

1. **Research Title:** *Wideband Digital Beamforming*

2. **Individual Sponsor:** Andrew Duly, AFRL/RYDR, 937-713-8874, [andrew.duly.1@us.af.mil](mailto:andrew.duly.1@us.af.mil)

3. **Academic Area/Field and Education Level:** Electrical/Computer Engineering and Computer Science (MS or Ph.D. level)

4. **Objectives:** Phased array beamforming has traditionally been accomplished using analog means (time or phase control). Digital beamforming, particularly for receive, is attractive because it would eliminate imprecise analog components, would enable multiple simultaneous receive beams, and is amenable to programmable and adaptive processing. To date, digital beamforming applications have been limited to relatively modest instantaneous bandwidths (10s of MHz) and relatively few channels or degrees of freedom. Recent advances in wideband phased array and miniature wideband digital receiver hardware have enabled the realistic possibility of implementing large scale digital beamforming over broad instantaneous bandwidths (100s of MHz to GHz). Several open questions remain including, but not limited to 1) optimal order of signal processing (i.e., spatial processing first then time frequency or vice versa), 2) beamforming weights and calibration over broad bandwidths 3) spatial and time-frequency algorithms, 4) static vs. adaptive beamforming techniques, 5) Degree of Freedom (DOF) reduction algorithms 6), digitized element vs. digitized sub-array implementations, i.e., full DBF vs. hybrid analog and digital beamforming. The goal of this research is to investigate one or more of these issues and establish parametric analysis and tradeoffs of various techniques.

5. **Description:** This research will identify one or more open topics in wideband digital beamforming. Various techniques for implementing digital beamforming will be examined. A parametric analysis of the benefits of each proposed technique will be performed. AFRL will provide representative antenna, subarray and receiver/digitizer configurations. Researchers will compare the identified beamforming techniques on the representative configurations.

6. **Research Classification/Restrictions:** This research is unclassified.

7. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was \$4000):**

8. **Eligible Research Institutions:**

Universities (DAGSI & AFIT)

AFIT (only)

USAFA