Trade-offs Associated with Antennas for Software Defined Radios

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Software defined radio (SDR) systems have the potential to provide flexible functionality, allowing real-time changes to carrier frequency and modulation schemes. Modulating and de-modulating signals, signal correlation, and related tasks are readily accomplished in software. Public safety cognitive radio (PSCR) is based on the SDR paradigm and adds the ability of the radio system to sense other radios, which may be operating at different frequencies and with different modulation schemes, and allow them to communicate with one another. PSCR systems are primarily software based, but all radio elements cannot be digitized. The antenna is one such component.

Most of the public safety spectrum stretches from 30 MHz up to 889 MHz, in discrete sub-bands. We desire a single antenna to provide the required performance in VSWR, gain, and pattern across this frequency range. Many times an omni-directional monopole-like pattern is the goal. Because radios for public safety usually require the facility for both transmit and receive, a practical target for VSWR is somewhere between 2:1 and 3:1 over the whole band. To satisfy the VSWR and gain requirements at the lower frequencies, a physically long antenna is required. Unfortunately this same structure becomes an electrically large antenna at the higher frequencies. Typically this produces a pattern with an elevated beam. In this case, much of the desired radiation from the antenna is directed at angles which may deviate from the desired direction. For this reason, a physically smaller antenna is desired (smaller antennas also help satisfy space limitations which can be an issue – particularly for handheld units).

This paper presents trade-offs and develops guidelines for simultaneously improving low-frequency and high-frequency antenna performance in terms of VSWR, gain and efficiency, and pattern. Various methods are considered to combat the problems associated with antenna dimensions and pattern distortion. For example, a series-distributed load along the length of an antenna might help mitigate pattern distortion as well as offer an improved VSWR over frequency, but at the expense of radiation efficiency. Techniques for the improvement of radiation efficiency for electrically small antennas are considered in the context of the effect at higher frequencies.