Electronic Scanned Array (ESA) Design

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Tutorial Description

The vast majority of high performance radars developed in the last two decades are based on electronic scanned arrays. ESA design principles were understood as long ago as 100 years but their application only became ubiquitous when government investment and commercial electronics development provided the low cost and manufacturing base to align the cost and benefits.

This course will discuss the basic theory of aperture antennas, contrast capabilities of ESA and reflector antennas as well as ESA feeds for reflectors, enumerate the design principles which underlie all ESA design, show how these designs may be realized with available components and technology and analyze the design tradeoffs employed by fielded systems. The focus will be antenna hardware specifically radar antennas. Because the primary benefit of ESA antennas is increased functionality, radar requirements and radar modes will be discussed to the extent that they benefit from this increased functionality.

A number of ESA design issues will be described, such as array partitioning and subarrays, rectangular and triangular lattice, feed design, grating and quantization lobes, time delay vs phase beam steering and amplitude weighting for beam shaping. Numerical examples developed with MatLab will illustrate performance of specific designs.

The contribution of specific ESA components determines how closely actual antennas approach their predicted performance. Performance and cost of these components will address radiating elements, T/R modules, monolithic microwave integrated circuits (MMICs), microwave distribution and packaging. Power and thermal constraints will be covered in some detail.

The presentation will conclude with examples drawn from recent radar satellite designs.

Instructor – John Williams

Mr. Williams received his bachelors and masters degrees in physics from CalTech and the University of California at Irvine respectively. He has worked on ESAs since 1979 and contributed to proposals for the USAF SSPA, B1 radar, J/STARS radar, F-22 and F-35 radars and Ground Based Radar while employed at Hughes Aircraft Company. He managed T/R module, ESA and Manufacturing Technology programs for all three services. He is currently employed at The Aerospace Corporation where he supports advanced development including the Space Based Radar program.