**Far Field of Large, Wideband, Scanning Arrays**

Randy L. Haupt and Payam Nayeri
EECS, Colorado School of Mines, Golden, CO 80401, USA

The wave radiating from the phase center of an antenna has a constant phase over a sphere of diameter $R$ just like a point source. When this spherical wave impinges on a receive antenna, as shown in Fig. 1, the wave arrives at the center prior to the edges by $\Delta R / c$ seconds. This spherical wave approximates a plane wave (plane of constant amplitude and phase) when the maximum phase deviation across the aperture is less than $\lambda/16$ or $\pi/8$ radians. The IEEE antenna standard stipulates that the spherical wave approximates a plane wave at the receive antenna at a distance of

$$R = \frac{2D^2}{\lambda} \tag{1}$$

where $R$ is the separation distance between the transmit and receive antennas, and $D$ is the larger of the maximum dimension of the receive antenna and transmit antenna. Low sidelobe antennas need a larger separation distance, because $\Delta R$ must be smaller due to the higher phase accuracies associated with low sidelobe levels. Most of the time, an antenna is in the far field, so a plane wave accurately describes the transmit and receive signals.

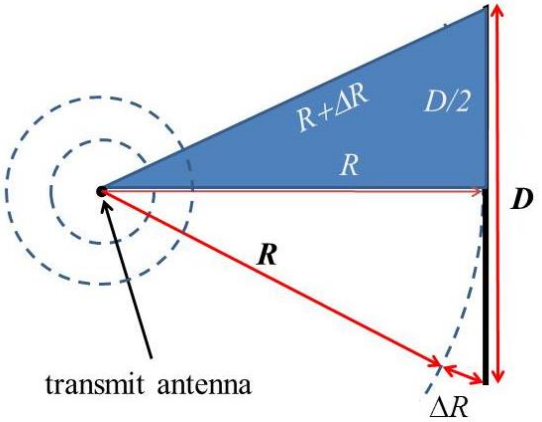


Fig. 1. Antenna far field definition.

The existing IEEE definition of far field is based upon the phase of a single frequency or narrow bandwidth signal. An alternative definition might be derived from a time domain signal. For instance, if $\Delta R$ represents 1/16th the distance traveled by the signal in the time represented by one pulse or one bit, then

$$\begin{aligned} R^2 + \left(\frac{D}{2}\right)^2 &= \left(R + \frac{\tau c}{16}\right)^2, \\ R &\geq \frac{2D^2}{\tau c}. \end{aligned} \tag{2}$$

The selection of $\Delta R = \lambda/16$ as the standard for the far field is somewhat arbitrary. Selecting $\Delta R = \tau c/16$ as a standard would also be arbitrary.

This presentation will discuss the far field definition implications on pulse dispersion for large, wideband, scanning arrays.