High Directivity Parabolic Reflector Antenna for Simultaneous Transmit and Receive (STAR)

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Abstract

Simultaneous Transmit and Receive (STAR) systems can transmit (TX) and receive (RX) at the same time and frequency which can theoretically double the system throughput and alleviate the congestion in the frequency spectrum. High isolation between co-located TX and RX subsystems, on the order of 120 dB or more, is essential for successful realization of a STAR system. Typical approach is to combine the isolation from the antenna layer with additional cancellation from one or more among analog, digital baseband, and signal processing layers to achieve the required level. This work focuses on maximizing the isolation from an antenna layer. While most of the monostatic STAR systems are implemented at lower frequencies, only the bi-static antenna systems have been considered at millimeter wave (mm-wave) frequencies in the open literature. To address the emerging needs at higher frequencies, a monostatic STAR antenna system operating from 26 to 32 GHz is proposed herein. The system employs a high-directivity parabolic reflector antenna for long-range communications. The chief goal of the design is to achieve gain > 20 dBic while maintaining a compact reflector antenna realization. The main design challenge of such parabolic antenna is to keep the blockage as low as possible and maximize aperture efficiency. Therefore, a splash-plate reflector antenna with a top-hat feed is designed. Specifically, a standard 8mm diameter, dielectrically loaded Ka-band circular waveguide is used to feed the reflector. The dielectric is tapered to function as an impedance transformer while mechanically supporting the feed. The STAR operation is realized using the balanced circulator approach where two identical circulators, and two 90° hybrids are used to cancel the leaked and coupled TX signals through the circulators. High isolation can be achieved with this approach regardless of the utilized circulator isolation. The employment of corrugations at the top hat feed and its influence on the aperture efficiency of the reflector and the system isolation is also investigated. The proposed antenna has VSWR < 2, gain >20 dBic, good quality circularly-polarized radiation patterns with low side lobes, and isolation > 35 dB over the operating frequencies.