Security Issues of Retrodirective Arrays

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Retrodirective arrays (RDAs) have the interesting and unique property of automatically responding back toward an incident signal's direction without having any prior knowledge of the location of the interrogator. This process is commonly carried out in a completely analog fashion with phase-conjugating mixers, offering a high-speed self-tracking feature that makes RDAs useful for point-to-point communication applications. Therefore, retrodirective systems can accelerate the detection of targets and reduce the complexity of systems compared with conventional phased array architectures since no phase shifters, no complex beamforming network, and no signal processing is required.

Demonstrating much flexibility, RDAs have been effectively presented in widely ranging applications from simple transponders to full-duplex communication systems and radar sensors. In each case, the benefit of high speed automatic target tracking is exploited to enhance the system's functionality. However, seldom investigated and probably the main limiting characteristic in a retrodirective system is its inability to operate effectively under interference, or in general with multiple interrogators.

Because a RDA blindly responds back toward an interrogator, it also has no method of distinguishing between multiple signals, and will therefore respond back toward any and all interrogators. This radiation is based directly on what was received by the array, as the signals are individually and automatically phase conjugated at each element. On this basis, in the case where a "non-friendly" source interrogates the RDA at the same time as a "friendly" source, the user will respond back simultaneously to both sources. What this implies is that any stored data by the user can simply be stolen or intercepted by a "non-friendly" if it tunes its interrogation carrier to the correct frequency. In fact, since the phase reversal of an incoming wavefront is achieved instantaneously and automatically through phase-conjugators, the array can not distinguish between each interrogating source, and therefore no additional beamforming control can be applied. In other words, each incoming signal can not be separated prior to retransmission.

This issue of security vulnerability and link disruption will be investigated and discussed. Two retrodirective architectures with methods of addressing this issue will be presented. Each case attempts to introduce a function to alleviate the issue of security while maintaining the natural benefit of analog RDAs, or the high speed automatic tracking feature. Measured retrodirective patterns and data transfer scenarios verify the proposed methods and their effectiveness. This issue of security is currently the most prominent drawback for RDAs, and addressing this issue is a key toward developing practical retrodirective systems.