RY16-1

Attachment 1 – Research Topic Template

1. **Research Title:** Data-Constrained Digital Beamforming Techniques
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
   Electrical and Computer Engineering (MS or PhD level)
4. **Objectives:** This work will investigate receive spatial processing techniques for digital arrays. While being digital at every element certainly has its advantages, digital beamforming can be challenging to implement on hardware due to an inability to route large amounts of data. With restrictions on digital transceiver data rates, novel techniques for digital beamforming will be explored with an emphasis on architecture design.
5. **Description:** Much of the academic literature on MIMO radar assumes a digital at every element capability to exploit waveform diversity on both transmit and receive. Digitization at every element, while a cornerstone for many MIMO radar algorithms and waveforms, is challenging to realize in practice. As systems increase in bandwidth and array size, processing the data and routing it using commercial data links becomes a significant challenge. While digital transceivers today exhibit impressive bandwidths, they cannot fully support conventional beamforming for large planar arrays and state-of-the-art high-speed converters. To fully embrace the promise of digital at every element, beamforming architectures must be developed which are cognizant of the available hardware.

   This topic will investigate alternative spatial processing techniques to conventional centralized beamforming. When data rates exceed those of commercially available transceivers, novel and innovative approaches must be explored to reduce data rates while minimizing the impact on system-level radar performance. This work should explore, but is certainly not limited to, the following topics: hierarchical beamforming, data reduction algorithms, and distributed beamforming approaches for monostatic arrays. Hierarchical beamforming schemes may aid the data routing problem. These architectures scale more gracefully with increasing array size and limited data link speeds. A fresh perspective would tailor these algorithms to be hardware-deployable and analyze their performance compared to centralized digital beamforming. Novel data reduction algorithms may also be implemented to operate over constrained data links. The performance of range, angle of arrival and Doppler estimation, along with clutter rejection, will be modeled to develop suitable techniques to process the data. Finally, distributed approaches may also be considered. Strategic methods to trade off reducing bandwidth, time division

duplexing array elements, and packetizing data will develop innovative approaches to handle the data. This in-depth academic study will investigate hardware-cognizant signal processing, and holds the potential to enact a paradigm shift in digital beamforming.

6. **Research Classification/Restrictions:** None
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

☒ **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