Large Aperture Metasurface Antennas to Enable Rapid-Revisit, Satellite-Based Synthetic Aperture Radar

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Abstract

We present the case for waveguide-fed, metasurface apertures as spaceborne antennas for synthetic aperture radar (SAR) imaging. Remote surveillance of earth has gained increasing relevance, both for military as well as commercial purposes. Low- and mid-frequency microwaves have the advantage of penetrating clouds and possibly other obstructions, enabling the capability to persistently monitor terrestrial targets. However, widescale coverage over large portions of the earth requires a significantly large constellation of satellites, each equipped with an appropriate SAR system operating in either a monostatic mode or cooperating with other satellites in a multstatic mode. The SAR antenna must have a suitably large aperture to produce a reasonable beam profile; must have minimal DC power requirements; must be efficient, preferably without active heat management; should be able to steer over a wide angular range electronically; should be low-cost; and should have minimal weight and profile. These and many other similar requirements motivate the use of metasurface apertures, which can be designed to satisfy all of these requirements due to their simplified architecture. With recent advances in launch capabilities rapidly driving down the costs and complexity of satellite deployment, a high-performance, low-profile, and low-cost SAR antenna is the key component to enable an appropriately sized constellation for earth observation. Such a constellation could achieve rapid revisit times, allowing the same target to be imaged at radio frequencies over intervals of tens of minutes or fewer. Given the cost per square meter and relative performance of the metasurface aperture, we believe metasurface apertures will play a pivotal role in future satellite-based SAR systems.