Cellular Reflectarray Antenna

This next-generation antenna has application in the broadband satellite communications market, including conventional or HDTV programming.

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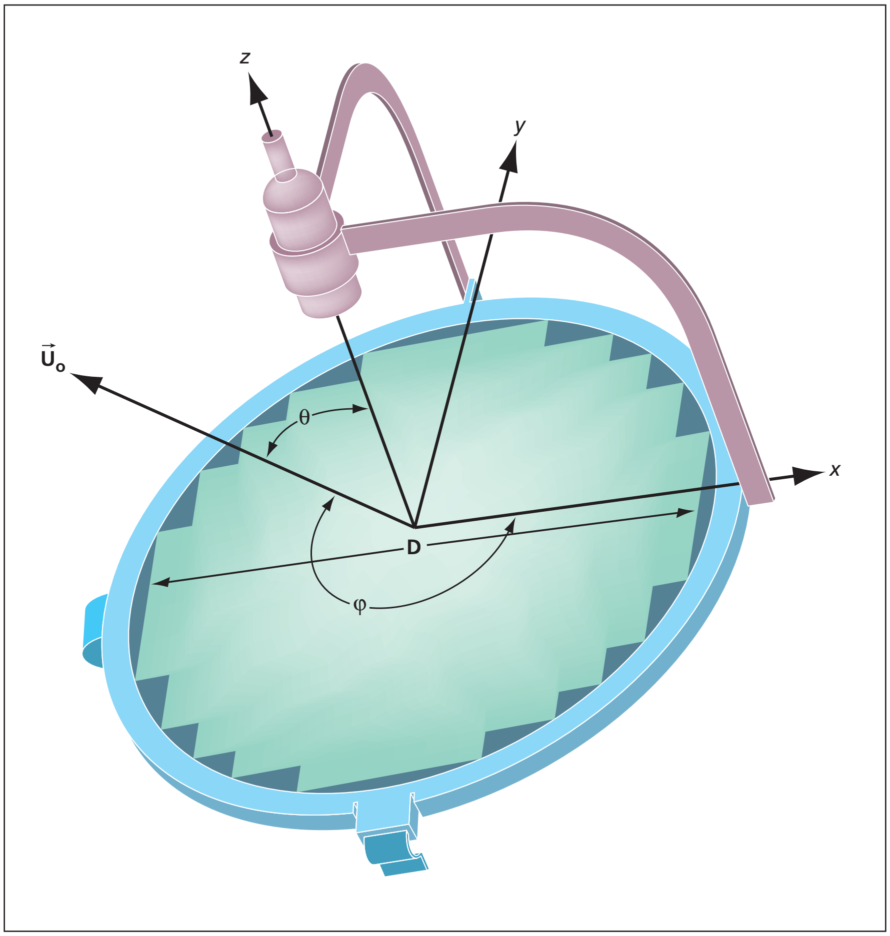
The cellular reflectarray antenna is intended to replace conventional parabolic reflectors that must be physically aligned with a particular satellite in geostationary orbit. These arrays are designed for specified geographical locations, defined by latitude and longitude, each called a "cell." A particular cell occupies nominally 1,500 mi^2 (3,885 km^2), but this varies according to latitude and longitude. The cellular reflectarray antenna designed for a particular cell is simply positioned to align with magnetic North, and the antenna surface is level (parallel to the ground). A given cellular reflectarray antenna will not operate in any other cell. There is no need for a highly skilled installer to mechanically point the antenna. The antenna also has an inherent measure of security (i.e., prevents equipment piracy) because it will not operate outside of its designed cell space.

This innovation is more aesthetically pleasing than parabolic reflectors, can be installed by a typical consumer, and is flat so that wind loading is no longer an issue. A software code accepts a subscriber's zip code as input and automatically generates the appropriate phase shifter settings of each reflectarray elemental radiator so that the antenna beam is directed to the appropriate satellite for that subscriber's geographic location.



The basic **Cellular Reflectarray Platform** configuration is shown. The *x*-axis is aligned to magnetic North, and the *z*-axis is perpendicular to the ground.

A given antenna is supplied to a subscriber with an index indicating how to align it to magnetic North. The subscriber simply needs to determine the direction of magnetic North from his or her location. Transmission lines integrated with the elemental radiators are used to induce circular polarization and to provide the proper electrical delay to achieve the required phase shift for that element to contribute effectively to forming a collimated antenna beam in the direction of the geostationary satellite. If transmission lines are affixed to orthogonal edges of an elemental radiator, and one line is electrically 90° longer than the other, the reflected signal from the feed will be polarized in the same sense as the feed. The signal scattered from the elemental radiators and ground plane will be oppositely polarized by virtue of the reversal of propagation direction.

If the dielectric constant and thickness of the printed circuit board substrate are chosen such that the path length difference between the front (elemental radiator) surface and back (ground plane) surface are about 90°, the image from the feed that is projected normal to the array is largely cancelled. By judiciously choosing the substrate thickness and dielectric constant, the reflectarray aperture can operate at two distinct frequencies to cover receive and transmit modes. Using a relatively high dielectric constant material (e.g., $\varepsilon_r \approx 10$) allows interlacing of the low band and high band elements while preserving necessary, half-wavelength inter-element spacing to prevent grating lobes (i.e., to ensure only one main antenna beam).

This work was done by Robert R. Romanofsky of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18248-1.