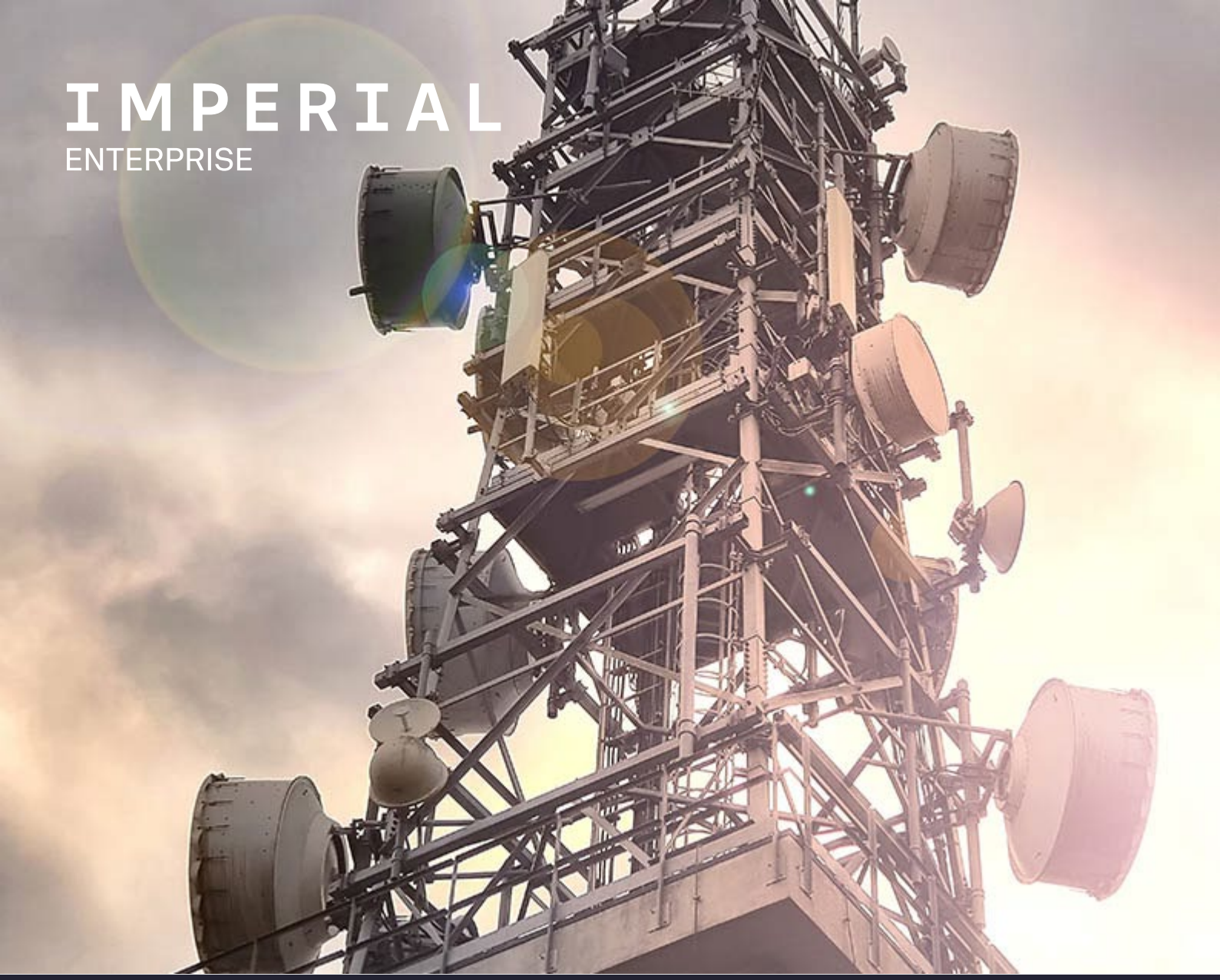
IMPERIAL
ENTERPRISE



A Novel Beamforming Technology Based on Reconfigurable Microwave Networks

Microwave linear analog computer (MiLAC), enables flexible, efficient, and scalable beamforming for devices with a high number of antennas.

Miguel Cheng

Commercialisation Executive

– Faculty of Engineering

m.cheng@imperial.ac.uk

Technology reference: 12011

Intellectual property information
Priority Application GB2504662.4 - Reconfigurable Microwave Network

PCT Application PCT/GB2026/050511 - Reconfiguration Microwave Network

Inventor information
Professor Bruno Clerckx
Dr. Matteo Nerini
Dr. Ali Araghi

IMPERIAL
ENTERPRISE

Application

Our technology, named microwave linear analog computer (MiLAC), enables flexible, efficient, and scalable beamforming for devices with a high number of antennas. MiLAC can be used to precode the transmitted symbols at the transmitter or combine the received signal at the receiver in the analog domain. This is achieved by leveraging the light-speed propagation of the signal through a microwave network. By dynamically reconfiguring such a microwave network, MiLAC can efficiently implement any existing transmission and reception technique in the analog domain, such as zero-forcing beamforming (ZFBF) with significantly reduced computational complexity.

Target market

MiLAC will benefit all vendors of wireless devices, including base stations and mobile terminals, with particular emphasis on vendors building large antenna arrays, where digital processing is prohibitively costly or power-intensive. .

Problem addressed

In future wireless communication, the number of antennas at the base stations and the number of transmitted streams of information are expected to increase significantly, posing two crucial problems.

1. High hardware cost and power consumption due to a high number of RF chains.
2. High computational complexity, increasing power consumption and latency.

Our technology, MiLAC, solves these two challenges. Specifically, it enables future wireless communications with high numbers of antennas and streams by processing the transmitted symbols in the analog domain, leading to limited hardware cost, power consumption, and latency.

Technology Overview

A MiLAC is a reconfigurable microwave network made of interconnected impedance components, which processes microwave signals in the analog domain.

At the transmitter, a MiLAC receives the (upconverted) symbols on its input ports, precodes them at light speed, and returns the transmitted signal on its output ports, connected to the transmit antennas. At the receiver, a MiLAC receives the received signal on its input ports, combines it at light speed, and returns the symbols used for detection at its output ports.

Publications

M. Nerini, B. Clerckx, Analog computing for signal processing and communications - Part I: Computing with microwave networks arXiv:2504.06790, 2025.

M. Nerini, B. Clerckx, Analog computing for signal processing and communications - Part II: Toward gigantic MIMO beamforming arXiv:2504.07477, 2025.

M. Nerini, B. Clerckx, Capacity of MIMO systems aided by microwave linear analog computers (MiLACs) arXiv:2506.05983, 2025.

M. Nerini, B. Clerckx, MIMO systems aided by microwave linear analog computers: Capacity-achieving architectures with reduced circuit complexity arXiv:2506.15052, 2025.

Click here or scan below to find out more

Benefits

- Maximum flexibility: MiLAC offers the same flexibility as fully digital beamforming and therefore can obtain maximum performance.
- Minimum number of RF chains: MiLAC only requires as many RF chains as the number of transmitted symbols.
- Low-resolution ADCs/DACs: MiLAC only requires low-resolution ADCs and DACs.
- No computations at every symbol time: MiLAC does not require any computation on a per-symbol basis.
- Minimal computations at every channel coherence time: MiLAC can perform ZFBF without requiring any matrix inversion, as all operations are done in the analog domain, hence with minimal computation at each channel realization.