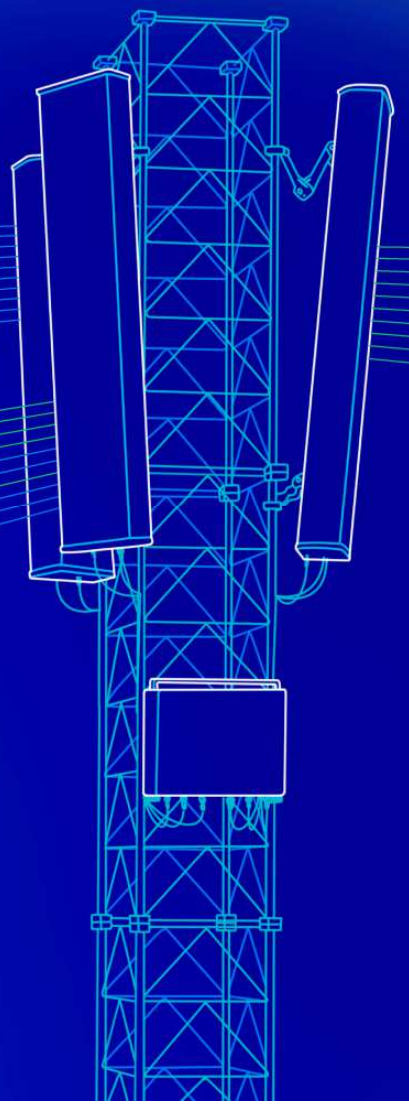
Antennentechnologie für 6G Mobilfunknetzwerke



Dr. Martin Jacob, Ericsson

VDE ITG Workshop Antennenkonzepte für 3D Netze der Zukunft

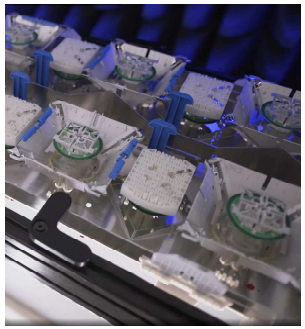
Ericsson Antenna System responsibility

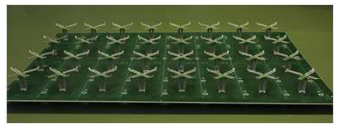
- Focus on multi band macro base station antenna products: Active + Passive
- Production in Romania and Mexico
- **R&D** in Rosenheim and US
  - Serial development
  - Test & verification
- Antenna **Research and Innovation**
  - Internal & **external** research projects
  - 5-10 Years development perspective
  - 6G research topics

Passive antennas

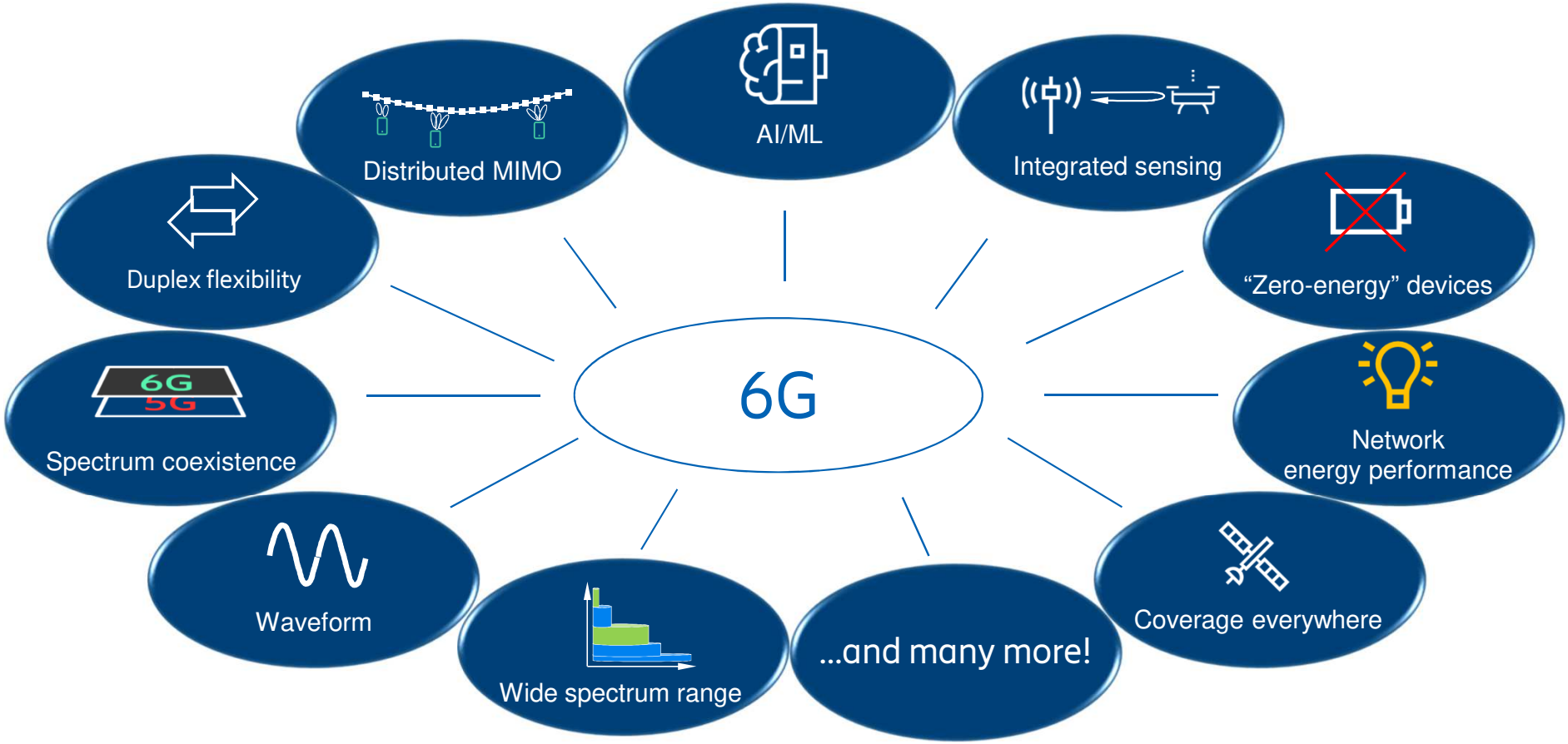
Hybrid/ Interleaved Air

Active antennas

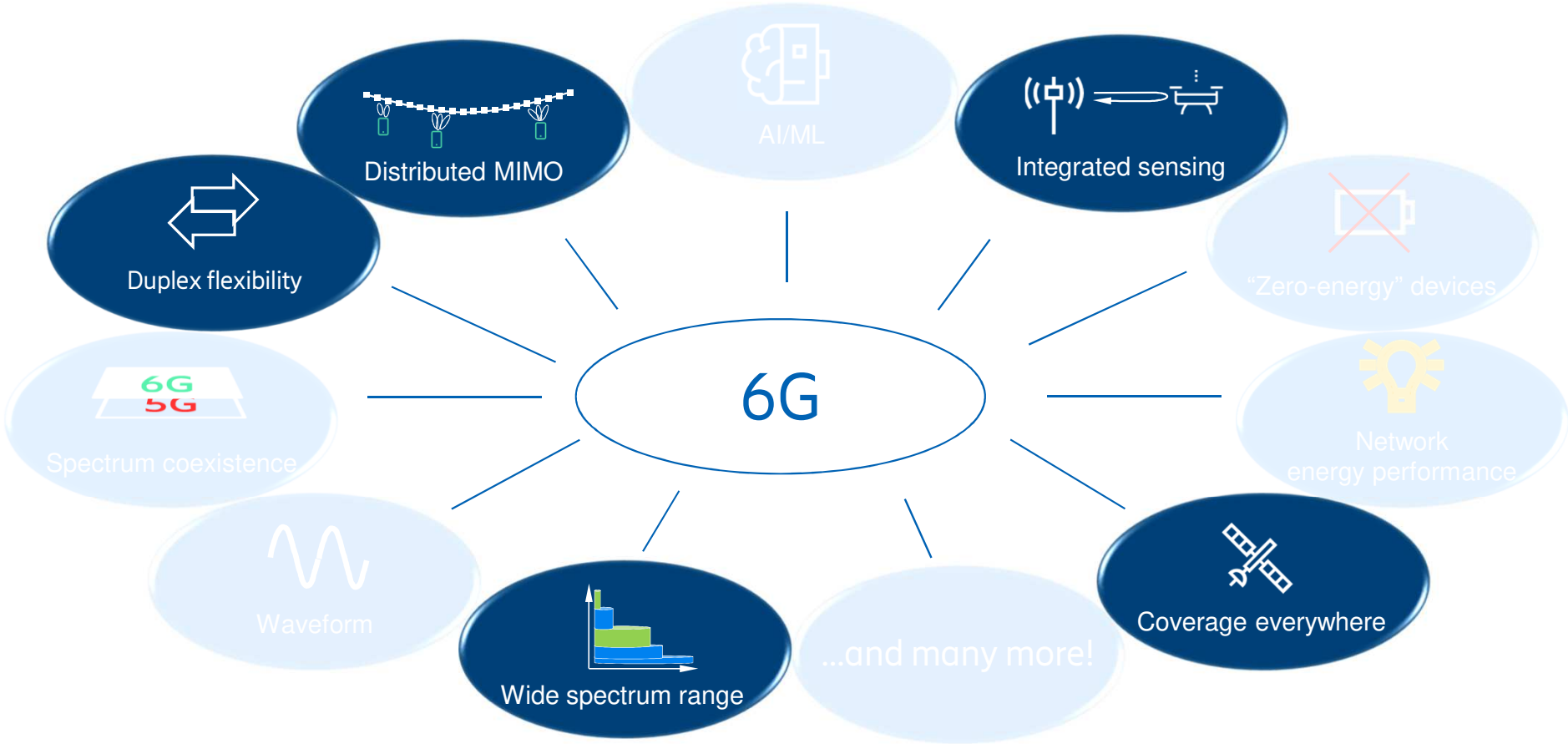




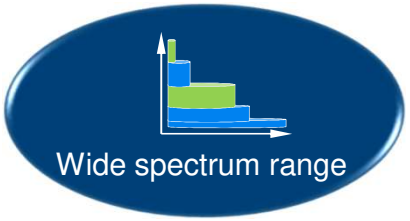
6G RAN technology components



But what does this mean for "6G antennas"?



6G spectrum



From below 500 MHz to beyond 100 GHz

Spectrum used by current systems ("sub-6" and "mmw")

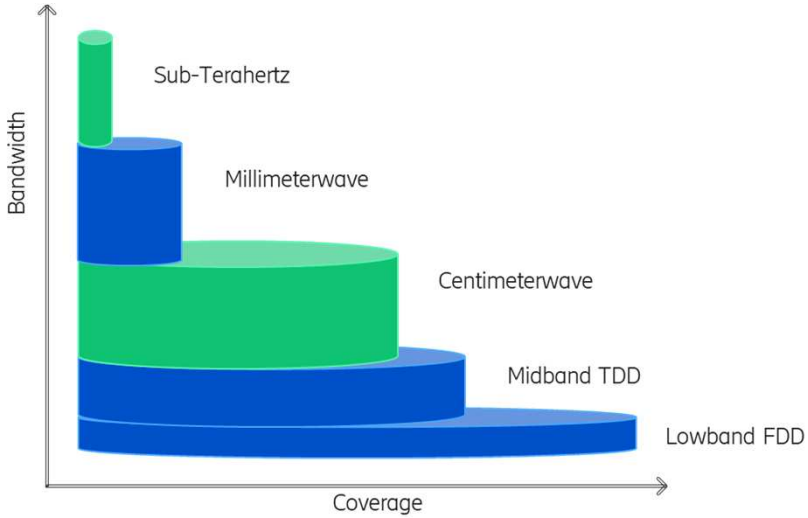
New spectrum between "sub-6" and mmw bands

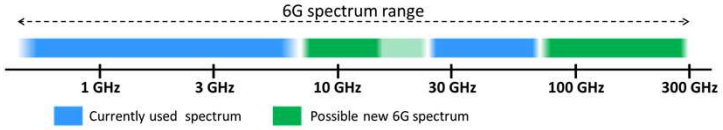
- "Centimeter-wave"
- Focus on 7-15 GHz

New spectrum above 71 GHz ("sub-THz")

- For extreme data rates in specific scenarios – and possibly for a later phase of 6G

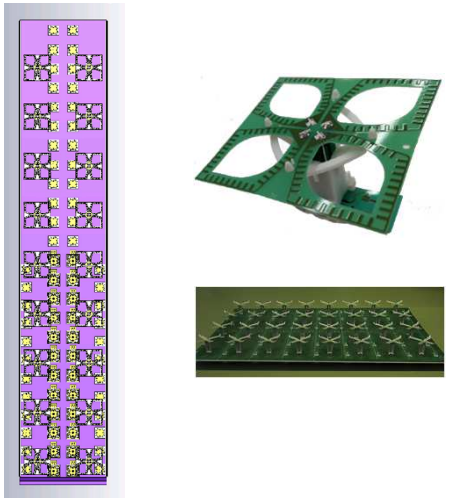
→ 6G antennas needed for **current** and **new spectrum**



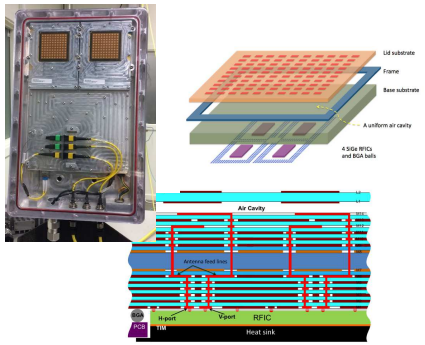


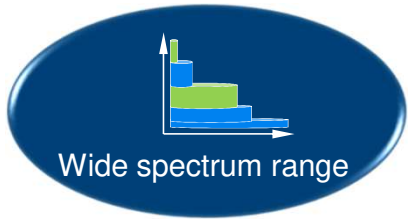
Exploring antenna technology for 6G frequencies

Ericsson sub 6 GHz
5G antenna technology



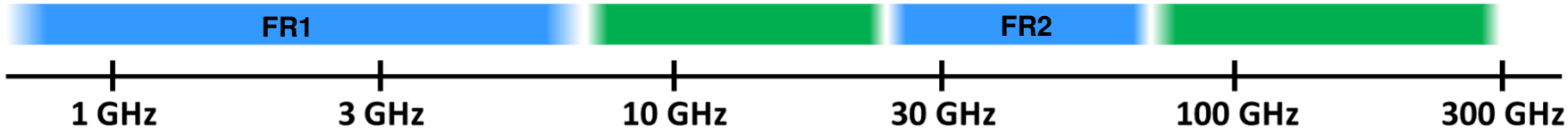
Ericsson 5G
mmWave antenna
technology



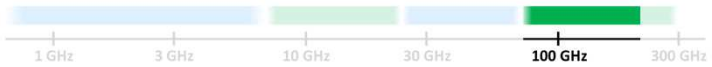


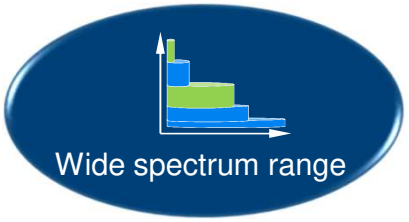
Dipole radiators with metallic reflector

Patch radiators on
multilayer RF PCBs

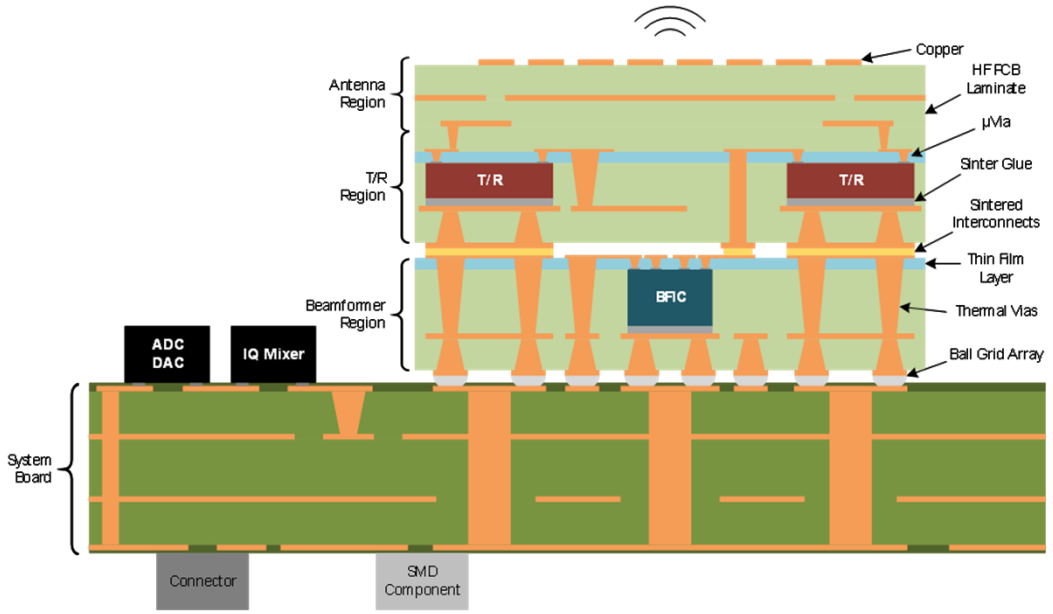


6G Terakom - AiP





- D-band (110-170 GHz) **Radio Unit (RU)**
  - Integration of frontend module as **Antenna-in-Package** (AiP)
    - RFICs embedded into PCB substrate
    - Modular approach (T/R + BF modules) due to sintered RF interconnects
  - **IC Design** (CMOS, GaN)

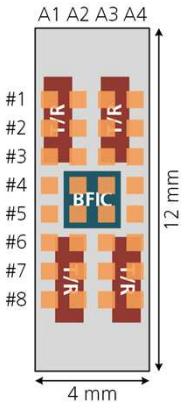


- End-to-End system demonstration with FPGA based BB unit

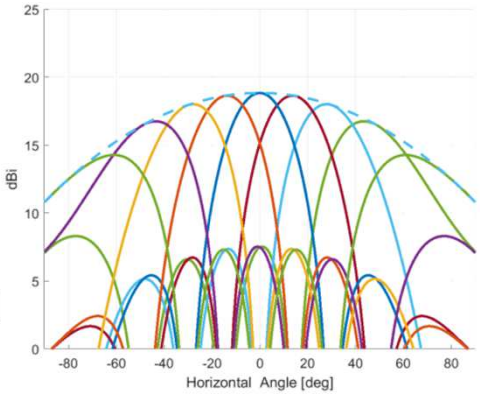
→ Very **high degree of** antenna/electronics **integration** required to reach **good efficiency at D band**

6G Terakom – Scalability

- Single AiP module consists of
  - 32 antenna elements (8x4)
  - 4 T/R MMICs
  - 1 Vector modulator Beamformer
- Modularized approach with D band BGA interface allows scalability to various use cases
  - 41 dBm EIRP/module

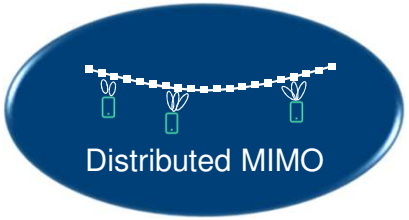


8 x 4

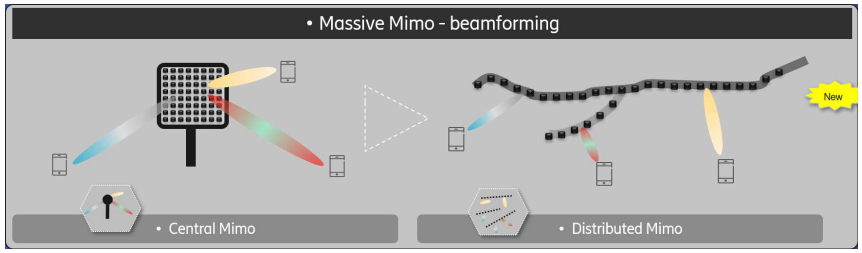


First measurements planned in **March 2024**

6G MassIMO

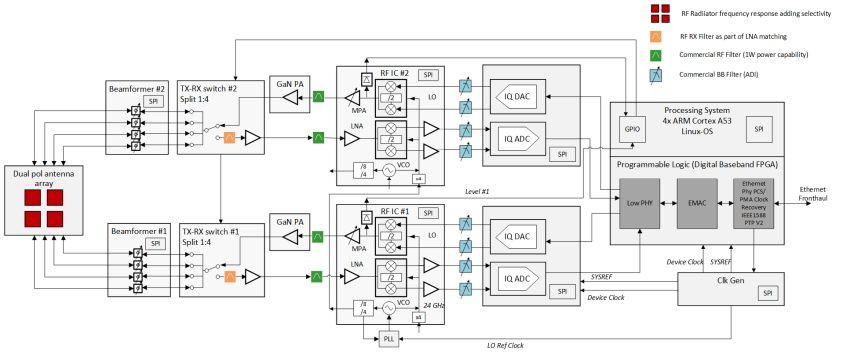


- Cell-free and user-centric networks eliminates cell boundaries and hence inter cell interference



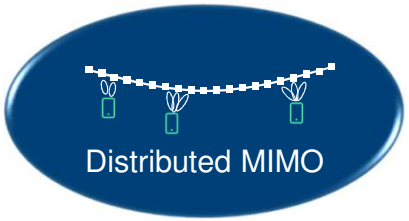
- In D-MIMO there are tightly coordinated intelligent **Antenna Processing Units (APU)** required
  - **Compact**
  - **Energy efficient**
  - **Cost optimized**

- MassIMO use case: **industrial environment** with newly developed **12 GHz** APU hardware
  - ASIC development: Beamformer, RF transceiver, power amplifier, ADC/DAC
  - Hybrid Beamforming, including 2 x 2 analog BF



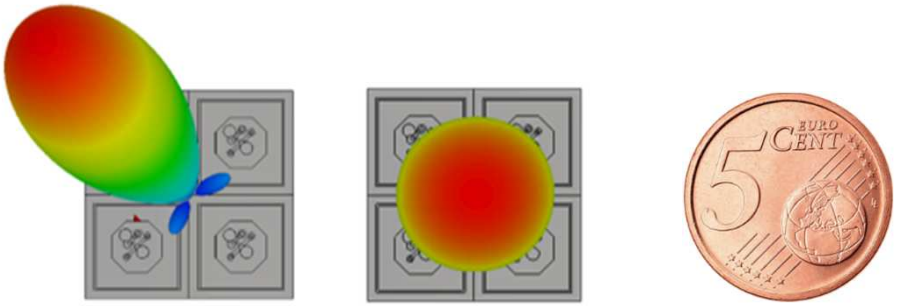
MassIMO APU architecture

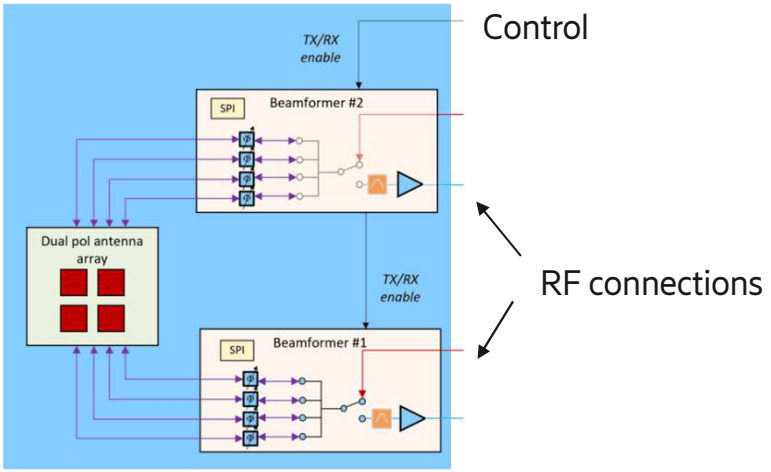
6G MassIMO



- Integrated **active beamforming antenna**
  - 2x2 array configuration allowing for **coarse analog beamforming** in horizontal and vertical domain
  - **PCB based** dual polarized **antenna** elements
  - **Beamformer IC** (SOI CMOS)
    - 4 Phase Shifters
    - Switch
    - LNA

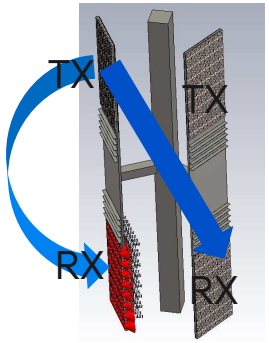
First measurements planned in **April 2024**



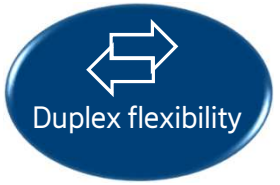


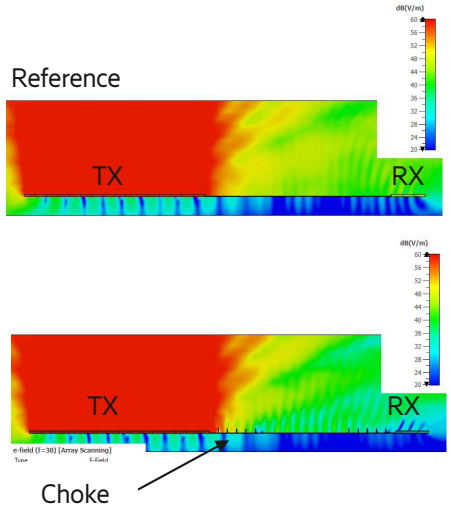
(Sub Band) Full Duplex

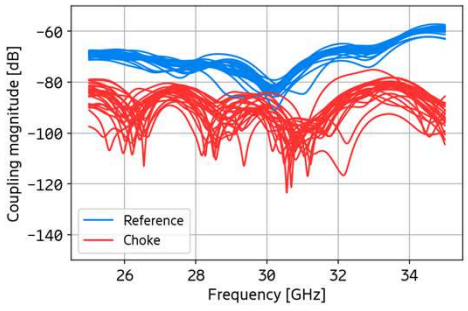
- Full Duplex Schemes can significantly **improve the spectrum efficiency**
  - BS transmits and receives at the **same time** at (nearly) the **same frequency**
  - Antenna challenges: High isolation



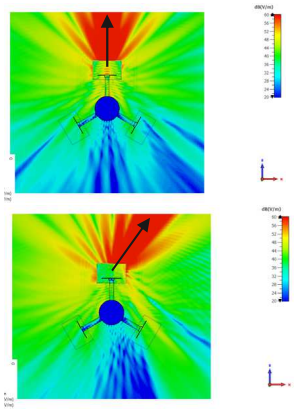
→ **Intra antenna isolation** as well **front to back ratio** is crucial for FD operation

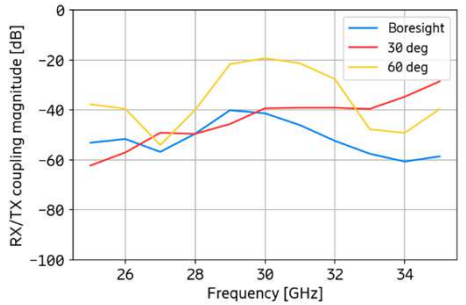






BS TX and RX self-interference

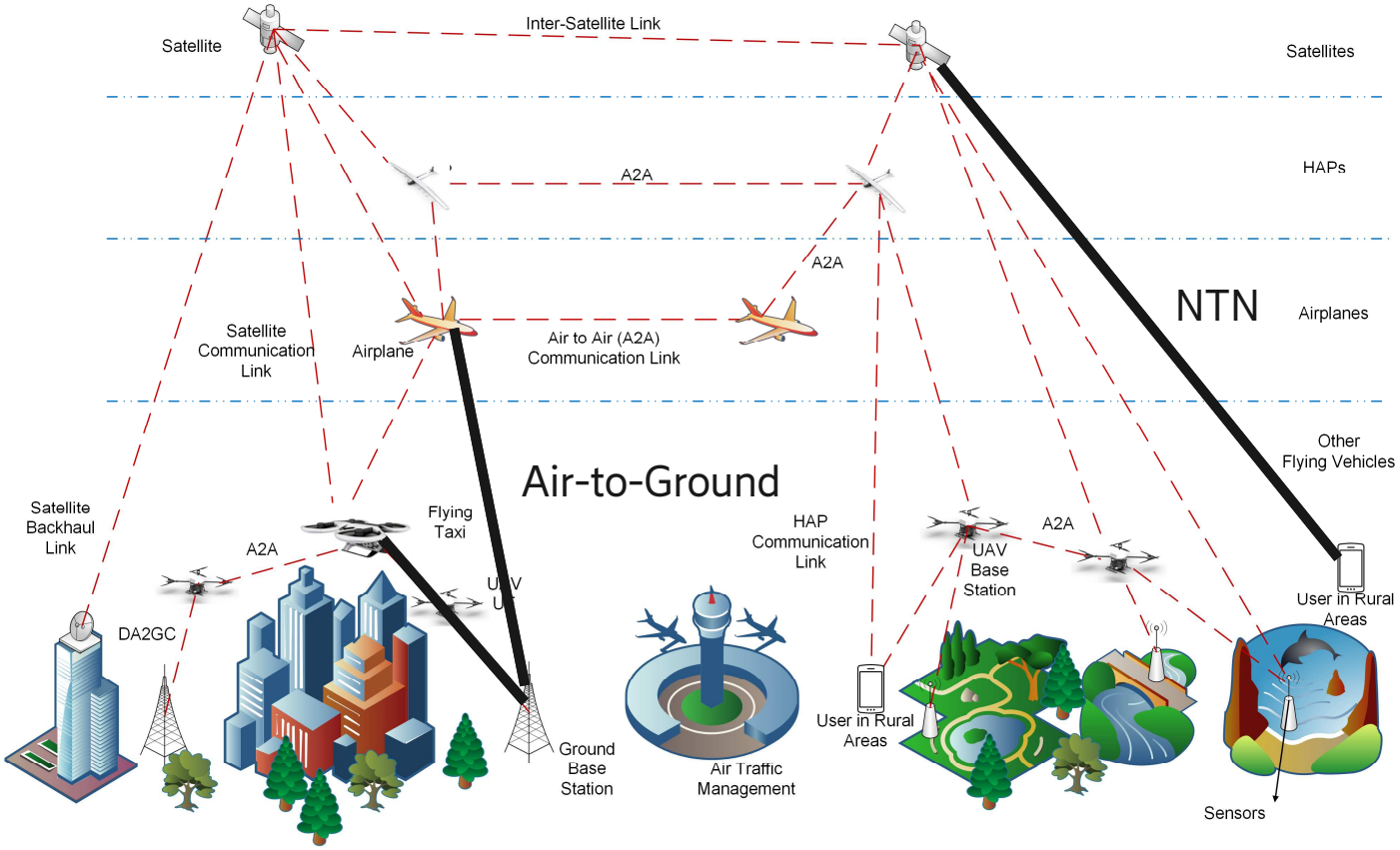




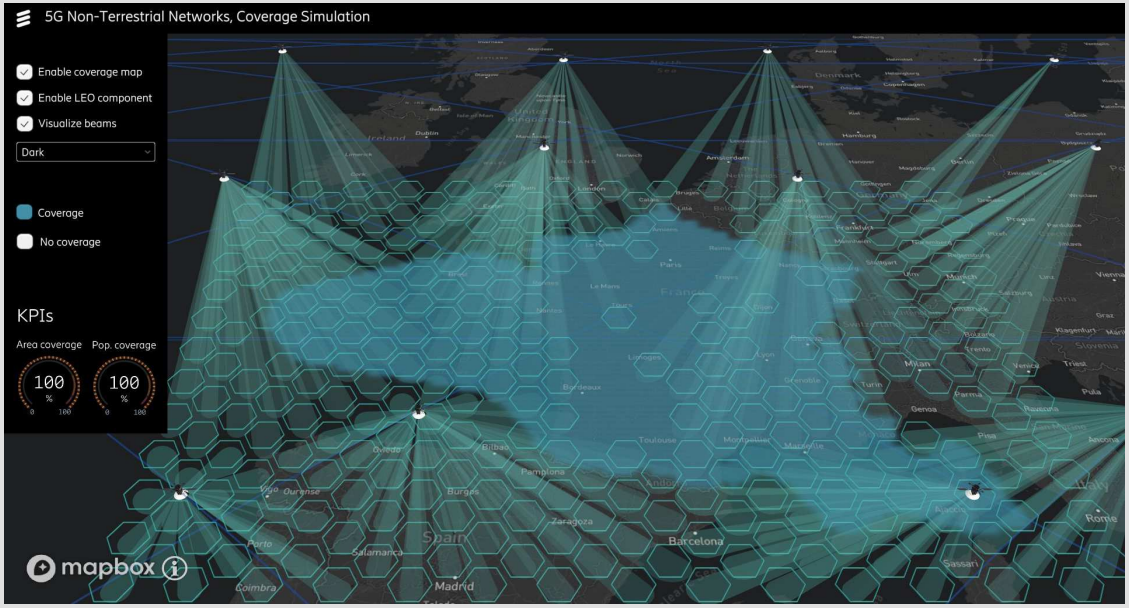
Inter sector interference

L. N. Ribeiro, D. H. Nguyen, P. K. Gentner, Section 2.2 of "Analysis of issues related to self-interference and co-channel CLI R4-2212620," 3GPP TSG-RAN WG4 #104,

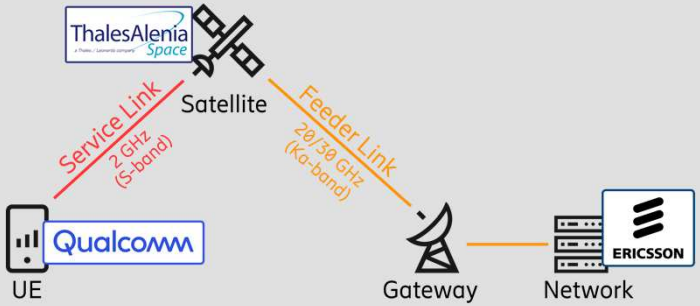
6G for connected sky – a step towards the digital airspace



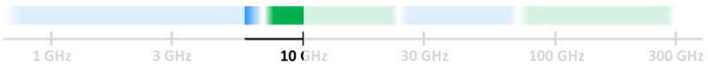
5G Non-Terrestrial Networks – The PoC



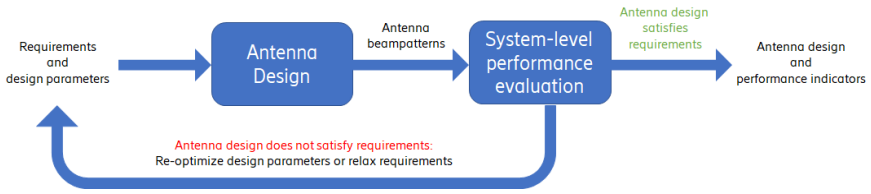
Ericsson (France), Thales and Qualcomm have partnered for a PoC to demonstrate 5G NTN end-to-end connectivity

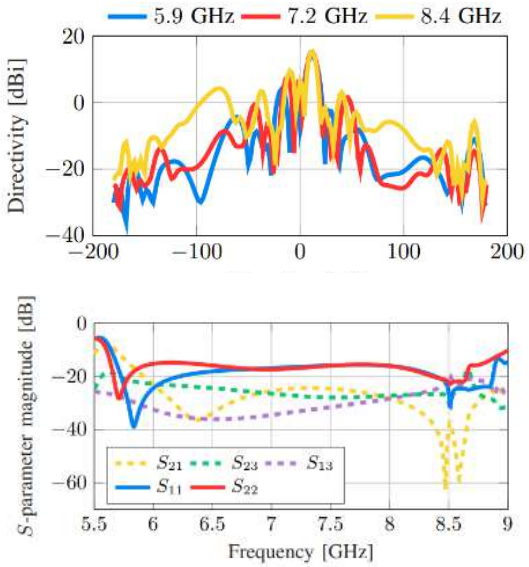


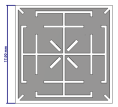
A2G MIMO antenna

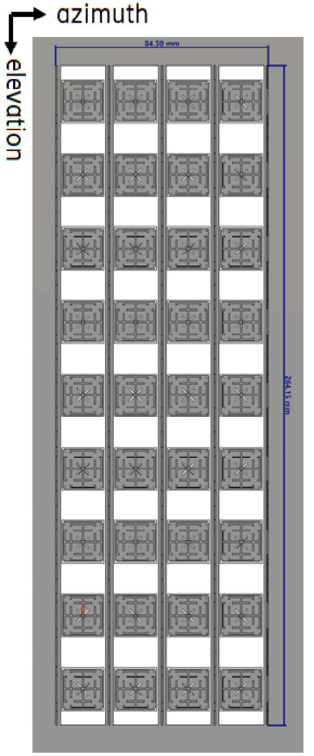


- Massive MIMO antenna array design
  - **5.9 - 8.4 GHz** (easily scalable to other frequencies)
  - 3D patch radiators fed by balun
  - 4 x 9 array allowing for beamforming in azimuth and elevation



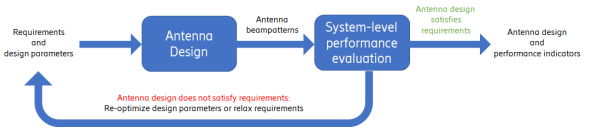




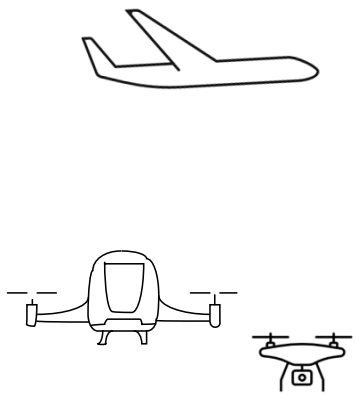


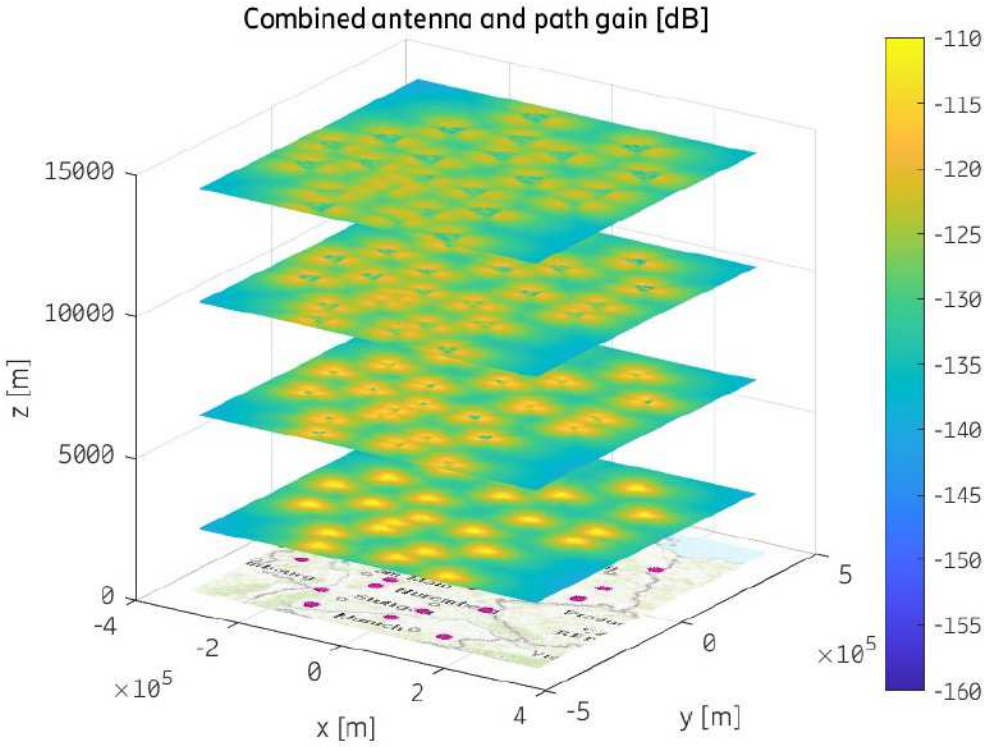
L. N. Ribeiro, S. Hasturkoglu, J. Graevendieck, "Ground Base Station Antenna Design for Air-to-Ground Communications," to be presented at EuCAP 2024.

3D Aerial Coverage Optimization



Site deployment



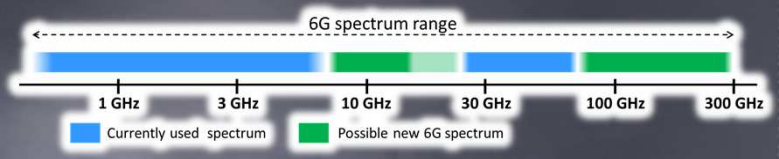


→ 3D networks require new antenna designs and new ways of planning

Where do we go in 6G?

New Functionality

New Spectrum



New network architectures

More and higher degree of integration within the antenna

(Frequency and Electronics)

New spectrum, functionalities & network architectures brings a need for innovative new 6G antenna technology and architectures

Cost-efficient and sustainable solutions enabling unlimited communication everywhere

Thank You.