6GTandem

A Dual-frequency Distributed MIMO Approach for Future 6G Applications

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Factsheet 01: 6G

Current State: The demand for high-performance, energy-efficient smart networks addressing an increasing variety of applications pushes the telecom evolution beyond 5G. The progression from 4G to 5G has marked significant advancements in wireless communication technology. 4G, introduced in the early 2010s, provided faster data speeds and better connectivity, enabling widespread mobile internet use and basic Internet of Things (IoT) applications. In contrast, 5G, currently being deployed globally, offers ultra-fast speeds up to 10 Gbps, extremely low latency around 1 millisecond, and supports massive connectivity for **IoT, smart cities, autonomous vehicles**, and **augmented reality.** Massive MIMO (Multiple Input Multiple Output) was successfully introduced with 5G. MIMO is a method for multiplying the capacity of a radio link using multiple transmission and receiving antennas to exploit multipath propagation. However, the deployed massive MIMO approach is sensitive to **line-of-sight blocking** and can suffer from large **quality-of-service** variations when operating at very high frequencies. Therefore, there is a high interest in **distributed MIMO**, combining the beamforming gain and spatial interference suppression capability of conventional massive MIMO with co-located arrays on the one hand, and the bigger chance of being physically close to a service antenna as offered in small cells on the other hand. However, this has so far not been developed for deployment **up to sub-THz**. Frequency bands beyond 100 GHz (sub-THz) offer wide available bandwidths, making them attractive for future **6G telecom services**, such as high-resolution localization, scanning and positioning, and ultra-high-capacity connectivity.

What is 6G? 6G represents the next evolutionary step in wireless technology, succeeding 5G. It aims to push the boundaries further by offering even faster data rates, lower latency, greater reliability, and advanced capabilities to meet the demands of future digital applications by the utilization of terahertz frequencies for increased bandwidth and data transmission rates. Envisioned features include:

- data rates of up to 1 Terabit per second (Tbps),
- ultra-low latency below 100 microseconds,
- support for billions of connected devices per square kilometre.

Challenges: Developing 6G technology poses several challenges. One major hurdle is harnessing terahertz frequencies (beyond 100 GHz) effectively, overcoming issues like signal attenuation and propagation limitations. Another challenge involves establishing global standards to ensure interoperability and compatibility across different technologies and regions. Additionally, deploying the necessary infrastructure, such as small cells, advanced antenna systems, and possibly satellite networks, presents a significant logistical and financial challenge.

Advantages: 6G will deliver dramatically faster data speeds and significantly higher capacity, enabling seamless high-definition video streaming, real-time remote operations (like remote surgery), and instantaneous data transfer. Ultra-low latency capabilities will facilitate real-time applications such as autonomous vehicles, precision manufacturing, and immersive augmented reality experiences.

Current Development: Currently, 6G technology is in the research and development phase. Various stakeholders, including academia, industry, and standardization bodies, are actively involved in advancing core technologies and conducting prototype trials. While commercial deployment timelines are not yet firmly established, 6G is expected to start becoming available in the late 2020s or early 2030s, contingent upon technological advancements, regulatory frameworks, and market readiness.

The 6GTandem project aims to provide uniform ultra-high throughput coverage, off-load lower frequency bands and provide new services such as high-resolution sensing and positioning in high traffic, densely populated areas by using a thin and light dielectric waveguide (i.e., a plastic fibre) to distribute a sub-THz RF signal through a daisy chain connection of low-power antenna units (AUs), following the radio stripe concept.
By combining lower frequency bands with the sub-THz bands in a dual frequency distributed MIMO 6G mobile network, 6GTandem will develop technologies that benefit from the attractive capacity that sub-THz communications offer. Key elements for the implementation of the 6GTandem system are:

- A comprehensive system conception that will define the main specifications of the 'aligned tandem' dual frequency distributed MIMO architecture.
- The definition of medium-aware waveforms, transmission schemes and communication strategies for energy-efficient operation and development of cross-layer solutions to offer required service levels on the novel dual-frequency infrastructure.
- Novel hardware design for the low-cost easy-deployable sub-THz infrastructure.
- Conception of a combined low-frequency and sub-THz distributed MIMO system supporting joint communication, high-resolution sensing, and high resilience and reliability.

Validation of the two tandem concepts of dual frequency optimization and joint transmission scheme and medium design.

Conclusion: 6G represents a significant leap forward in wireless communication technology, poised to revolutionize various industries and enable new applications that were previously unimaginable. As development progresses, global collaboration and innovation will be essential to harnessing the full potential of 6G and ensuring its successful deployment and adoption worldwide.

Consortium
9 Partners
5 Countries

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€ 5.3 Million
95,97% EU-funded

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6GSNS

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