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The Electrospace model as a tool for Spectrum Management

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The function of licensing the right to use the radio spectrum with increasedflexibility has been slowed partly by lack of a good tool to use in dividing licensed spectrum into parcels that could be used in an independent and non-interfering manner. This paper suggests that the concept of "electrospace" is a candidate for such a tool.

The electrospace is occupied by radio signal (electromagnetic energy) and has dimensions of location, frequency, time, and possibly others. Because these dimensions are mutually orthogonal, a given occurrence of energy (a radio signal) has a unique descriptor describing its position in the electrospace. Moreover, any two signals having different unique electrospace descriptors can theoretically be separated by a simple receiver. For example, two signals described as having the same location and time of occurrence could be distinguished by tuning a receiver to the frequency of the desired signal. Or, two simultaneous signals having the same frequency could be distinguished by moving the receiving antenna to different locations.

Since any signals having different electrospace descriptors can be separated by a suitable receiver, the radio spectrum can be partitioned by dividing it along any or all of the electrospace dimensions. Each portion of spectrum divided this way can theoretically define a suitable receiver that can separate out the desired signal from all other signals. The electrospace furnishes a basis for spectrum user rights that are completely flexible with respect to aggregation or subdivision of electrospace portions.

There are two main problems with the use of the electrospace. Although the electrospace furnishes an unambiguous description of the location, time, and frequency at which a signal can be present, there are substantial difficulties in getting radio signals to stay within their specified boundaries, since there are no "fences" that can constrain radio signals. The propagation of radio signals typically produces signal contours that are very irregular and discontinuous. This makes it awkward to establish practical rules to determine when a signal is exceeding its allowable geographical bounds, without being extremely conservative. Propagation also produces field strengths that often increase substantially with increased elevation, requiring additional complexity in describing electrospace geographical boundaries.

The other problem is that a strict electrospace model implicitly assumes that all receivers operate ideally. The continuing interference in the 800-MHz LMR band is an example of this problem. Therefore, electrospace rules could be made even more useful if they are supplemented by rules that make it easier to build adequate receivers. Such receiver-based rules might contain limits on maximum field strength near transmitting antennas, as well as rules controlling how power density can be situated within an aggregated licensed passband.