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On the Use of Substrate Integrated Waveguide Technology in the Radiating Section Design of Reconfigurable Phased Arrays for 5G Applications

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In recent years, the need for suitable infrastructures to the advent of the so-called 5G communication standards has been more and more highlighted [1]. This ever-growing interest has been spurring an outstanding amount of research activities focused on antenna design to be applied to the synthesis and dimensioning of phased arrays for 5G base stations working both at sub-6GHz and millimeter-wave (mmW) frequencies; for this kind of devices, there are a number of features which are highly desirable for an effective antenna deployment in a 5G communications scenario.

First of all, the phased arrays should be featuring a compact and possibly planar structure, for easy integration with the complete system and mounting [2].
In the dimensioning of the array for a selected application, a certain radiation mask is given, with indications regarding the peak gain, sidelobe and grating lobe level, as well as the azimuth and elevation scanning angles required. The choice of the number of elements, their clustering scheme, the feeding method and phase-shift resolution, along with all the aspects related to the synthesis of the array configuration, are directly linked to the requirements of the proposed radiation mask.

In addition to that, the approach used to implement the signal-phase selection within the phased array configuration plays an important role in the design; the phase-independence within the elements that constitute the array is strongly linked to the possibility to steer on a given plane with satisfactory performance (reduced grating lobes and scan loss). There is actually a tradeoff between the number of possible phase configurations that can be selected and the complexity and cost of the array itself; for this reason, a number of novel and possibly game-changing techniques for phase-shift synthesis are under study and development [3, 4].

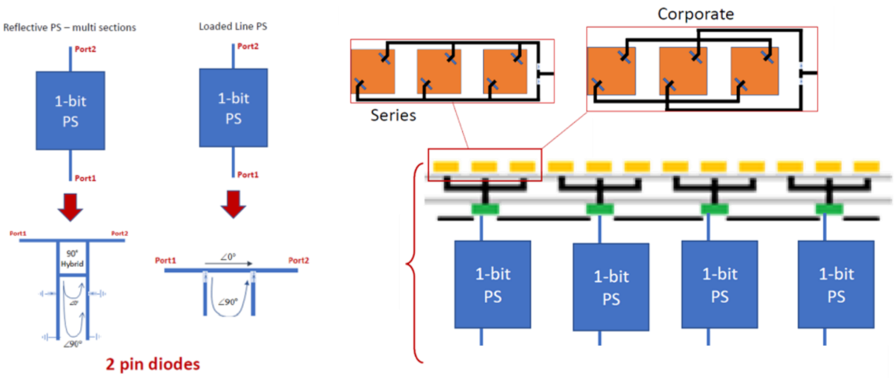

Figure 1. Examples of different ways to synthesize the signal phase distribution in portions of a phased array.

In this scenario, the use of Substrate Integrated Waveguide Technology in the design of the filtering/feeding/radiating section of an array for 5G communications may lead to a number of benefits, namely low insertion losses compared to microstrip- and stripline-based technologies, as well as planarity and easy fabrication [5].
Indeed, a number of studies have been recently carried out, focused on arrays that have a feeding and radiating section based on SIW technology. In these array configurations the phase-shift selection (that leads to beam steering) is obtained by use of a number of PIN diodes that are either activated or switched off [6].
In the technical presentation to be proposed, Huawei will illustrate its industrial view on the adoption of a SIW-oriented approach to the design of reconfigurable phased arrays for 5G applications, with particular insight on the use of this technology to obtain a phase-shifting method that is both low-cost and directly integrated in the antenna footprint.

References

[1] N. Al-Falahy and O. Y. Alani, "Technologies for 5G Networks: Challenges and Opportunities," in IT Professional, vol. 19, no. 1, pp. 12-20, Jan.-Feb. 2017.

[2] R. Valkonen, "Compact 28-GHz phased array antenna for 5G access," 2018 IEEE/MTT-S International Microwave Symposium - IMS, Philadelphia, PA, 2018, pp. 1334-1337.

[3] K. Pham, R. Sauleau, A. Clemente and L. Dussopt, "Electronically Reconfigurable Unit-Cell and Transmitarray in Dual-Linear Polarization at Ka-Band," 2019 13th European Conference on Antennas and Propagation (EuCAP), Krakow, Poland, 2019, pp. 1-4.

[4] F. Giuppi, A. Georgiadis, A. Collado, M. Bozzi and L. Perregrini, "Tunable SIW cavity backed active antenna oscillator," in Electronics Letters, vol. 46, no. 15, pp. 1053-1055, July 22 2010.

[5] M. Bozzi et al., “Review of substrate integrated waveguide (SIW) cir-cuits and antennas,” IET Microwave Antennas Propag., Vol. 5, No. 8, pp. 909–920, June 2011.

[6] F. Giuppi, H. Sheng, C. Men, I. Russo, R. Lombardi and M. Mattivi, "Substrate Integrated Waveguide-Oriented Design Applied to the Antenna Section of mm-W Communication Systems: Challenges and Advantages," *2019 IEEE MTT-S International Wireless Symposium (IWS)*, Guangzhou, China, 2019, pp. 1-3.