Silent Radar White Paper
Custom Microelectronic Systems, Inc.
LT Wurtz, Phd
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Figure 1. Prototype Silent Radar in field testing

The "Silent Radar" concept is an active CW radar that hides its illumination at or under the noise floor to significantly lower the probability of detection. The prototype system shown in Figure 1 uses a [redacted] to hide [redacted] the transmit signal at or below the noise floor. A novel concept of randomly changing the [redacted] will prevent foreign assets from using coherent integration techniques for detection. The tested system is designed to detect objects as small as UAS drones with range accuracy of 3 meters and with enhanced range accuracy as the system evolves. The concept has been field tested, TRL 3, and moving quickly to a TRL 6 over the next few weeks. The prototype unit operates in the 5.8 GHz ISM band moving to X-band at 9.4 GHz for the next version and eventually to Ka-band. The Ka-band test version with prototype pan-and-tilt is shown in Figure 2. Further, the [redacted] concept along with randomization [redacted] inherently supports a system that would be difficult to jam. Future enhancements will replace the parabolic dish on pan-and-tilt with a phased array antenna for better mobility.

We feel the "Silent Radar" concept uniquely fits the needs of the Department of Defense with a low-cost option to effectively detect objects as small as UAS drones with the advantages offered by an active radar; yet, with the features of a passive-like radar that is jam resistant and demonstrates a low probability of detection.

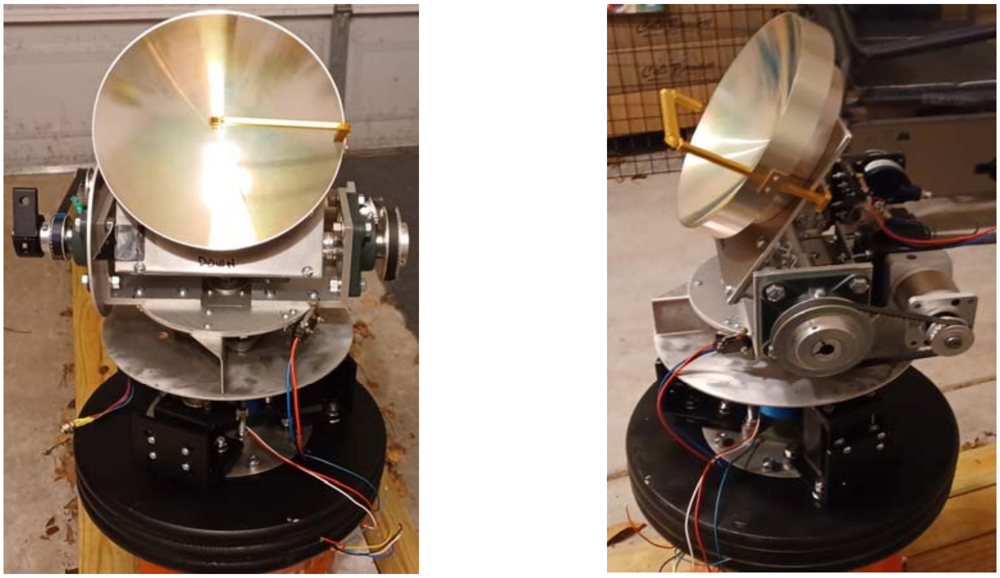

Figure 2. Prototype Ka-band antenna on pan-and-tilt for field testing

The "Silent Radar" concept is similar to the design of a passive radar based on illumination from GNSS satellites. With a GNSS-based passive radar, a receiver on ground collects GNSS satellite transmission reflections from objects in the atmosphere (i.e. aircraft, UAS drones, etc.) Those reflections are then processed to position and velocity as with any radar system. To illustrate, Figure 3 left shows a T-1A Jayhawk Air Force Trainer doing touch-and-goes around the Huntsville, Al airport. The aircraft is approximately 2000 ft above ground level and 2.5 miles away from the receiver shown

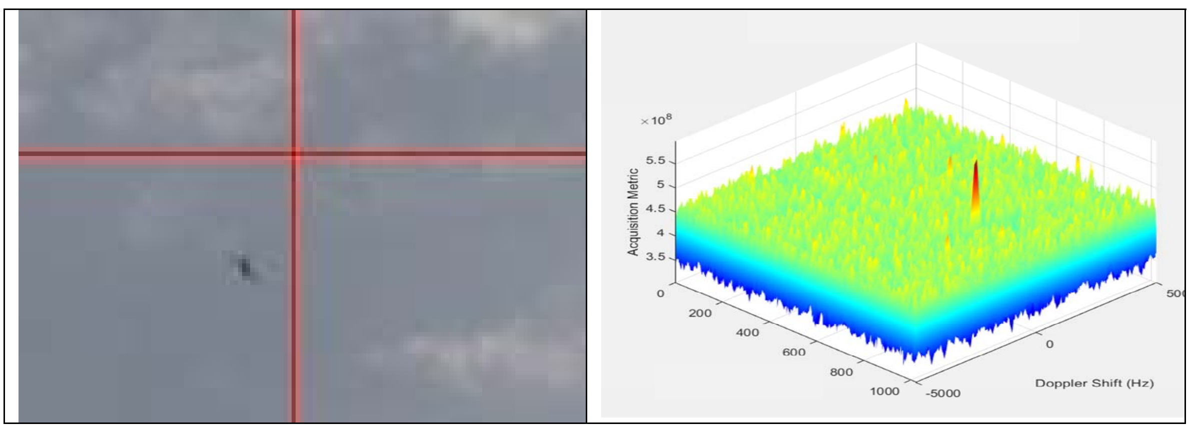

Figure 3. Aircraft and associated PRN Auto-correlation from reflection

in Figure 1. Figure 3 right shows the [redacted] autocorrelation (spike in red) from GPS satellite 5 reflected signal off the edges of the aircraft. GPS satellite 5 is approximately 12,550 miles above the aircraft with a transmit power level of ~ 27 watts.

[redacted]

However, if the satellite were to be essentially placed on earth merged with the receiver, as with the Silent Radar concept, distance to the reflected object would be greatly reduced thus requiring much less transmit power. Additionally, the radar cross selection, RCS, would be greater for a larger reflected signal return.

The metrics on which the performance of the Silent Radar performance will be based are those of a typical radar, i.e. accuracy and resolution of range, velocity, position, and discrimination of the reflective object along with the low probability of detection and jam resistance offered by the novel concept. The proposed concept fits the category of an active CW radar; however, the novel concept is its ability to offer very low transmit power spread into the noise floor. The randomly [redacted] scheme prevents adversary receivers from using coherent integration techniques for detection and further providing a jam proof quality for concealment.

The Silent Radar transmitter also supports FMCW and pulse-doppler modes of operation. Because the transmitter uses an IQ modulator for up-conversion, practically any modulation scheme can be implemented (i.e. BPSK, QPSK, QAM).

The proposed Silent Radar system supports portability with single controller/processor module and portable antenna with pan-and-tilt shown in Figure 1. Both components are designed to be as light as possible with emplacement/displacement requiring two personnel and less than 15 minutes setup time. Future enhancements will replace the parabolic dish and pan-and-tilt with a fixed phased array antenna.

The main controller shown in Figure 1 will provide full operability with the Forward Area Air Defense (FAAD) Command and Control (C2) System with communications over a SBU-E network. The architecture supports both Unix and Windows based operating systems to ease and simplify future software/firmware upgrades and development. All components in the main controller are standard low-cost COTS with focus on adaptability and availability to future technology and service (i.e. nothing fancy, just the components one would find in a high-performance desktop PC). The receiver within the main controller enclosure is software defined radio (SDR) based supporting future technology enhancements and adaptability. The antenna and associated pan-and-tilt along with the future phased array antenna upgrade fully support COTS and availability.

The proposed Silent Radar System is currently at a solid TRL 3 as seen in Figure 1 with field testing. Currently, data captured by the receiver is post-processed and taken to a typical radar output. Over the next few weeks, the novel passive-like system will be taken to a TRL 6 level with all processing in real-time. The main controller is already ruggedized for field-use. The antenna along with pan-and-tilt will be further ruggedized and made more portable.