Paper Title: High-Speed Sensing of the Electromagnetic (EM) Environment for Cognitive Radio Receivers

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In this paper, we demonstrate an EM environmentally aware (EMEA) radio called the Intelligent Transceiver Radio Node or ITRN, which is suitable for use in cognitive radio applications. The ITRN is an end-to-end solution that can quickly find interferers and act upon them defensively (e.g. filter, move the channel, move to different band, change modulation, etc). While the ITRN is capable of finding interferers in both the spectral and angular domains we present a framework that allows for future expandability into more measurement domains.

To break the scanning time vs. spectral and angular resolution tradeoff, we employ compressed sensing (CS). By making a few assumptions about the local EM environment's current state, we can perform spatial and spectral scans that are 10 times faster than the current state of the art. Information on the spectral locations of the interferers along with a current quality of service (QoS) estimate is then sent to a machine learning based decision engine (MLBDE) where reinforcement learning is used to determine the optimal channel selection.

For the ITRN's sensor, we use a custom, 8 antenna RF-ASIC fabricated in TSMC 65nm CMOS called the Direct Space to Information Converter (DSIC). The output of the DSIC is fed to an Ettus X310. A custom UHD interface was constructed in the FPGA to speed up the streaming data rate by using a variable data packet size. Custom UHD circuitry was also created to synchronize the DSIC with the clock on the X310. In GNURADIO, we perform the baseband DSP and Orthogonal Matching Pursuit (OMP), which is used to recover the spectral locations of the interferers. Lastly, the output of OMP along with a QoS estimation is sent to the MLBDE, which calculates the new optimal channel selection and retunes the ITRN.

In this paper we describe the multi-disciplinary design process of the ITRN, system parameter selection, tradeoffs and lastly a discussion and comparison to other cognitive radio architectures with a focus on sensing time and system scalability.

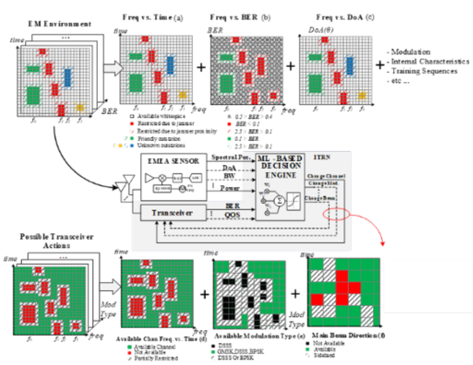

Figure 1.) The N-Dimension EM resource cube and M-dimensional countermeasure cube.

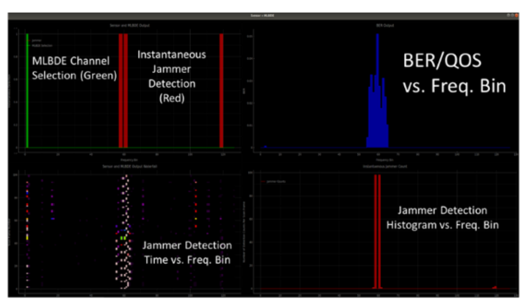

Figure 3.) GUI, output data and analytics

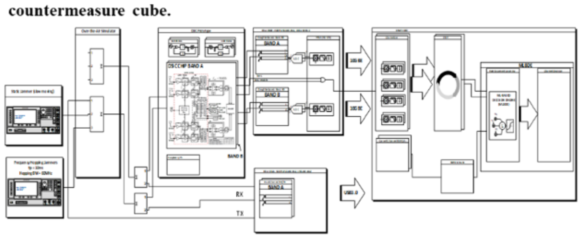

Figure 3.) ITRN and system diagram

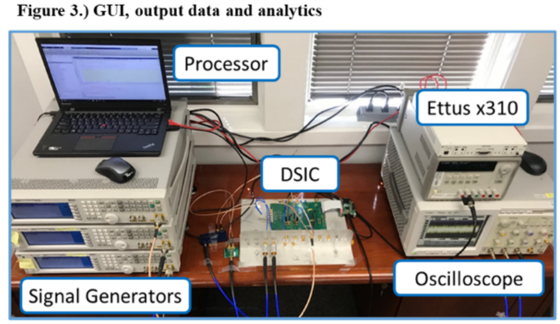

Figure 4.) System testbed and custom RF-ASIC