NASA TECH BRIEF

Goddard Space Flight Center

Variable-Beamwidth Antennas

The problem:

Parabolic dish antennas are typically designed for high-gain operations in satellite communication systems and radars. High-gain operations, however, produce relatively narrow antenna beamwidths which reduce the probability of signal acquisition. To improve this probability, such antennas can also be used in a low-gain, wide beamwidth mode. Once a signal is acquired, the antenna is reverted to high-gain operation for improved communications efficiency. A similar problem exists in transmission, as evidenced by the difficulty in directing a narrow beam toward a desired location. Unfortunately, attempts to include both the high-gain and the low-gain modes into one antenna design usually result in reduced performance efficiency.

The solution:

Two effective designs have been developed for Cassegrain and Gregorian antenna configurations. Each provides for both the high-gain and the low-gain operations. The Cassegrain system described sacrifices some efficiency due to a small amount of increased spillover loss. The Gregorian system described provides for independent spillover control with two feeds.

How it's done:

In the Cassegrain configuration, shown in Figure 1, a convex hyperbolic subreflector having an outer annular region is selectively translated along the antenna dish boresight axis. The movement of the outer subreflector region excites different areas of the antenna dish in response to excitation from a single feed.

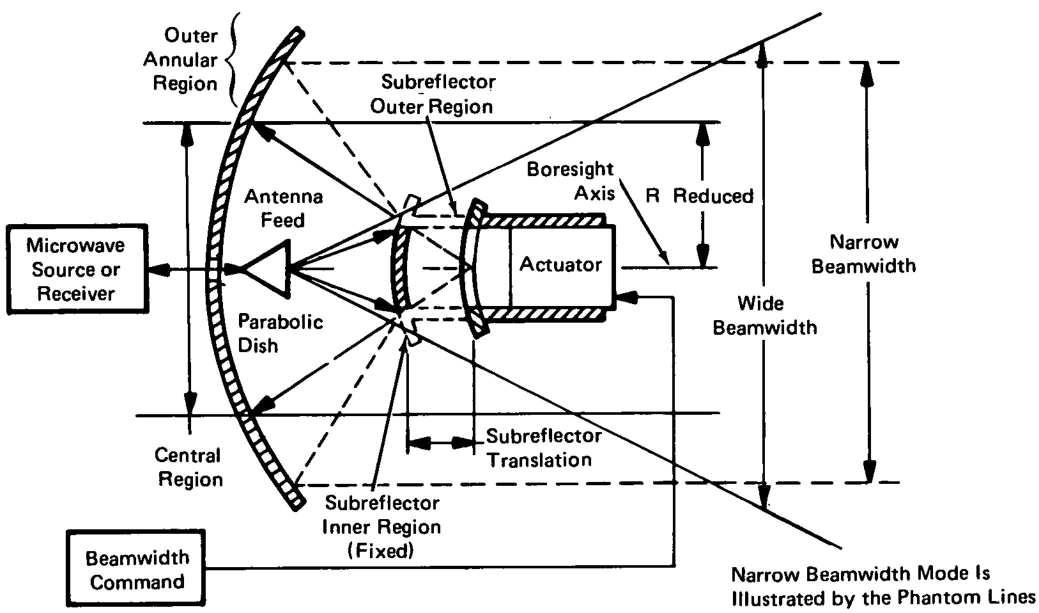

Figure 1. Cassegrain Configuration

(continued overleaf)

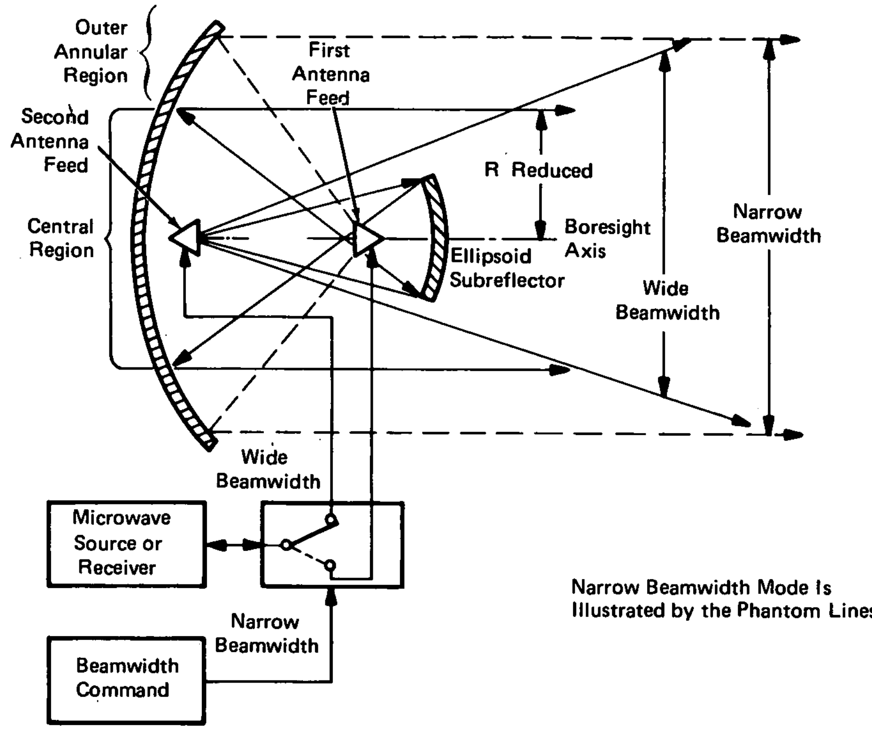

Figure 2. Gregorian Configuration

When the outer annular region is translated to an out-of-focus position for a wide-beamwidth (low-gain) mode, as shown, only a central circular region of the subreflector is active in exciting the antenna dish. Since there is substantially a one-to-one mapping between the radiation on the subreflector and the radiation on the parabolic reflector, the feed is not reflected to the outer annular region of the dish. Under such conditions, it is said that the subreflector is truncated. Hence only the central region of the antenna dish is effectively operative, and the beamwidth of the antenna is consequently increased. Conversely, when the outer annular region is in an in-focus position, the entire subreflector is active in exciting the antenna dish. The completely active dish then reduces the antenna beamwidth, providing the high-gain mode.

In the Gregorian configuration, shown in Figure 2, a truncated concave ellipsoid subreflector has a major axis located on the boresight axis of the parabolic dish. The ellipsoid subreflector has two foci in the front whereby the focus nearest the subreflector coincides with the focus of the main dish. A separate feed is provided at each subreflector focus and may be selectively activated to provide beam switching.

The first feed, located at the main dish focal point, faces the main dish and excites its entire surface, providing a narrow-beam mode. The second feed, located at the focus of the ellipsoid furthest from the subreflector, faces the subreflector and excites the main dish from the subreflector, providing a wide beam. The modes are selected by turning on the desired antenna feed. A means of permitting received energy to impinge on the ellipsoid during acquisition such as retracting the feed at the paraboloid focus, is required.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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