



Technical Lead

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Budget

€ 5.3 Million

€ 5.1 Million EU-funded



Consortium

9 Partners

5 countries



Duration

42 Months

01/2023 - 06/2026



6GTandem

Unlock new potential of wireless network

A dual-frequency distributed MIMO approach for future 6G applications

Message from the Technical Lead

As we mark the completion of the first year of the 6GTandem project, we are eager to share the progress made during this dynamic three year journey. While some projects have addressed the 6G vision, the needed services of the 2030s and key technology enablers are yet to be defined. 6GTandem stands as ground-breaking initiative, providing low cost and lightweight radio stripes that enable flexible deployment on ceilings and walls, addressing challenges from the design of hardware components, such as chips, to ensuring the seamless operation of the entire system.

Our primary focus revolves around the dense deployment of sub-THz radio units to deliver high data rates, complemented by sub-10GHz radio coverage to ensure a reliable connection. We are pleased to report that every facet of the project is progressing well. Use cases, requirements, and deployment scenarios have been identified, emphasizing indoor environments that require high throughput, low latency, and reliable wireless communication.

We are actively optimizing radio stripe deployment, exploring ideal distances between radio units, and determining the total length of radio stripes for energy efficient operation. Our commitment to sustainability extends to ensuring the system remains flexible for energy efficiency. The 6GTandem journey is about pushing boundaries and envisioning a future where wireless communication seamlessly integrates into our lives. We eagerly anticipate sharing more milestones in the coming years.



Updates on the current status of the technical work packages

WP2: Use cases, system requirements

The team initiated **WP2** by conducting an in-depth literature review, focusing on recent projects within the European Union's 6G landscape and the latest standardization documents. We categorized relevant 6GTandem use cases into four groups based on similarity of system Key Performance Indicators, with a current emphasis on deployment scenarios in arenas, metro stations, and industrial manufacturing sites. Concurrently, we explored various sub-THz over-the-air link budget scenarios, manipulating parameters like bandwidth and modulation schemes. The chosen scenario is intricately influenced by hardware components, packaging techniques, and overall architecture. Cascading Radio Units

was also examined to identify limiting factors - whether noise, power amplifier nonlinearities, or total power consumption on the same fiber. Results are being compiled into deliverable D2.1. Additionally, essential models have been gathered and are detailed in deliverable D2.2. The groundwork for sketching the hardware demonstrator has begun, marking a pivotal step in translating theory into practical applications. This holistic approach aligns with our commitment to understanding, documenting, and innovating within the dynamic landscape of 6GTandem.

~ **Parisa Aghdam (Ericsson AB)**

WP3: Models, medium-aware waveforms, and algorithms for energy-efficient, robust, and new 6GTandem services

In the latter part of 2023, **WP3** commenced research and development pertaining to a wireless communication system, engaging in two specific activities:

First, the development of models, which should enable analytical and simulation based system studies and second the exploration of the dual frequency tandem system concepts, to achieve very high capacity network in quasi-static environments and support new 6G functionalities.

The development of models targets the transmission over the plastic fiber, the wireless propagation at sub-THz, and losses and impairments introduced by non-perfect hardware, in particular

the high frequency RF components. This work requires communication and cooperation across the hardware and system experts. Communication system exploration has started from initial link budget analysis, both for the transmission on the fiber and over the air. These have provided evidence that the constraints on signal power and linearity will limit the dynamic range of signals that can be reliably transmitted. Thus, high-bandwidth signals and dense deployments are explored in order to achieve the targeted very high throughput in the network.

~ **Liesbet Van der Perre (KU Leuven)**

WP4: D-MIMO Sub-THz radiostripe

WP4 is aiming to develop fully integrated communication links at sub-THz frequencies (the D-band) based on dielectric waveguides also known as plastic microwave fibers (PMFs). By using thin plastic fibers and mmWave radio signals it is possible to provide a robust communication link of short-to-medium distances (up to 20 m), long enough to support the distributed AUs at 10 m spacing typically. To achieve this goal, 6GTandem will develop sub-THz transceivers combined with couplers (for signal transition between the PMF and the MMIC) and antennas in one package. During the past months, Ericsson, Chalmers University, Infineon and Lund University have discussed various system architecture and packaging options for targeted scenarios. Specifically, Infineon

and Lund University are working closely designing compact Sub-THz antenna-in-package (AiP) for distributed deployment. A publication related to that has been submitted to the 2024 European Conference on Antennas and Propagation. Regarding chip design, Chalmers University has successfully submitted chip designs on amplifiers, frequency multipliers, mixers, phase shifters, switches to Infineon's B12HFC process in June 2023 and B11HFC process in November 2023. The work has been carried out by Huber&Suhner by delivering PMFs to Infineon and by performing simulations. These enrich the discussion to further develop the PMF design and the launcher design.

~ **Zulaicha Parastuty (Infineon Technologies Austria AG)**



Dissemination activities

6GTandem made a remarkable appearance at the EUCNC 2023 in Gothenburg, Sweden, where our consortium members, Liesbet Van der Perre, Parisa Aghdam, and Alex Marinsek were at the forefront, representing the 6GTandem project. The audience was captivated by the presentation, and we are looking forward to spreading the results.

In the middle of November a **video** has been published that should summarize and explain the most important ideas behind 6GTandem to the public. The main intentions behind the project and its potential are not only being explained but also visualized in order to give everyone an understanding of what we aim to create.

Furthermore, there are three interviews available offering valuable insights into the project's goals and challenges. These interviews provide both technical and general information, shedding light on the innovative aspects of the project and the difficulties encountered along the way. They serve as valuable resources for understanding the project's objectives and the collaborative efforts of the consortium in overcoming obstacles. The project coordinator Barbara Gaggl from Technikon as well as Maria Jozwicka from Huber + Suhner and Daan Delabie representing KU Leuven shared insights on the project in this small video series that can be found on the 6GTandem **website** and on **social media**.

Technical Meetings

At the **first technical meeting** in Gothenburg in July 2023 the Agenda was packed with status updates about all the work packages, topics that concern more than one work package as the HW fiber characteristics or the waveform and transmission system design. The meeting was very enriching for the project and two days spend together were also refreshing after all the online meetings!

The **second technical meeting** took place at the beginning of November 2023. The aim was to kick off the activities from WP3 and fix the model requirements from task 2.2. Additionally, the consortium wanted to continue with the revision of the tandem concept in the subsequent WP4. Discussions on dense employment and multi-user support were held and alignments between different partners could be achieved.



In talk with **Barbara Gaggl**
Technikon Forschungs- und
Planungsgesellschaft mbH



Explainer Video



In talk with **Daan Delabie**
KU Leuven



In talk with **Maria Jozwicka**
Huber + Suhner AG

Results

01 Conference paper

“An Open Dataset Storage Standard for 6G Testbeds” by Gilles Callebaut, Michiel Sandra, Christian Nelson, Thomas Wilding, Daan Delabie, Benjamin J.B. Deutschmann, William Tärneberg, Emma Fitzgerald, Anders J. Johansson, Liesbet Van der Perre. IEEE CAMA 2023

“Impact of Array Configuration on Head Mounted Display Performance at mmWave Bands” by Alexander Marinsek, Xuesong Cai, Lieven De Strycker, Fredrik Tufvesson and Liesbet Van der Perre. EuCNC/6G Summit


02 Academic Article

“6G Radio Testbeds: Requirements, Trends, and Approaches” by Gilles Callebaut, Liang Liu, Thomas Eriksson, Liesbet Van der Perre, Ove Edfors and Christian Fager

04 Publications to come

XR user mobility can have a major impact on very high frequency links (mmWave/sub-THz) and may require dedicated mitigation strategies to ensure reliable connections and avoid service outages. However, only a subset of XR use cases, exhibiting limited user mobility, have been considered in prior art. Therefore, we performed dedicated experiments to extend the characterization of relevant future XR applications featuring a high degree of user mobility. The target applications namely encourage the user to

explore this environment in all six degrees of freedom (6DoF) and to conduct rapid movements. To facilitate this, we have executed a tailor-made measurement campaign. Interpretation of the data and mobility modeling is ongoing. We intend to share the database in open access, and a paper clarifying the experiments and findings is in progress and will be published in the MTT-S TC-23 Wireless Communications Focus Issue of the IEEE Microwave Magazine.



All past and upcoming events can be found on the 6GTandem official webpage:

horizon-6gtandem.eu/events

The 6GTandem Consortium

The 6GTandem consortium consists of 9 partners from 5 different countries (Austria, Sweden, Belgium, Germany and Switzerland). It consists of a well-balanced mixture between academic and

industrial players, from large semiconductor to small SMEs. The team comprises a diversified competencies pool with the knowledge and capability to tackle and resolve upcoming challenges.

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LINKÖPING UNIVERSITY

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