

MAXIMIZING GROUND STATION DOWNLOAD CAPACITY FOR
LEO SATELLITES USING GENETIC ALGORITHMS

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We present several techniques for maximizing the contact time between a low earth orbiting (LEO) satellite and a ground station array of electronically steered antennas. Such arrays will benefit EESS applications, promising a decreased cost and increased reliability as compared to ground stations consisting of large dish antennas. Because of their low-cost design, these arrays will enable the construction of a distributed downlink network for efficiently retrieving the ever-increasing amount of EESS science data.

The optimization for maximum contact time is necessary because the distance between a ground station and a LEO satellite is not constant throughout a pass; the signal strength incident on a ground station can vary by more than 10dB while the satellite is in view. By taking advantage of the scan loss properties of the electronically scanned fixed antennas, the array is arranged so that the aggregate gain of the array results in a received signal strength that is very close to the threshold value for demodulation, regardless of the distance to the satellite.

Genetic algorithms were chosen as the optimization method. Three optimization models will be considered:

1) Electronic scanning in the elevation direction and mechanical scanning in the azimuth direction: The antenna boresight directions are optimized to minimize the elevation angle at which a signal is acquired.

2) Total electronic scanning with fixed antennas: The boresight direction of each antenna is optimized to maximize the contact time per day by using the probability density function of the satellites position as well as the ground stations location.

3) Electronic scanning with mechanical repositioning: The boresight directions are optimized prior to each pass. The array is fixed and electronically scanned for the duration of a pass.

Results will be presented for the application of these models to an array of Space-fed Lens antennas that is designed to receive X-band data from the satellite SAC-C. It will be shown that by properly orienting the antennas in the array, the contact time with the satellite is greatly increased as opposed to alternative arrangements. Additionally, under certain conditions, one array can receive data from several satellites simultaneously, further reducing the cost-per-link of the ground station.

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2. F - Wave Propagation and Remote Sensing
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4. C - Contributed Paper
5. We are submitting to Commission F because of the relevance of this work to earth remote sensing applications. However, this would also be suited to Commission B if the Chair prefers.