Steerable, Millimeter Wave, Sparse Array for Satellite Observations under Cloudy Conditions on Haleakala

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The Air Force Maui Optical and Supercomputing (AMOS) is a contributing sensor to the Space Surveillance Network (SSN). It is tasked by Air Force Space Command (AFSPC) to provide metrics and space object identification and operates continuously (24/7). Weather is the primary hindrance to AMOS operation. Over the last 10 years, statistics show an approximate 30% outage primarily caused by weather. One of the major contributors to weather outages is clouds. Several spectral bands in the millimeter wave (mmW) region exist with significantly lower water absorption than visible or infrared radiation. Because of the low water absorption, thermal radiation in these mmW bands, either reflected or emitted from objects in low earth orbit, can be imaged on the ground through thick clouds. In this paper we will describe a concept for a mmW imaging system compatible with the AMOS Haleakala site that can image and track objects in low earth orbit through heavy clouds.

At the long wavelengths considered a 300 to 600 meter aperture would be required for resolving a one-meter satellite in low earth orbit. A conventional mirror or lens of this size would be impractical and a conventional sparse pupil array would require an unwieldy many tens of thousands of elements in order to achieve the required spatial resolution and coverage of the sky. However, a sparse array made up of several hundred elements with individually steerable antennas could provide the resolution, signal to noise and sky coverage required by the AMOS facility.

Basic elements and issues associated with the array including the mmW receivers, electronically steerable mirrors, motion compensation, image reconstruction algorithms and array design optimization will be discussed.