

Integrated Devices, Electronics, and Systems (IDEAS) for Future Communication and Sensing

Prof. Hua Wang

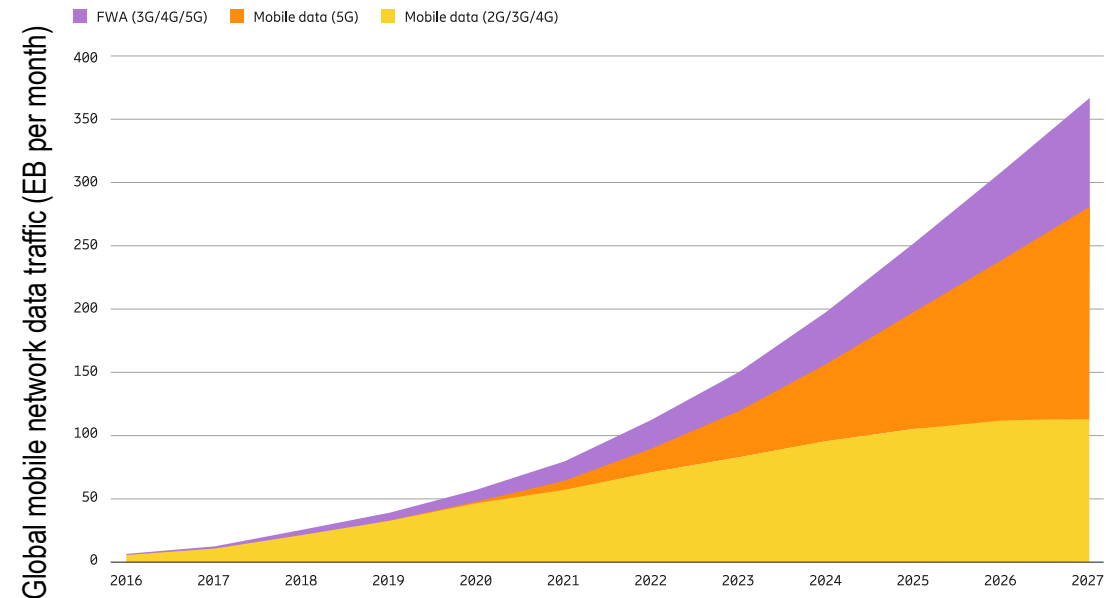
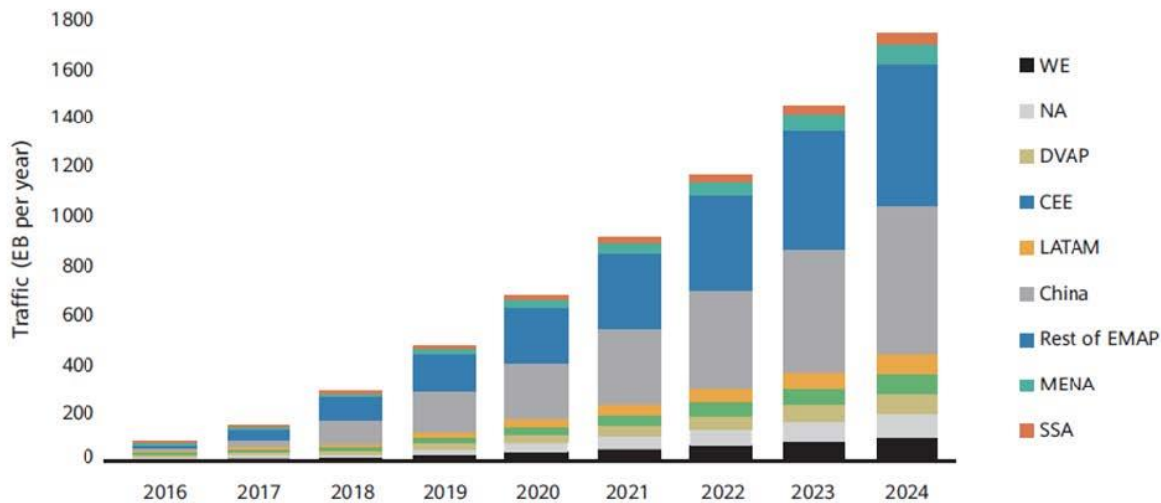
Dept. of Information Technology and Electrical Engineering

ETH IDEAS Group (<https://ideas.ethz.ch/>)

Technology Trend of Wireless Communication and Sensing



Data Traffic over Fixed and Mobile Networks

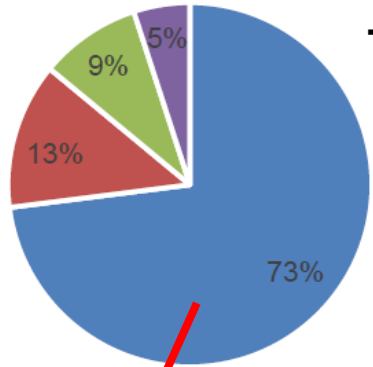


Green Future Networks – Network Energy Efficiency, Version 1.1, Dec. 2021

Ericsson Mobility Report Data and Forecasts 2022

The Challenges

Energy and Efficiency



Total Operator Energy Use

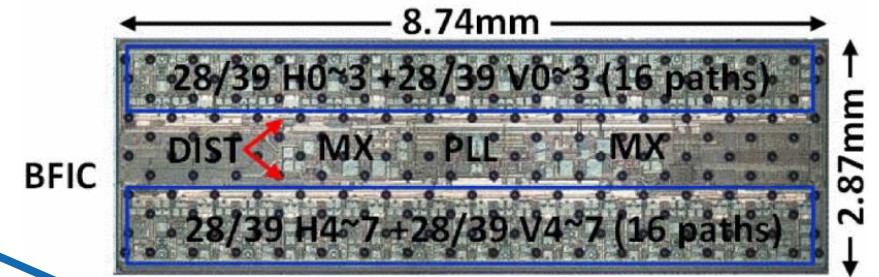
- Radio Networks
- Core Network
- Data centres
- Other operation

30% for Wireless Radio Frontends + 30% for Air Conditioning and Cooling

Green Future Networks – Network Energy Efficiency, Version 1.1, Dec. 2021

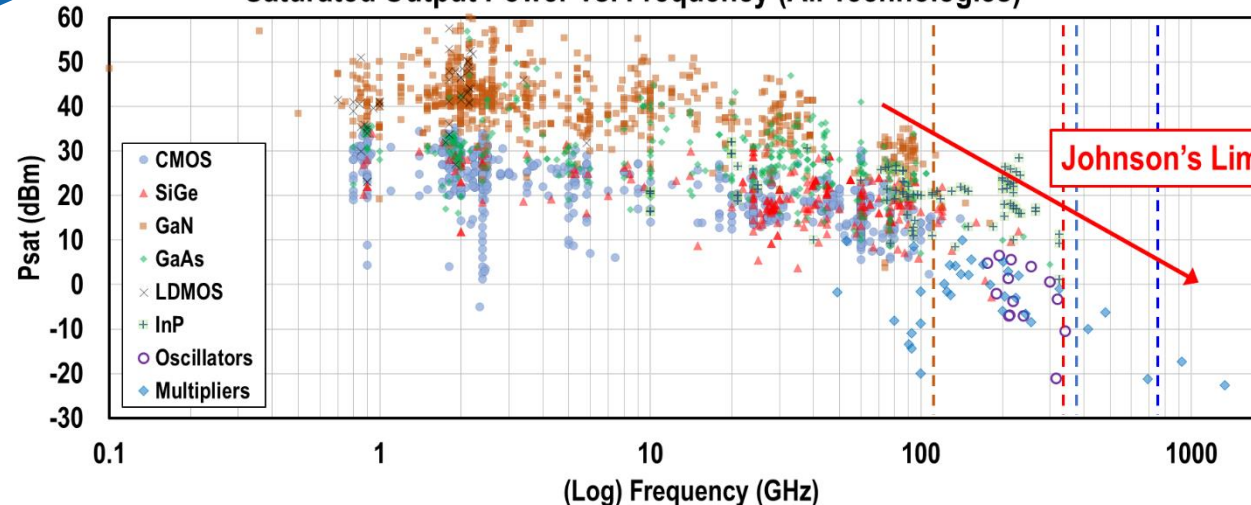
Integration Level

SAMSUNG 28GHz and 39GHz 5G NR 32-path dual-polarized phased array FEM transceiver chip (ISSCC 2022)



Output Power

Saturated Output Power vs. Frequency (All Technologies)



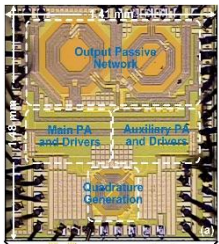
ETH Power Amplifier Survey 2000-Present, ETH IDEAS Group, Sep. 2022

Our Solutions: Devices — Circuits — Systems — Applications

Our Example Chips: RF/Mm-Wave Frontends with P_{out} , Efficiency and Linearity

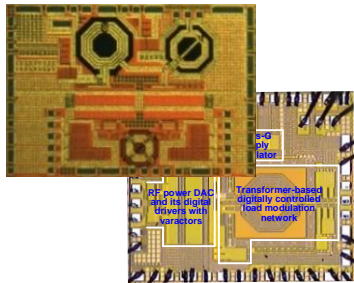
A Digital Polar Doherty PA in CMOS

RFIC 2014 Best Student Award (1st Place), JSSC 2015, T-MTT 2015



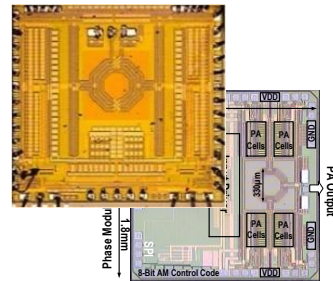
A Hybrid-Mode Digital PA in CMOS for Deep PBO

ISSCC 2015, Microwave Magazine 2015 (Best Paper Award), JSSC 2016, RFIC 2016, JSSC 2017



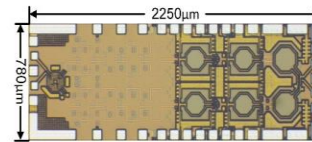
Dual-Band 2.4/4.8GHz Digital PAs

CICC 2015 Best Student Paper Award (2nd Place), JSSC 2016, ISSCC 2018, JSSC 2018



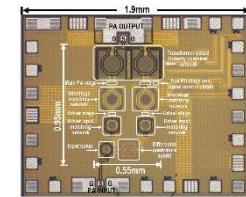
World-First 28GHz/37GHz/39GHz Multiband Doherty PA for 5G Massive MIMO

ISSCC 2017, JSSC 2019



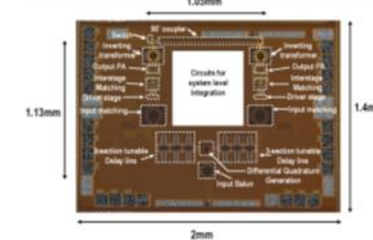
A Highly Linear Super-Resolution Mixed-Signal Doherty PA for Mm-Wave 5G

ISSCC 2019, JSSC 2019



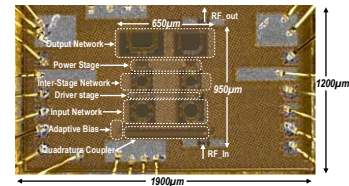
A Reconfigurable Series/Parallel Doherty PA with VSWR Resilient Performance

ISSCC 2020



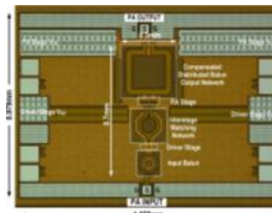
A 26-60GHz Continuous Mode Coupler Balun Doherty PA

ISSCC 2021



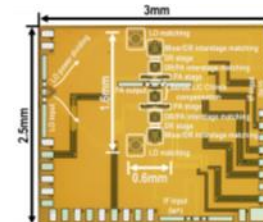
An Instantaneously Broadband Ultra-Compact Highly Linear PA for 5G over 24-40GHz

ISSCC 2020



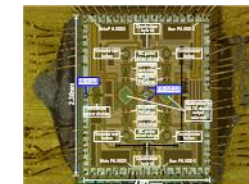
A 28GHz Current-Mode Inverse-Outphasing Transmitter for 5G Communication

ISSCC 2020



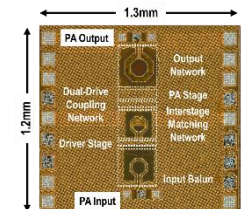
A 24-30GHz Watt-Level Broadband Linear Doherty PA with Multi-Primary DAT

ISSCC 2020



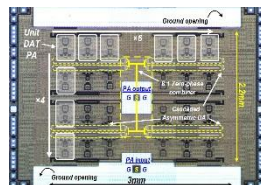
A 28GHz Class-W Multi-Drive Mm-Wave PA

ISSCC 2021



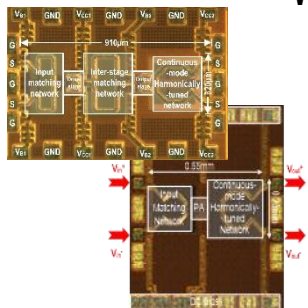
World-First 60GHz 1-Watt CMOS PA with Cascaded Asymmetric DAT

ISSCC 2019



Continuous-Mode Harmonically-Tuned Ultra-Linear PAs

ISSCC 2018, RFIC 2018, T-MTT 2019

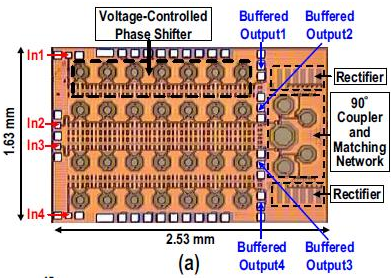


Our Solutions: Devices — Circuits — Systems — Applications

Our Example Chips: Phase Array MIMOs with Compactness, Data-Rate, Low Latency

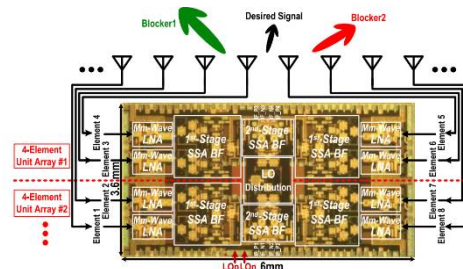
An All-Passive RF Negative Feedback Network for Autonomous Beam-Forming

RFIC 2016 Best Student Paper Award (2nd Place), JSSC 2017



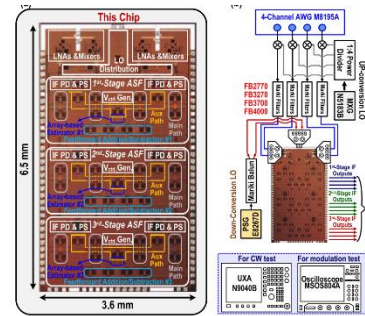
23-30GHz 1 × 8 MIMO RX array with full-FoV autonomous hybrid beamforming in GFUS 45nm CMOS SOI

ISSCC 2018 and T-MTT 2019



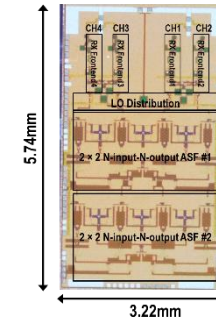
27-41GHz 1 × 4 MIMO RX array with full-FoV autonomous hybrid beamforming

ISSCC 2019 and JSSC 2019



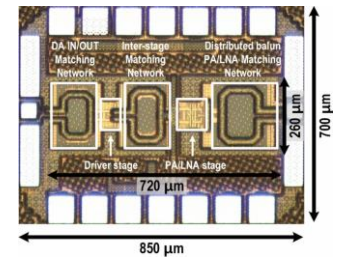
24-42GHz 2 × 2 MIMO RX array with 2-stage 2D autonomous beamforming

CICC 2022



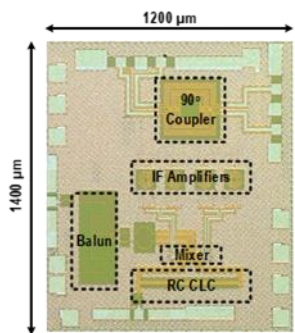
A 26-to-39GHz Ultra-Compact Bi-Directional PA/LNA Front-End for Multi-Band 5G MIMOs

ISSCC 2022



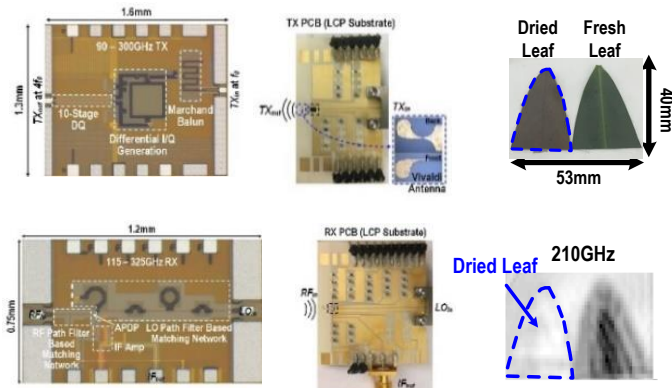
40-100GHz RX frontend in GFUS 22nm CMOS SOI

CICC 2020 and JSSC 2020



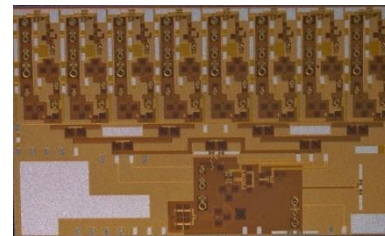
A Packaged 100-300GHz CMOS TRX with Vivaldi Antenna for Full-Band CW THz Hyperspectral Imaging

ISSCC 2017



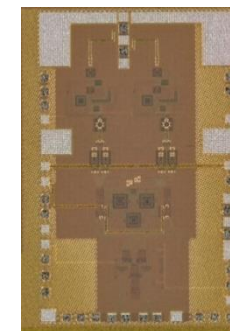
A 24-42 5G 1 × 8 MIMO TX/RX array with hybrid beamforming in GFUS 45nm CMOS SOI

RFIC 2019 and JSSC 2020



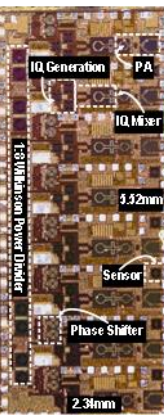
A 24-42 5G RX with autonomous polarization alignment

CICC 2021 and SSCL 2021



A 25-34GHz 1 × 8 MIMO TX array for keyless secured communication

RFIC 2021 (Best Student Paper Award) and JSSC 2022





**Thank you for
your attention!**

Prof. Hua Wang

Email: huawang@ethz.ch

Web: <https://ideas.ethz.ch/>

ETH Zurich

ETZ J95

Gloriastrasse 35

8092 Zürich

**A 5×5 Lens-Coupled 230GHz Source in GF 22nm CMOS SOI
for 6G Wireless Communication and Sensing**