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PAF TELESCOPE TECHNOLOGY FOR 5G BASE-STATIONS

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Telecommunications research and development efforts are currently focused on the next generation mobile communications standard, called fifth generation (5G). One of the goals of 5G is to offer data-rates of up to 10 Gbps at much higher system capacities [1]. In order to achieve this, additional frequency bands have to be allocated. Here, the millimeter-wave (mm-wave) band is considered an attractive option [2]. However, the free space path loss at mm-wave frequencies is significantly larger than for currently used sub-6 GHz frequencies. Therefore, high gain antenna systems that allow the generation and steering of multiple beams are required on the base-station side in order to serve multiple users simultaneously and with a sufficient signal-to-noise ratio (SNR). At the same time, the mobile communications market demands for low-cost solutions in order to achieve acceptable prices for the end user.

An often suggested antenna system approach for 5G mm-wave base-stations is a classical phased array, see e.g. [3]. An advantage of this approach is that the effective isotropic radiated power (EIRP) that is required in order to reach far-away users can be achieved by a combination of increased antenna gain and increased number of power amplifiers (PAs). Hence, when using as many PAs as antenna elements in the array, the EIRP scales with N^2, where N is the number of antenna elements. However, due to the use of standard (Bi-)CMOS technology, the heat dissipation of the front-end electronics may prohibit the use of densely spaced arrays. Increasing the element spacing on the other hand gives rise to the appearance of grating lobes. Moreover, if k users have to be served at the same time and within the same frequency band, the available transmit power must be divided between the users such that the maximum available EIRP decreases with an increasing number of users (alternatively, the array may be split into k sub-arrays, which would have the same effect). Lastly, the available transmit power of the user equipment (UE) is far below the output power of the base-station. Hence, increasing the EIRP by adding PAs is only possible for downlink, i.e. from base-station to UE, and not for uplink, i.e. from UE to base-station.

The European project SILIKA ([4]) takes a different approach for the base-station antenna system. Here, a phased-array-fed reflector-antenna is chosen as an alternative solution. This antenna type offers a large antenna gain at a potentially low-cost. Hence, compared to phased arrays without reflector, the large antenna gain allows the use of lower transmit power levels for achieving the required EIRP. This, in turn, also results in a higher link budget for the uplink case, assuring a bi-directional communication for larger distances. Moreover, different array elements cover different communication directions such that not all elements are active at the same time and the transmit power of an individual element does not have to be split between users. Thermal issues within the array and decreasing EIRP with increasing number of users are therefore less likely. However, phased-array-fed reflector-antennas are known to exhibit only a small beam-steering range of a few degrees. Increasing the scan range without (over-)compromising on the advantages of this antenna type is therefore one of the challenges within SILIKA. The experience and expertise of the SILIKA consortium on focal-plane arrays with key academic partners Eindhoven University of Technology and Chalmers, and leading industrial project partners NXP and Ericsson, will form the basis for this concept. At the symposium, the SILIKA concept will be presented, supported by relevant results of past and ongoing research.

[1] "5G Radio Access," Ericsson White Paper, April 2016 (http://www.ericsson.com/res/docs/whitepapers/wp-5g.pdf)
[2] World Radiocommunication Conference 2015, "Resolution 238; Studies on frequency - related matters for International Mobile Telecommunications identification including possible additional allocations to the mobile services on a primary basis in portion(s) of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond," Tech. Rep. RESOLUTION 238(WRC-15), WRC-15, Geneva, October 2015.
[3] B. Sadhu et al., "7.2 A 28GHz 32-element phased-array transceiver IC with concurrent dual polarized beams and 1.4 degree beam-steering resolution for 5G communication, " *2017 IEEE International Solid-State Circuits Conference (ISSCC)*, 2017, 128-129
[4] "Silicon-based Ka-band massive MIMO antenna systems for new telecommunication services (SILIKA), " research project funded by European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska Curie grant agreement No 721732 (www.silika-project.eu)