RY16-3

Attachment 1 – Research Topic Template

1. **Research Title:** "Adaptive Control of Cancellation Mechanism for Simultaneous Transmit and Receive"
2. **Individual Sponsor:**

Dr. Andrew Wegener, AFRL/RYDR
ARFL/RYDR Bldg 620
2241 Avionics Circle
WPAFB, OH 45433-7333
Andrew.Wegener@us.af.mil

3. **Academic Area/Field and Education Level**

   Electrical / Computer Engineering (MS or PhD level)

4. **Objectives:** The goal of this DAGSI topic is to investigate automated tuning algorithms for control of tunable isolation circuitry embedded in antenna arrays (provided by AFRL). These algorithms should be able to be embedded into FPGA digital back-ends, and have potential to be run in real time in order to maintain high isolation in the presence of a changing physical environment. An additional research goal would be to apply the tuning algorithms to develop innovative techniques to broaden effective isolation bandwidth within the array.

5. **Description:** Tunable resonators have been demonstrated [1,2] to provide isolation between adjacent antennas in an array, as shown in figure 1. There are several semi-independent paths of coupling between the adjacent antennas shown in figure 1. In order to achieve isolation, the resonators must be tuned such that the coupling paths through them cancel the direct coupling path.

   This isolation between antennas is highly dependent on the near field environment and antenna temperature, and as such is easily detuned. Currently tuning is accomplished by manually changing the voltages applied to the varactors, which in turn tune the resonant frequencies of the resonators. While suitable for development in a laboratory environment, it is desirable to incorporate a means to optimize the tuning in a real-time fashion more suitable to the operation of a resonant tuning array in its intended applications.

   The proposed project will research algorithms for the purpose of automatic tuning of various cancellation techniques to maintain high levels of isolation for simultaneous transmit and receive operation. This automatic tuning would require an understanding of the isolation mechanism implemented in near field cancelation filters, a proposal of an approach to monitoring the performance in-situ, and determining and implementing efficient techniques of estimating the coupling from transmit to receive. This should be accomplished with minimal complexity in the hardware layer.

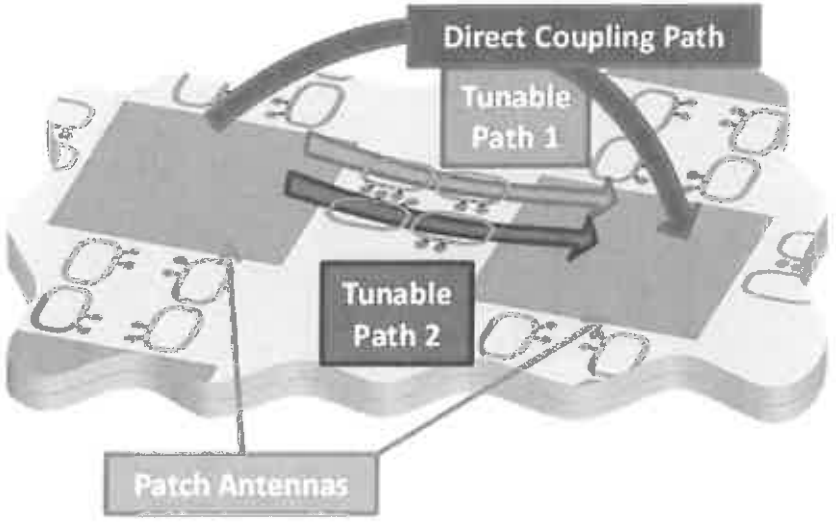

Figure 1: Tunable resonators used to cancel direct coupling between antennas for STAR.

Antenna arrays with tunable near-field resonators will be provided. A digital backend capable of controlling the near-field filters will also be available.

[1] Wegener, A.T., "Broadband near-field filters for Simultaneous Transmit and Receive in a small two-dimensional array," *Microwave Symposium (IMS), 2014 IEEE MTT-S International* , vol., no., pp.1,3, 1-6 June 2014

[2] Wegener, A.T.; Chappell, W.J., "Coupled antenna scheme using filter design techniques and tunable resonators to show simultaneous transmit and receive," *Microwave Symposium Digest (IMS), 2013 IEEE MTT-S International* , vol., no., pp.1,4, 2-7 June 2013

6. **Research Classification/Restrictions:** ITAR

7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

[X] **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release. Need PA Approval #

[ ] **AFIT (only)**

[ ] **USAFA (only)**

If you are submitting a topic for the USAFA, indicate if you are also interested in

sponsoring a USAF Cadet in summer 2015 (Average cost for USAF Cadet for 33 days is $5000)

☐ Yes ☐ No