Beamforming and reflector antenna approach for silicon-based Ka-band massive MIMO base stations

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Abstract

Presenting a combination of hierarchical beamforming and reflector antennas to cope with the degradations faced at higher frequencies. The overall objective is to develop a focal line/focal plane array (FLA/FPA) base station system to enable mm-Wave for 5G communications in urban outdoor environments.

Introduction

Driven by the steadily growing demand for higher data rates and the rising number of mobile communications devices, the goal is to utilize mm-Waves. The benefits from this is a wider bandwidth and that large scale arrays become feasible. This work contributes to the development of a focal line/focal plane array (FLA/FPA) within the EU project SILIKA [1]. Therefore, this paper presents a promising reflector concept as well as a system-level beamforming approach. Furthermore, it is shown how both can be tested in a simulator based on real-world scenarios.

Reflector concept

As in [2] discussed, there are new challenges like higher and quicker changes of path loss in the mm-Wave band. At the same time the antenna structure becomes smaller. Hence, massive MIMO becomes feasible and so low-cost silicon amplifiers can be used. Furthermore, by introducing reflectors a similar gain with fewer antenna elements can be achieved. Since this lowers the complexity, more sustainable massive MIMO systems can be realized.

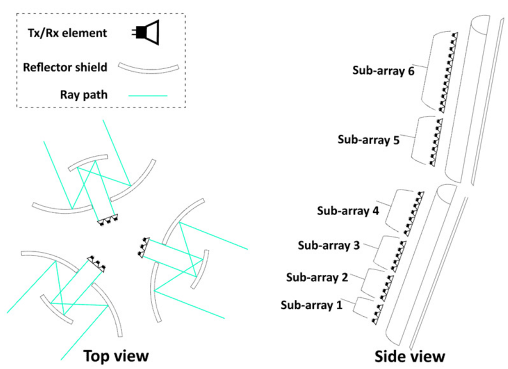

Figure 1: Top and side view of an upright cylinder reflector

To provide service in urban scenarios, as defined for LTE in [3], it is needed to realize a sufficiently high effective isotropic radiated power (EIRP) to overcome the degradations faced at higher frequencies [2]. A promising design is the upright cylinder reflector shown in Figure 2. This merges the advantages of having a wide steering angle in elevation and a reflector gain in azimuth. Furthermore, as it is pointed out in [4], the use of sub-arrays lower the complexity. An additional improve can be achieved by dividing it into two tilted reflectors, by which a lower scanning angle in elevation is needed.

Beamforming approach

By combining analog and digital beamforming it is possible to design a cost and power efficient base station that is able to perform adaptive beam steering. For a further decrease in complexity the system can be divided into sub-arrays. Therefore, the goal is to optimize the hierarchical beamforming approach as shown in Figure 2.

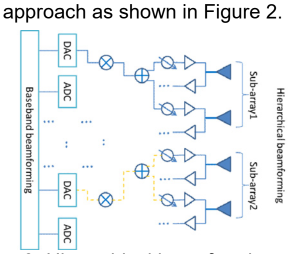

Figure 2: Hierarchical beamforming network

To ensure that an optimal solution can be found, a system simulator is needed. As displayed in Figure 3, a prior defined scenario is generated and the developed signal processing and antenna blocks are tested.

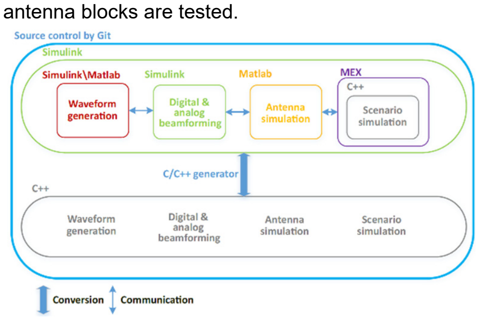

Figure 3: System simulator structure

Conclusions

Based on urban scenario conditions a most promising reflector concept is identified as well as the beam former approach. To optimize both entities, the development of the presented system simulator is in progress.

References

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