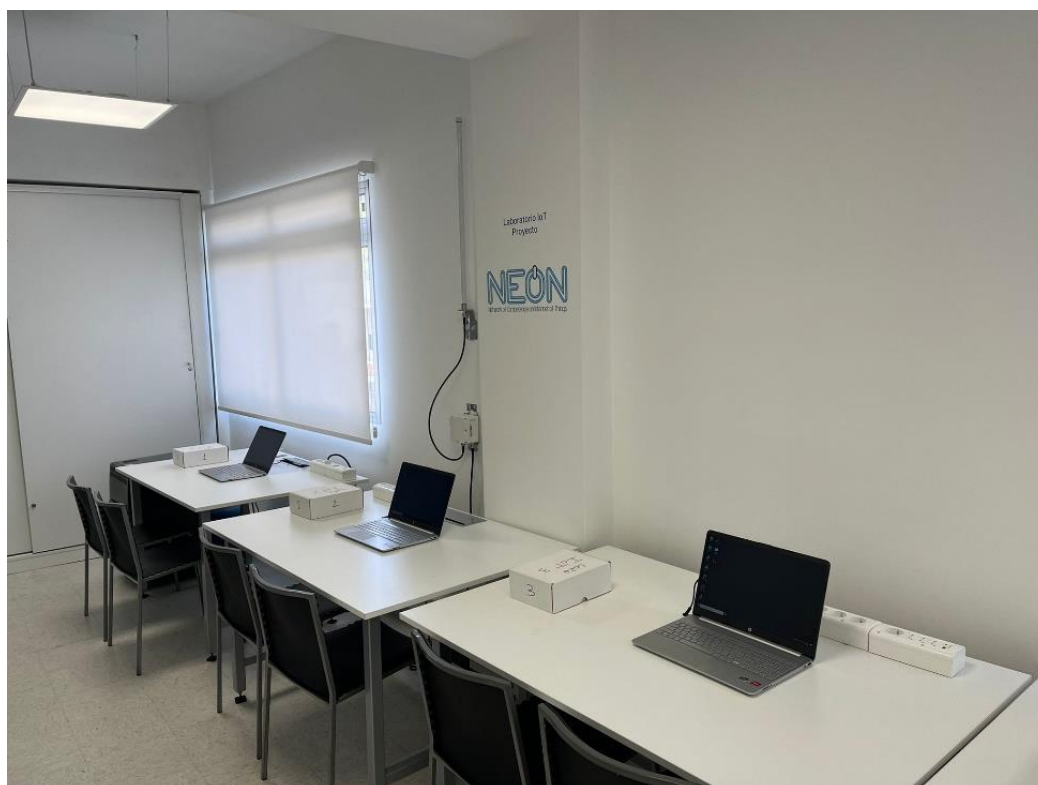


Figure 17. UCU laboratory

IoT Laboratory (UdelaR)

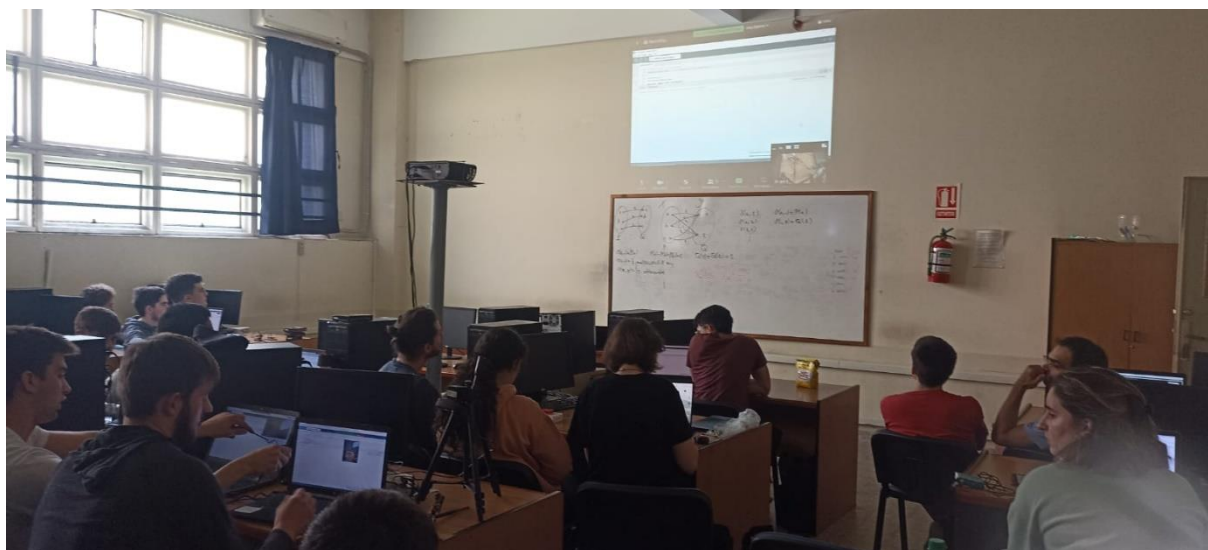


Figure 18. UdelaR laboratory



Figure 19. UdelaR laboratory

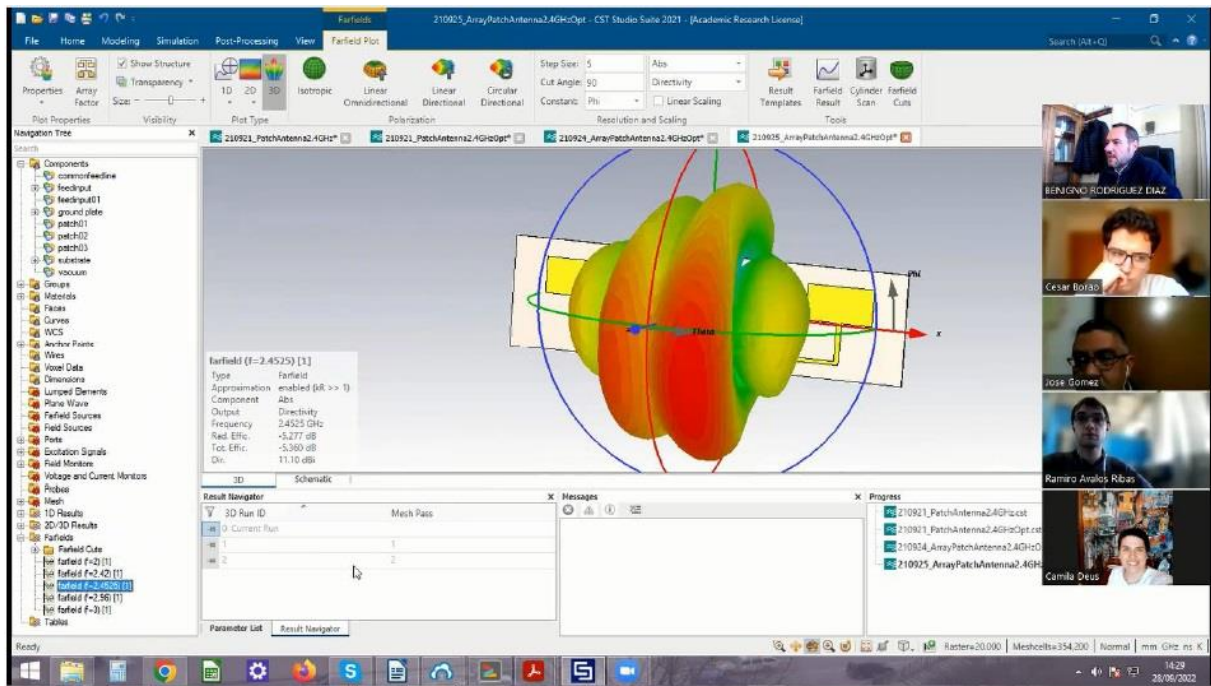


Figure 20. UdelaR laboratory



Figure 21. UdelaR laboratory

8. References

- [1] NEON project proposal, 2020.