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Test Bench for Beamforming Network Impact Assessment on Antenna Arrays

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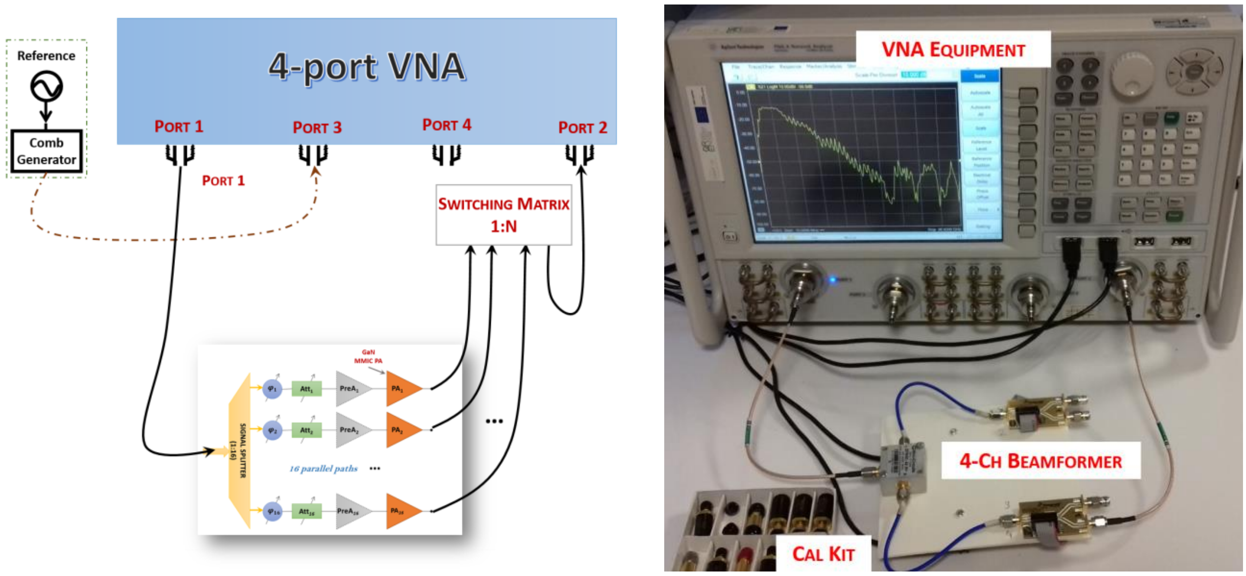
1. Extended Abstract

Active antenna arrays will be important system blocks for the next generation 5G systems to allow signal radiation optimization and to point and track the desired mobile user. The same baseline is already being explored in satellite communications with multi-feed-per-beam architectures already employed in available satellites.
One of the crucial components inside this active antenna arrays is the beamforming network (BFN) as it would be essential to excite coherently each of the antenna elements (pairs of amplitude and phase shifts) to steer main lobes and nulls. Typically, it is placed before the radiating elements, or in some of the cases just with some active elements in the middle, see Fig 1a.

In this paper it will be shown a new testbed for beamforming network (BFN) characterization devoted to extract an almost real-time assessment on its impairments and their impacts to the overall antenna array radiation diagram.
The proposed laboratory setup is demonstrated for a 4-channel BFN circuit, as shown in Fig. 1b. Moreover, it will be explained the complete scalability of the proposed measurement test bench into BFN with multiport inputs or outputs.



(a) (b)

Figure 1. Schematic of the measurement setup to be explored (a) and preliminary laboratory setup to be used in validations.

This approach allows to obtain in quasi-real-time the output radiation diagram for the different combinations of amplitude and phase in the various parallel channels, in a calibrated point of view. Together with simulated or measured radiation diagrams for the individual antenna elements (patches, horns, etc.) and employing the array factor calculation, see (1), we will be able to predict the BFN performance, by using existing hardware as a common 4-port VNA and a commercially available Comb-Generator. Compared to existing proposals, we reduce very much the needed hardware to show a similar outcome in terms of complete radiation diagram. This can also be integrated in anechoic chamber test benches for far-field approaches.

$$\begin{aligned} F(\theta,\phi) = & \sum_{m=1}^{M}\sum_{n=1}^{N} I_{mn} f^{mn}(\theta,\phi)\exp\{jk[(m-1)d_x\cos\phi \\ & +(n-1)d_y\sin\phi]\sin\theta + j\phi_{mn}\} \end{aligned} \quad (1)$$

where I_{mn} is the element excitation current amplitude; φ_{mn} is the excitation current phase; *k* is the free-space wave number.