CELTIC-NEXT
Next Generation Communications

Project Information

Energy-Efficient Radio Systems at 100GHz and beyond: Antennas, Transceivers and Waveforms

ENTRY100GHz

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Closure date: 31 August 2024

Partners:

AALTO University, Finland
Chalmers University of Technology (CTH), Sweden
Core HW Oy, Finland
Ericsson AB (EAB), Sweden
Gapwaves AB, Sweden
Gotmic AB, Sweden
HENSOLDT-GEW Technologies, South Africa
LEAX Arkivator Telecom, Sweden
LG Electronics Oy, Finland
Omnipless-Cobham Group, South Africa
Optenni Oy, Finland
Qamcom Research and Technology AB, Sweden
Radientum Oy, Finland
Reutech Radar Systems, South Africa
SAAB Group Finland, Finland
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www.celticnext.eu/project-entry100ghz

ICT and telecom sectors will go through another major evolution with the development of new visionary concepts in the higher millimetre-wave (mm-wave) frequency band to support ultra-high data rate for various applications such as sensing and security, IoT, autonomous driving, e-health, cloud computing, and virtual reality.

The aim of the current project is to develop a unique energy efficient integrated antenna hardware platform which is capable of adaptive waveform generation in spatial, temporal, and frequency domains to be used in beyond 5G (B5G) wireless communication infrastructure at 100GHz band to enable ~100Gbps data connectivity.

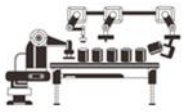
Main focus

The main focus of the project is to achieve the following breakthroughs:

Remote Radio Head (RRH) with high power integrated antenna array architecture to overcome the atmospheric attenuation at 100 GHz and beyond.

Improved overall power efficiency and thermal management for high power GaAs/GaN front-end module integrated to a low-loss antenna module.

Low power AD/DA converters and DSP circuits, with extremely high-throughput digital processing capabilities and efficient algorithms for determining the digital beamforming and digital pre-distortion, and the low peak to average power waveforms.



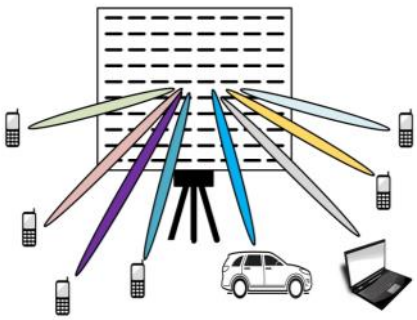
Low-cost mass production of the abovementioned 100GHz active antenna array to remain competitive in the international market.

Approach

Low-loss dual polarized fully metallic **gap waveguide antenna array** and **3D printed waveguide** antenna array will be investigated during the project.

Also, compact **high Q multi-mode filter** solutions will be investigated based on the metal waveguide technology. The filtering loss will be minimized by reducing the order of the filter in the chain.

High-power density technologies like GaN will be used to develop front-end circuits at 100 GHz. The higher junction temperature of the GaN will have a large impact on the thermal design, especially for outdoor, potentially enabling passively cooled active arrays. As an alternative, GaAs technology, which is more established, will



- Superior Antenna efficiency and significantly higher EIRP due to GaAs/GaN front-end.
- Low-loss filtering and suppression of out of band spurious.
- Significantly lower power consumption, co-design of mixed mode electronics, RF transceivers and digital algorithms.
- High efficiency waveform generation with low Peak to Average Power Ratio (PAR).

Fig. 1 Key features of the remote radio heads (RRH) in beyond 5G network envisioned in the project

also be considered. Within the project **1Watt (30dBm output power) GaN/GaAs power amplifiers** will be developed.

Another key component is the **mixed-mode ASIC** which will enable optimized operation of the full entity, and thus boost the overall performance. The SOC demonstrator implementation will be at state-of-the-art level with high integration density of the digital and mixed-mode segment, while being able to simultaneously interface the above-mentioned RF elements at 100 GHz.

Power generation is very challenging and absolutely critical at 100GHz frequencies. Thus, it is important that the hardware design is supported with waveform design, facilitating **power-efficient waveforms** that enable operation of the hardware at its limits with high signal quality.

Low loss **transitions and packaging solutions** for tightly placed RF circuits will play a crucial role in the proposed RRH. Thus, the project aims to develop novel non-galvanic interfaces to couple energy from RF circuits to the antennas and filter. This will be tested in the final 100GHz remote radio demonstrator.

Main expected results

- Triple the overall antenna efficiency using low-cost waveguide -based solutions.
- The losses in the filter solution will be cut down to 60% compared to today's solution and improve RF energy efficiency significantly.
- Integration of active electronics with PIN diodes to achieve low-loss switches combined with power or low-noise amplifiers.
- Optimized performance, and reduction of the cost and power consumption of the mixed-mode ASIC by 30%.
- New integration platform which will improve integration losses by 50% and will double the bandwidth, compared to today's solution.

Impact

The proposed project intends to strengthen academia and industry collaboration and aims to stimulate technological breakthroughs needed to meet societal and industrial demand for future wireless services. The 100GHz radio hardware developed within this project is considered to be **the key building block in the beyond 5G (B5G) communication infrastructures** that will be able to adapt to the requirements of various business sectors such as content (gaming, video), e-health, smart cities, sensing, autonomous driving, factory automation and industrial IOT etc. Industries involved in the project will be able to use the technological break throughs and knowledge base from this project to develop their dedicated applications and required features for different business sectors.

About CELTIC-NEXT

CELTIC-NEXT is the EUREKA Cluster for next-generation communications enabling the digital society. CELTIC-NEXT stimulates and orchestrates international collaborative projects in the Information and Communications Technology (ICT) domain.

The CELTIC-NEXT programme includes a wide scope of ICT topics based on new high-performance communications networks supporting data-rich applications and advanced services, both in the ICT sector and across all vertical sectors.

CELTIC-NEXT is an industry-driven initiative, involving all the major ICT industry players as well as many SMEs, service providers, and research institutions. The CELTIC-NEXT activities are open to all organisations that share the CELTIC-NEXT vision of an inclusive digital society and are willing to collaborate to their own benefit, aligned with their national priorities, to advance the development and uptake of advanced ICT solutions.

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