Simultaneous Transmit and Receive Architecture for Reflectarray Antennas

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Abstract

A reflectarray aperture is a planar surface that mimics the parabolic reflector by using a doubly periodic array of carefully designed scatterers. Reflectarray antennas are rapidly becoming an attractive alternative to the traditional parabolic reflector systems due to the primarily application driven requirements and advantages such as size, weight, deployment mechanism, and cost. The major issue with reflectarrays is; however, their narrowband performance and therefore reduced throughput when used for RF communication purposes. To overcome this drawback, Simultaneous Transmit And Receive (STAR) configurations can be deployed. STAR is a technology that allows reuse of the channel bandwidth in a full duplex communication mode, therefore theoretically doubling the channel throughput and improving the spectral efficiency of the system. Reflectarray STAR configuration is particularly useful is commercial applications like satellite communications, repeaters/signal boosters, and 5G, where high gain antenna is required and the available bandwidth is low because of immense congestion of the electromagnetic spectrum.

In this work, we propose a monostatic STAR architecture for reflectarray antennas. The proposed configuration consists of two sub-systems, each for Tx and Rx, integrated in single monostatic antenna system. The Tx (or Rx) sub-system comprises 20x20 elements reflectarray fed with a circularly polarized feeding antenna, while the Rx (or Tx) sub-system consists of circularly polarized active radiating element embedded inside the unitcell of reflectarray. The sense of polarization of Tx and Rx source is chosen such that the resultant Tx and Rx signals are in the same polarization. The isolation between Tx and Rx ports of the antenna is achieved by exploiting the temporary cross-polarization wave formed internal to the system between reflectarray and its feed. A prototype of proposed configuration is designed and fabricated for Ka-band operation to demonstrate its utility in 5G applications. The obtained level of isolation ensures that the receiving low noise amplifiers will not be saturated therefore allowing the implementation of conventional RF and baseband domain techniques on the full STAR system.