An Improved Subarray Architecture for a Large, Hemispherical Coverage Phased Array Antenna

Michelle H. Champion*[(1)], Robert Schmier [(2)], and George D. Kakas[(1)]
(1) Sensors Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH 45433
(2) Alpha Omega Electromagnetics, Millersville, MD 21108

The Geodesic Dome Phased Array Antenna (GDPAA) has been demonstrated as a viable architecture for large communications phased array antennas used in support of satellite tracking, telemetry and command (TT&C) operations (M. Henderson, M. B. Davis and M. Huisjen, IEEE Phased Array Conf, 2010). The GDPAA architecture offers significant improvement over the parabolic reflector antenna systems currently used for the Air Force Satellite Control Network (AFSCN). However, despite their high performance in throughput, responsiveness, flexible operability and lower maintenance costs, phased arrays have not been adopted for this application due to their high initial acquisition costs. To address these high acquisition costs, a new low-cost passive subarray and planar transmit/receive (T/R) module were designed and integrated into a complete active subarray. The new subarray architecture is shown in Figure 1.

The planar antenna subarray developed under this effort provides superior performance to the L- and S-band subarrays developed under the original GDPAA program. The subarray consists of a multi-layer printed circuit board with integrated radiating element aperture and RF feed network, as well as control, interface and support structures. As in previous versions, the subarray is able to support simultaneous transmit and receive with high (>45 dB) isolation, full-duplex multiple beams (at least one transmit and two receive beams from a single subarray), 120^{o} field-of-view, and high gain over noise temperature (G/T) performance. To achieve the cost objectives, several significant changes were made to the architecture: (a) replaced high cost beamforming network (BFN) and radiating element materials with low cost, high quality FR4 type alternatives, (b) implemented lower cost radiating aperture/BFN integration scheme, (c) developed lower cost T/R module interconnect scheme, (d) developed high efficiency planar T/R module, and (e) modified subarray architecture to allow for integration and thermal management of planar T/R module. These modifications resulted in significant cost, weight, prime power and cooling savings. Details on the architecture and measurement results will be presented at the conference.

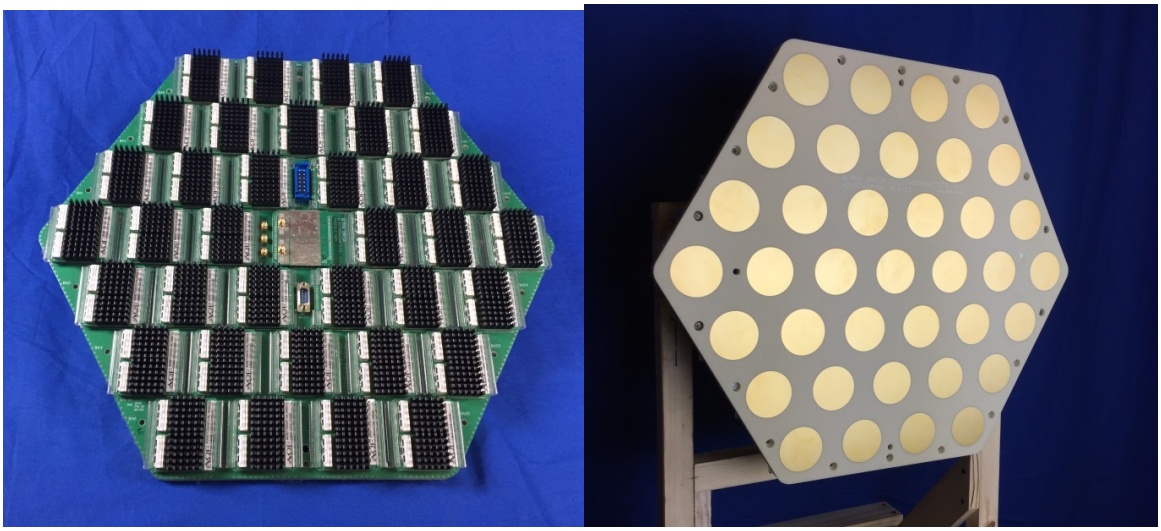

Figure 1. Planar subarray architecture as fabricated and tested (back on left, front on right).