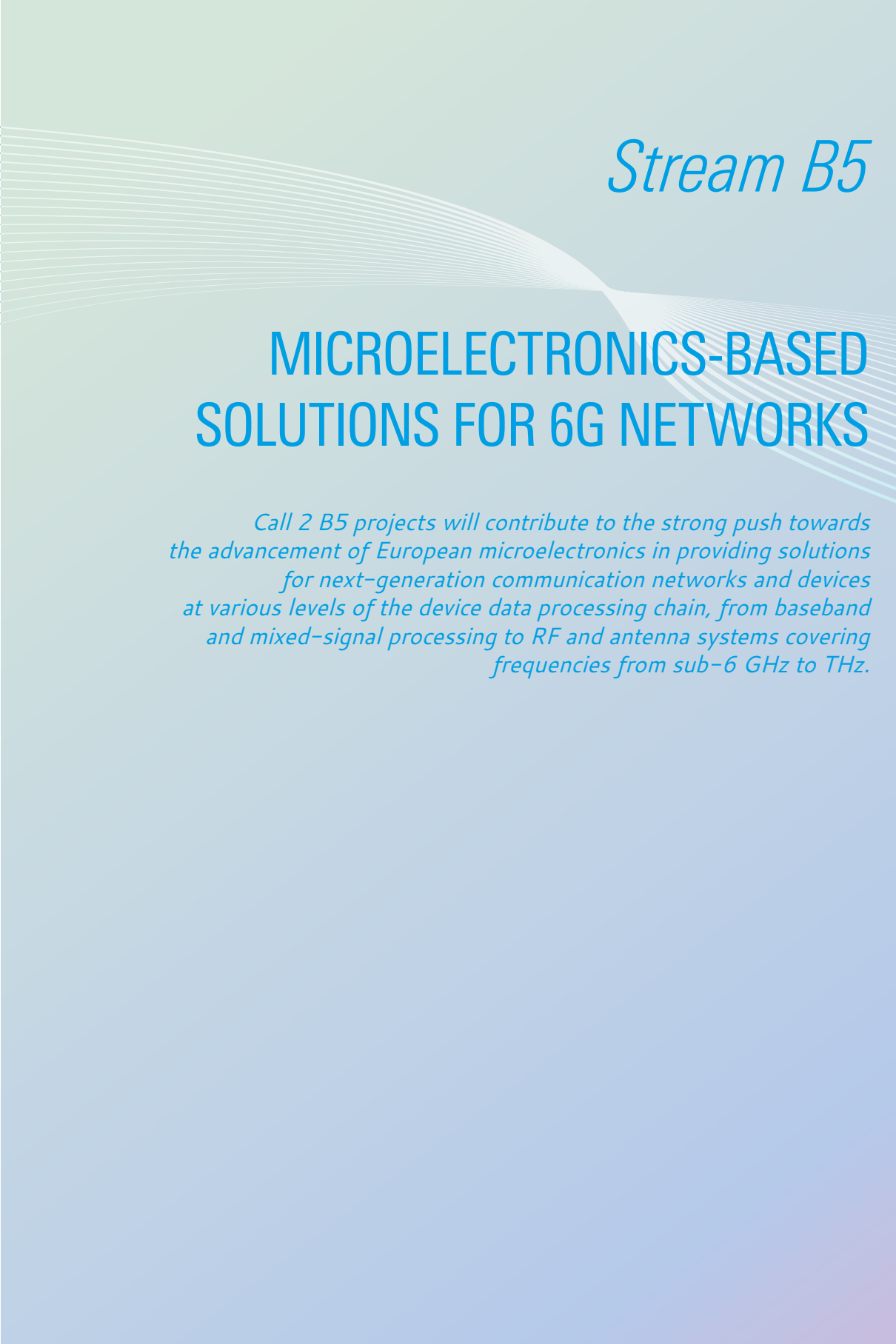




Stream B5

MICROELECTRONICS-BASED SOLUTIONS FOR 6G NETWORKS

Call 2 B5 projects will contribute to the strong push towards the advancement of European microelectronics in providing solutions for next-generation communication networks and devices at various levels of the device data processing chain, from baseband and mixed-signal processing to RF and antenna systems covering frequencies from sub-6 GHz to THz.

6G-REFERENCE

6G-REFERENCE targets transceiver hardware innovations enabling 6G densely distributed systems exploiting Distributed MIMO (D-MIMO).

OVERVIEW

6G-REFERENCE investigates integrated circuit (IC) and antenna hardware for centimetre-wave (cm-wave) integrated communication and sensing, enabling multi-users through a cell-free network of distributed radio units (RUs). In this context, distributed multiple input multiple output (MIMO) plays a central role in extending coverage, improving reliability, increasing data rates, mitigating interference and enhancing power efficiency.

In dense deployment scenarios, fibre connectivity to RUs cannot always be assumed. As a result, highcapacity wireless backhaul and precise overtheair synchronisation become critical hardware enablers. Achieving fully coherent distributed MIMO represents a key long-term objective, requiring major advances in synchronisation accuracy. In parallel, integrated sensing and communication (ISAC) is recognised as a fundamental building block of future 6G systems.

CONCEPT/ ARCHITECTURE/ TECHNOLOGIES

Key use scenarios and an example deployment grid is illustrated assuming that only one central RU has fibre access, while all other RUs communicate wirelessly.

A dense hexagonal grid of RUs with 25 m spacing is proposed, with hardware research focusing on RU platforms and five key project objectives:

1. Cooperative transmission to user terminals by clusters of distributed RUs, supported by efficient over-the-air (OTA) fronthaul data distribution;

2. Accurate over-the-air synchronisation (OAS) of distributed RUs;

3. Accurate sensing and localisation using the same RU hardware platform;

4. Frequency and spatial selectivity to enable coexistence with other services in the FR3 bands;

5. Economic and environmental sustainability achieved through low power, cost effective hardware solutions.

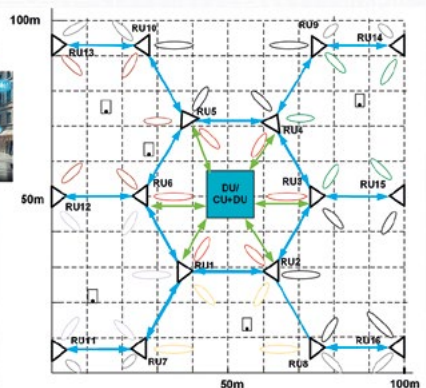
6G-REFERENCE scenarios



taken from https://hexa-x-1.eu/wp-content/uploads/2025/05/hexa-X-01-01-4_slideset_final.pdf

Scenario assumptions:

- Factory Hall scenario (& Urban square)
- Densified Distributed MIMO RU-network (grid 25m)
- Fiber access only at Distributed/Central Unit (CU/DU)



INNOVATIONS

The project focuses on developing advanced hardware and RF solutions to enable high-performance distributed MIMO networks, integrating communication, synchronisation, and sensing functionalities:

1. In-band Full-duplex transceiver ICs and antenna arrays to enhance data capacity between distributed MIMO RUs, reduce latency for communication and synchronisation and minimise self-interference supporting monostatic radar;

2. Novel synchronisation solutions to achieve accurate frequency and time synchronisation, enable fast and continuous synchronisation;

3. Novel RF and antenna components including time modulated arrays (TMA) to reduce power, complexity and cost, frequency modulated arrays (FMA) to increase positioning accuracy, supporting for reconfigurable intelligent surface (RIS) solutions to enable beam re-direction, antenna arrays, including environmental sensors, filtering cm-wave antennas.

USE CASES/ TRIALS/ APPLICATIONS

The focus is on IC and antenna hardware enablers that support low latency full duplex communication, high precision synchronisation and accurate sensing and localisation. Demonstrators are

designed to validate the basic feasibility of these hardware solutions and to characterise the limits of achievable performance.

RESULTS/ IMPACT

To guide the development of a distributed MIMO system for communication, sensing, and timing synchronisation, key specifications and performance analyses were established:

System specifications for operation at 14.8-15.35GHz:

- Communication Key Performance Indicator (KPI)s: 480 Mbps per user, 43 Mbps/m², 0.1–1 ms latency
- Sensing KPIs: resolution <0.5 m and 0.5 m/s, 0.1 s refresh time
- Synchronisation KPIs: $\Delta f/f < 2$ ppb, $\Delta\phi < 22.5^\circ$, $\Delta t < 100$ ns

Link budget analysis for 50–400 MHz channel bandwidth indicates sufficient margin for 4x4 antenna arrays at low-mW transmit power per element.

Ray-tracing simulations in a factory hall model the channel impulse response for both communication and synchronisation.

Antenna array and IC co-simulation suggest that a full-duplex link budget is challenging but potentially feasible.



*6G haRdware
Enablers For cEll
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& sEnsing*

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