Utilizing Periodic Structure Loading on Wideband Antenna Arrays for Next Generation Base Station Applications

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Modern wireless communications demand high data rates, reliable user experience and a seamless link. With the arrival of Internet of Things (IoT) that will interconnect the physical and the human world through sensors further requirements appear and a massive number of devices will have a network connection. The base station should then be able to communicate and support not only the classic communication protocols utilized today but protocols for sensing devices, automated cars, smart buildings etc. It is imperative then to have base stations that are able to cover all these different communication bands with the same interface. Wideband antenna arrays are an excellent candidate to support all the new requirements.

In this work we utilize periodic structures in combination with Vivaldi antenna arrays. The Vivaldi arrays have a long and successful history as a wideband antenna arrays and have the ability to provide a decade bandwidth with $\pm 60^{o}$ scanning performance while keeping an active VSWR$\leq$3. The two main disadvantages of the classic design are high cross polarization in the D-plane of the array and edge radiation from the edge elements. We introduce a soft condition along the Vivaldi flare in order to confine the travelling wave inside the flaring. This approach has a dual impact; it miniaturizes the element and reduces the levels of cx-pol. In addition we utilize one more soft condition along the outer array edges that acts as a spatial filter for the edge born waves. This soft surface reduces the back radiation and the side-lobes of the array. Finally we introduce a combined wide angle impedance matching layer (WAIM) – polarizer that further improves the cx-pol and the scanning performance. This structure is a periodic strip loading that continues after the Vivaldi flaring. These innovative structural modifications are based in the physical insight on the Vivaldi element operation and target to improve the performance with proper guiding wave manipulation.

Our work shows that utilizing metasurfaces and strategically periodic structure loading improves the operation of the Vivaldi element. Our investigations are in accordance with our measurement results and show that we can improve the cx-pol levels, side lobe levels and back radiation with the above mentioned implementation.