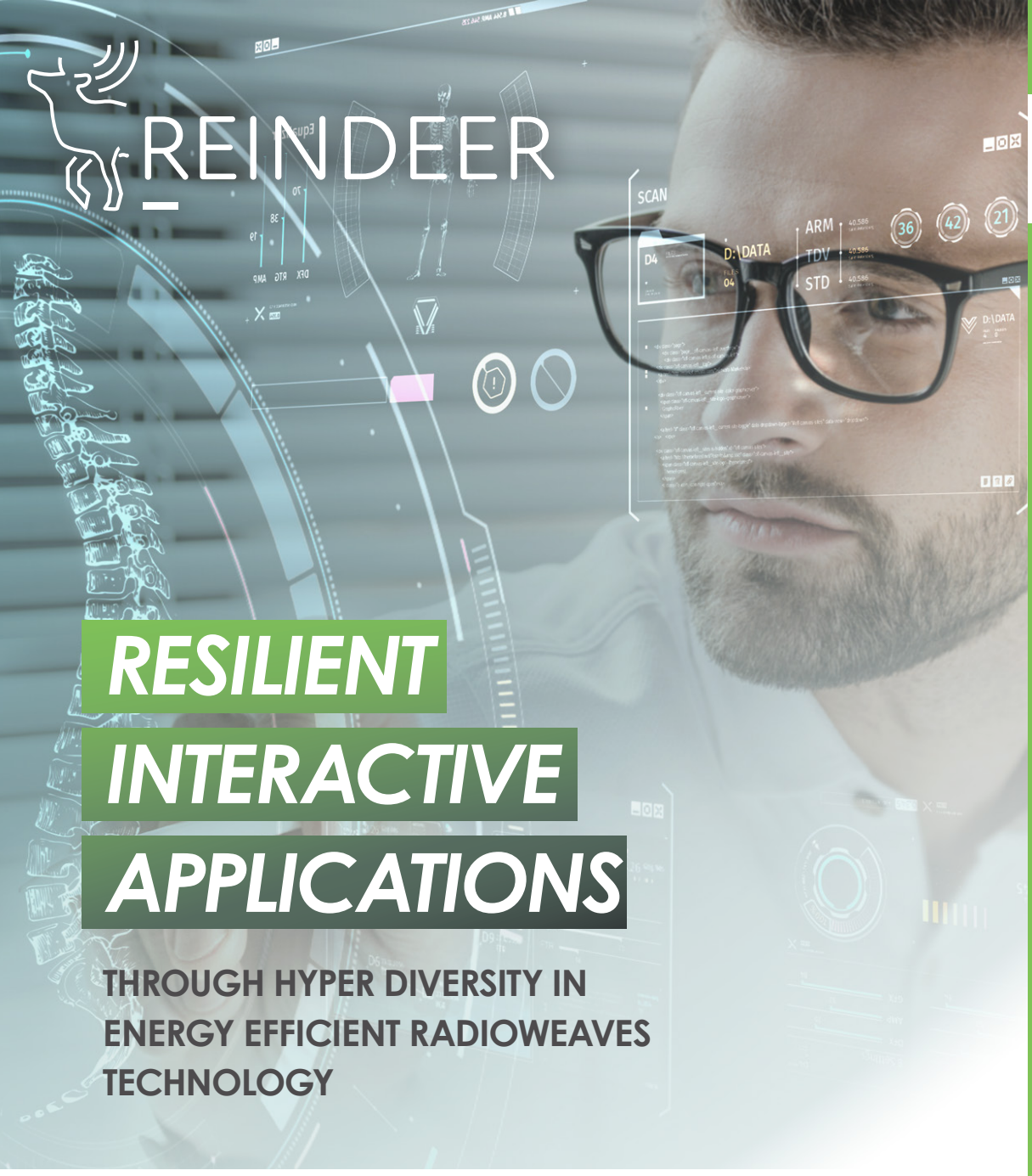

REINDEER

RESILIENT INTERACTIVE APPLICATIONS

THROUGH HYPER DIVERSITY IN ENERGY EFFICIENT RADIOWEAVES TECHNOLOGY

Issue 03

July 2024

reindeer-project.eu

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reindeer-h2020

Technology Lead

Liesbet Van der Perre

KU Leuven

Project Coordinator

Marion Habernig

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Budget

€ 4.7 Million
100% EU-funded

Consortium

9 Partners
4 countries

Duration

48 Months
01/2021 - 12/2024

Message from the Coordinator: REINDEER Team Unites in Madrid: A Step Closer to Completion

As the REINDEER team met in Madrid for a 2-day technical meeting in April 2024, the excitement was feelable. This latest milestone marks another significant step forward on our journey towards completion. With every passing day, we're getting closer to acheiving our goal and celebrating a successful project closure. The team's hard work and dedication are paying off, and it's clear that we're all motivated by a shared sense of purpose. While there's still some technical fine-tuning to be done, the end is in sight, and we can't wait to share our results with the world. It's been an incredible ride so far, and we're proud of what we've accomplished together.

5G PPP PUBLIC-PRIVATE PARTNERSHIP

The REINDEER project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101013425.

REINDEER Technical Meeting, Madrid

Telefonica SA hosted a 2-day technical meeting (25th – 26th April 2024). As the project timeline progresses, the team gathers once more for a meeting, marking another step forward in our journey towards completion. While the end is in sight, there are still technical discussions to be had and final deliverables to be refined before we can celebrate a successful project closure.

REINDEER Project Makes Progress in Defining Technical Requirements and Developing RadioWeaves Architecture

The REINDEER project has made significant progress in defining technical requirements for future interactive applications that rely on wireless connectivity. The project has identified 13 innovative use cases across various domains, including adaptive factories, immersive entertainment, and smart homes. Additionally, the project has refined its analysis of the RadioWeaves architecture, focusing on distributing processing across the infrastructure to support energy-efficient connectivity. Two new documents have been delivered, providing a detailed overview of the project's findings. The project is now preparing for experimental validation, with plans to integrate RadioWeaves in a reconfigurable space at KU Leuven to demonstrate seamless integration of electronics and scalable experiments.

WP1

Radio Channel Measurement Campaigns Complete

The REINDEER project has completed several channel measurement campaigns in two set-ups at University of Lund and TU Graz to simulate indoor radio propagation environments. These measurements help to characterize the radio channel for RadioWeaves, an energy-efficient connectivity infrastructure.

The results of these measurements are used to study technical aspects of channel conditions and how they affect network capabilities within the RadioWeaves architecture.

WP2

RadioWeaves Architecture Refined

In WP2, we've refined our initial analysis from D2.1 to create two new deliverables: D2.2 and D2.3.

D2.2 delves into the distribution of processing across the RadioWeaves infrastructure, covering synchronization, processing elements, and topology governance.

Meanwhile, D2.3 explores the hardware requirements for energy transfer to energy-neutral nodes, including wireless power transfer coverage, implementation/regulatory challenges, and increasing backscatter communication coverage using the RadioWeaves infrastructure.

WP3

Algorithmic Advancements and Simulator Development

In WP3, our team has made significant progress in developing algorithmic approaches for:

- Synchronization of multiple Cognitive Radio Systems (CSPs)
- Robust beamforming with outdated Channelo State Information (CSI) for initial access phase
- Over-the-Air (OTA) signaling scheme for uplink/downlink reciprocity calibration and device activity detection in distribution MIMO networks

We have also developed a novel algorithm to optimize energy efficiency in dynamic TDD distributed MIMO networks.

In addition, we have investigated and developed alorithms for:

- Channel estimation using super-resolution algorithms applied to subarray data
- Kalman filter-based and graph-based alorithms for postitioning

Our team is also working on developing a link-level simulator to implement different waveforms. A novel FM-OFDM waveform has been designed, which fits well in ultra-reliable communication use cases.

WP4

Experimental Verifications and Enabling Techniques

In WP4, we've successfully verified the analytically evaluated achievable power budgets using synthetic array measurement data from WP1.

The results confirm that RadioWeaves significantly boosts receive power at the device side, lifting it from microwatts to milliwatts - a performance boundary push of orders of magnitude!

We've also manufactured hardware designs for both infrastructure (experimental testbeds) and energy-neutral devices, which reflect our joint antenna and circuit design goals.

In addition, we've developed key-enabling techniques for RadioWeaves interacting with energy-neutral devices:

- Initial access
- Closed-loop operation for Channel estimation and device positioning
- Direkt link interference suppression

These advancements bring us closer to realizing the full potential of a RadioWeaves infrastructure.

WP5

Experimental Design and Validation Planning

In WP5, we've developed a comprehensive validation plan and designed various testbeds and simulators to conduct experiments and validate our findings.

To facilitate data exchange and processing, we've also created a standardized Dataset Storage Standard (DSS).

We've designed three types of energy-neutral devices and two simulators, TugSim and LuSim, to cover the scenarios outlined in D1.1.

The goal of these designed experiments is to evaluate key performance indicators (KPIs) that will advance RadioWeaves technology for potential 6G distributed deployment.

WP6

Communication, Dissemination, and Standardization Efforts

In WP6, we've continued to strengthen our communication, dissemination, and standardization efforts.

Additionally, we've filed several patent applications to protect our innovative ideas and technologies.

Visit our website to keep up with all published conference papers, white papers, shared insights and research findings.

Video Interviews:

Interview with Gilles Callebaut

Join us for an exclusive peek behind the scenes with Gilles Callebaut from KU Leuven as he uncovers the real-world implementation of the REINDEER project's physical inventory. Gain invaluable insights into the project's inner workings and see it in action. Gilles furthermore shares what is special about the REINDEER project for him! Watch **here**!

Interview with Philipp Jauck

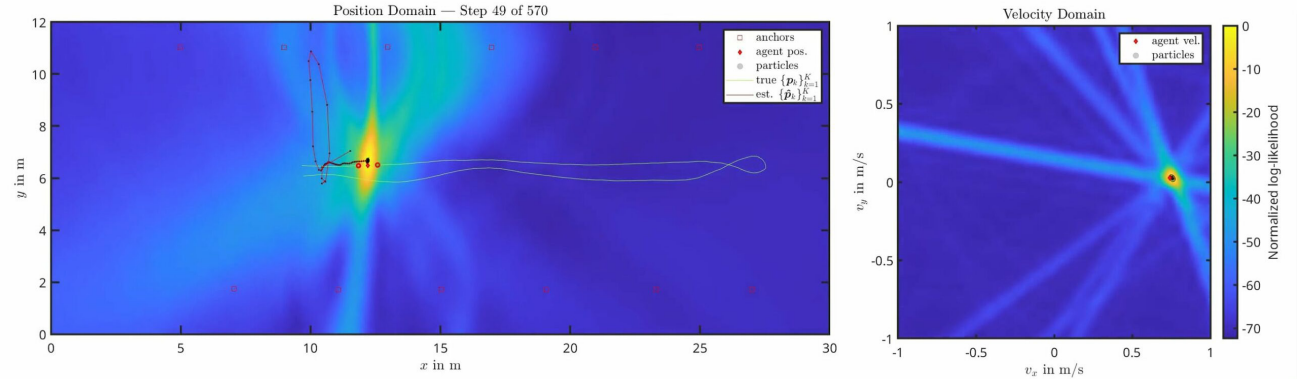
Join us in this enlightening discussion with Advisory Board Member Philipp Jauck as he delves into the significance of the REINDEER project. Discover why this initiative holds immense importance and how companies like SES-imagotag can reap the benefits of its innovations. Don't miss out on this insight into the future of 5G technology! Follow this **link**!

Interview with Technikon

Marion Habernig from Technikon is talking about the REINDEER project and its challenges. As the project coordinator, she gives insight into facts, feelings and goals of this collective venture. Interested? Then follow this **link**!.

Animation of Algorithm 4's performance on real-world data

The REINDEER project showcases the animation of Algorithm 4's performance on real-world data in its D3.4 deliverable (Figure 3.15). This animation, visualizes how the algorithm tracks an object over time by displaying particle distributions and likelihood functions in both the position and velocity domains. Initially, the algorithm has high positional uncertainty, but as the object accelerates, the tracking precision improves significantly. The dual-view plots demonstrate the algorithm's adaptability to dynamic motion, underscoring its efficacy in real-world wireless network applications. Follow this **link** to watch the animation.



Past Events

IEEE VTC2022-Spring
LIU gave a presentation on „Physical layer abstraction model for RadioWeaves“
Helsinki, Finland
19-22 June 2022

IEEE SPAWC 2022 Confrence
Presentaion of Paper: Dynamic Federations of 6G Call-Free Networking: Concepts and Terminology
Oulu, Finland
04-06 July 2022

2022 IEEE SPS - EURASIP
Summer School on „Defining 6G: Theory, Applications, and Enabling Technologies“
Linköping, Sweden
29 August - 01 September 2022

Joint Workshop COST INTERACT + 6
Huawei-iTeam on „Enabling Technologies for 6G“
Valencia, Spain
19-22 September 2022

TU Graz - Science for Future 2022: Digital Visions
Annual interdiscilinary science day: Societal Challanges and innovative technologies
Graz, Austria
21 September 2022

IEEE Synthetic Aperture Standardization Committee (SASC)
Synthetic Aperture Channel Sounding for Wireless Power Transfer
Online
19 October 2022

Asilomar 2022
Confrence on Signals, Systems and Computers 2022 and the future progress.
Online
30 October - 03 November 2022

Globecom 2022
Communication Convention „Accelerating the Digital Transformation through smart Communication“
Rio de Janeiro, Brazil
04-08 December 2022

2nd Workshop at IEEE ICC 2023
„Synergies between communications, sensing and localization“ Presentation KU Leuven
Rome, Italy
28 May - 01 June 2023

EuCNC - Workshop Synergies between communications, localization and sensing toward 6G
Presentaion by TU Graz
Gothenburg, Sweden
06 June 2023

ICASSP 2023
„Bistatic MIMO Radar Sensing of Specularly Reflecting Surfaces for Wireless Power Transfer“ by TU Graz
NIST Boulder, CO
10 June 2023

Panel in the IEEE Communication Theory
„The Role of Information Theory in 6G“ and Organisation „Electromagnetics and Wireless Communication“ by LIU
Hualien, Taiwan
02-05 July 2023

ESSCIRC confrence 2023
49th European Solid-State Circuits Confrence
Lisbon, Portugal
11-14 September 2023

IPIN 2023
13th international Confrence on INDOOR POSITIONING AND OUTDOOR NAVIGATION
Nuremberg, Germany
25-28 September 2023

Asilomar SSC 2023
Confrence on Signals, Systems, and Comuters
Pacific Grove, CA, USA
29 October - 01 November 2023

Globecom 2023
IEEE Global Communications 2023 Confrence „Intelligent Communications for Shared Prosperity“
Kuala Lumpur, Malaysia
04-08 December 2023

Technical Meeting in Madrid
Face-to-face Meeting was held in Madrid at our partner‘s facilities: the Telefonica building
Madrid (Telefonica), Spain
25 - 26 April

Upcoming Events

All past and upcoming events can be found on the REINDEER official webpage:

reindeer-project.eu

Results

Conference Paper	Joint Optimization of Switching Point and Power Control in Dynamic TDD Cell-Free Massive MIMO by Martin Andersson, Tung T. Vu, Pål Frenger and Erik G. Larsson 20 June, 2024
Conference Paper	Robust Precoding Weights for Downlink D-MIMO in 6G Communications by Ke Wang Helmersson, Pål Frenger and Anders Helmersson 17 June, 2024
Science Publication	Distributed MIMO Precoding with Routing Constraints in Segmented Fronthaul – academic article by Jale Sadreddini, Omer Haliloglu and Andres Reial 30 May, 2024
Science Publication	Robust Covariance-Based Activity Detection for Massive Access – academic article by Jianan Bai and Erik G. Larsson 15 May, 2024
Science Publication	Anchor Layout Optimization for Ultrasonic Indoor Positioning Using Swarm Intelligence – academic article by Daan Delabie, Thomas Wilding, Liesbet Van der Perre and Lieven De Strycker 15 May, 2024
And a lot more...	**Visit our website to find out!**

The REINDEER Consortium

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