6G-REFERENCE

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

OVERVIEW

To allow for flexible deployment, fibre access cannot be taken for granted. Synchronisation in frequency and time over the air then becomes a key challenge. Moreover, improvements in data capacity are wanted, while also supporting distributed sensing functionality. Realising all this functionality in practical hardware with low complexity, cost, and power consumption is a key challenge. We believe this may be possible exploiting the cm-wave 10-15GHz spectrum. Hence this project has 5 goals: i) transceiver cm-wave Radio Frequency hardware innovations to address the data capacity and scheduling challenge of D-MIMO. ii) Novel solutions for accurate over the air frequency, phase and time synchronisation. This would not only support high-capacity data rate communication, but may also enable high-resolution UTC distribution and accurate positioning and sensing. iii) New RF and antenna components providing extended spatial and frequency domain selective capabilities at reduced complexity, cost, and energy consumption. iv) Hardware solutions with low complexity, low cost, and low power consumption. v) Coexistence with existing services in the 10-15GHz range, which is targeted since it not only provides new spectrum opportunities but also efficiently balances the benefits and drawbacks of sub-6GHz and mm-wave solutions.

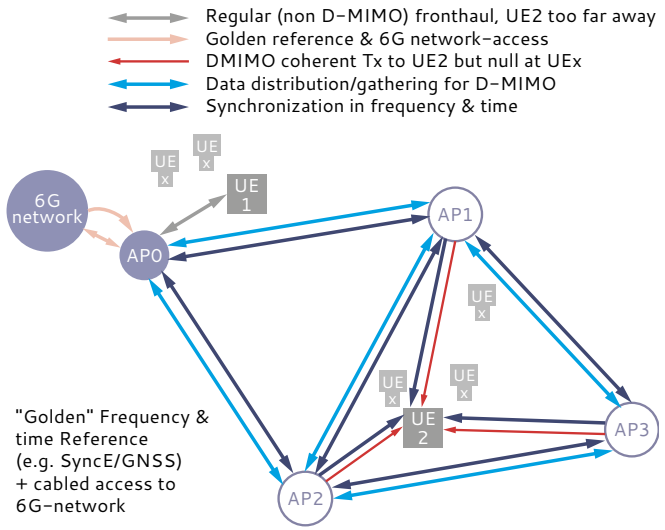
Remarkably, our vison of 6G based on distributed systems with integrated sensing and communication capabilities is shared with 5 out of the 6 projects in SNS Phase 2 Stream B-01-02 (6G-DISAC, iSEE-6G, INSTINCT, 6G-SENSES, 6G-MUSICAL). 6G-REFERENCE outcomes to those projects could be in the form of hardware designs solving key system aspects such as full-duplex operation or time/frequency synchronisation of distributed nodes, whereas 6G-REFERENCE may leverage on the results of these projects on system/device requirements from the signal processing point of view. A rather unique feature of 6G-REFERENCE is the focus on Frequency Range 3 (RF3), which already received a strong industrial interest including a study item in 3GPP.

USE CASES/ SCENARIOS

In urban areas, 6G will need to rely on a sustainable solution to cope with the ever-increasing traffic demands and population densification, while providing disruptive capabilities like the materialisation of the internet of sense. The solution envisioned by 6G-REFERENCE consists of ultra-dense cell-free deployments for joint coherent communications and sensing at cm-waves, which balance the benefits of sub-6GHz (e.g. reduced pathloss) and mm-wave (e.g. wide bandwidth) ranges. These systems face five fundamental challenges: i) the need of accurate synchronisation among distributed radio units; ii) fronthaul data distribution; iii) integration of sensing capabilities; iv) low complexity/cost/consumption radios; and v) coexistence with other services. 6G-REFERENCE will develop integrated circuit and antenna component solutions addressing all of them. Frequency/time synchronisation circuits will leverage recent innovations and explore new

architectures with faster synchronisation. Efficient full duplex fronthaul data distribution among cascaded radio units will be explored, while also enabling integrated monostatic radar sensing. Besides these, on the sensing domain, 6G-REFERENCE will explore environmental sensors integrated in the antenna estate, reuse the synchronisation framework for accurate localisation, and develop new array solutions building on recent innovations in modulated arrays. Finally, dynamic IF and antenna filtering will be explored to enable efficient spectrum coexistence schemes. The ultimate goal of 6G-REFERENCE is to develop hardware enablers that could end up constituting a reference design for future 6G distributed radios.

CONCEPT/ ARCHITECTURE



Simplified example of a Distributed MIMO system with only one cabled 6G-network node providing data and an accurate time and frequency reference. RUs/APs cooperate to realise Over-the-Air Synchronisation (OAS) via Full-Duplex Sync timeTx and timeRx signals (green) and data distribution/gathering (blue arrows).

EXPECTED RESULTS

6G-REFERENCE will contribute to the European leadership in microelectronic solutions for communication infrastructure by developing hardware enablers for densified cell-free deployments targeting not only coherent data transmissions but also high accuracy localisation and sensing, thus materialising the connection between physical, digital and human worlds. The green transition in 6G-REFERENCE will rely on densified deployments of low energy distributed nodes capable of providing at the same time enhanced multiuser beamforming schemes for data transmission and accurate sensing. Enabling a densified deployment of distributed radio units, 6G-REFERENCE will contribute to improve the availability in high density populated areas, ensuring coverage from multiple radio units in every corner. Moreover, it will be achieved in a sustainable manner, from the energy point of view. In addition, we will also directly contribute to UN SDG 13 on climate actions, by developed environmental sensors in antenna system hardware in order to realise virtual environmental quality maps. 6G-REFERENCE will not directly address new business models but will indirectly enable their conception, specially by integrating communications with localisation and passive radar sensing, which may definitely boost the creation of new applications and businesses. The ultimate goal of 6G-REFERENCE is to ensure the commercial feasibility of the developed hardware solutions not only by aligning them with current standardisation activities and goals, but also by facilitating that the standardisation work can be based on the correct knowledge of the capabilities and limitations of the developed hardware.

6G haRdware Enablers For cEll fRee cohEreNt Communications & sEnsing

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Verticals concerned :
Automotive, Public Safety

Project Consortium Members:
CTTC, Ericsson, University of Twente, CEA, Anteral, MTU Australo Alpha Lab, IMEC, Polytechnical university of Zurich, Advanced Circuit Pursuit AG, University of Birmingham.