a) The complete program of research and experimentation proposed including description of equipment and theory of operation:

The experimental license will be used in support of research conducted at the Wireless Communications and Networking Laboratory, University of Arizona. This research is focused on designing novel beam finding and tracking algorithms for millimeter-wave (mmWave) systems for indoor and outdoor operation. To validate the proposed algorithms, we plan to use National Instruments (NI)'s FlexRIO radios as baseband radios, combined with mmWave Tx/Rx up/down converters. The radios will be connected to custom-made electronically steerable/switchable antenna arrays for transmitting Matlab-generated control and data packets.

b) The specific objectives sought to be accomplished:

The experiments will be used to measure various performance metrics, including device discovery time, beam tracking capabilities, outage probabilities/regions, etc. Emulated 5G signals with low transmission powers will be sent over the air along one or more directions, and will be captured at receivers. Proposed algorithms will be contrasted with discovery/tracking algorithms used in 5G NR and WiGig standards.

c) How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion or utilization of the radio art, or is along line not already investigated.

mmWave beam finding and tracking algorithms are currently a very active research area. Significant efforts have been made to standardize these algorithms as a part of the upcoming 5G NR. However, proposed solutions for beam finding in 5G typically suffer from long device discovery times, which are especially unacceptable for ultra-reliable low-latency communications. Our novel beam finding protocols, so far studied by analysis and simulations, provide efficient methods to cope with blockages and discover single/multiple users in shorter time compared to existing techniques.

In addition to commercial 5G systems (e.g., network operators, device vendors, measurement/test equipment vendors), the proposed wireless experimental research will benefit WLAN systems, operating over other mmWave bands, such as WiGig. Lessons learned from the research will likely to have impact on fixed wireless backhaul, drone systems that operate on mmWave bands, and others.

We will also be testing new antenna architectures, including switch-beam smart antennas. Different from phased antenna arrays, the switch-beam antennas do not use costly phase shifters, which allow them to have lower manufacturing costs and power consumption. In addition, the beam patterns of phased antenna arrays deteriorate as the beam is steered farther away from the boresight, whereas switch beam antennas do not suffer from this issue and they always have the same beam pattern regardless of the beam direction.