Transient Antenna Patterns Based on the Antenna Equation

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Various authors have a variety of ideas about how to define transient antenna patterns. One challenge that arises is whether such patterns can be equally meaningful in transmission and reception. A second challenge is how to relate such a pattern to the frequency domain.

We provide here a framework for describing antenna patterns based on the newly developed antenna equation (E.G. Farr, "Characterizing Antennas in the Time and Frequency Domains," to be published in *IEEE Antennas and Propagation Magazine*, February 2018) and (E. G. Farr, "A Power Wave Theory of Antennas," *Forum for Electromagnetic Methods and Application Technologies* (online), Vol. 7, 2015, www.e-fermat.org). The antenna equation describes antenna performance in a manner that is both compact and elegant. It works in both the time and frequency domains, and in both transmission and reception. It provides the obvious way to standardize antenna characteristics in the time domain. It also adds a meaningful phase to antenna gain.

Embedded in the antenna equation is the antenna impulse response, $\mathbf{h}(t,\theta,\phi)$, which is a vector quantity that represents the radiation or reception in terms of two vector components, θ and ϕ. One can define an antenna pattern based on the "size" of this quantity as a function of angle. The "size" of a time domain waveform is determined by any of a class of norms.

Transient antenna patterns may be defined in terms of any norm one finds convenient. One norm of interest might one that measures the peak absolute magnitude of a waveform. Another might be one that measures the square root of the power in the waveform.

We show a class of antenna patterns that is equally meaningful in transmission and reception. They are also related to the frequency domain pattern by a simple relationship.