Question 4

Is this authorization to be used for fulfilling the requirement of a government contract with an agency of the United States Government? If "YES", include as an exhibit a narrative statement describing the government project, agency and contract number.

Agency: Office of Naval Research
Contract#: TBD - Topic #14-006
Narrative: S2 Corporation shall develop a broadband spatial/spectral receiver in support of the team developing a broadband staring receiver. S2 Corporation shall perform the necessary trade studies and iterative design, fabrication and test functions to achieve the performance milestones. S2 Corporation shall work towards accomplishing a subsystem demonstrator, where the team shall design, fabricate and test and demonstrate a wideband staring receiver, utilizing a novel light absorbing S2 crystal material acting as a frequency selected energy detector and when combined with digital assets, a rapid cueing receiver and direction finding tool, which can operate up to 110 GHz instantaneous bandwidth.

Question 6 Is this authorization to be used for providing communications essential to a research project? (The radio communication is not the objective of the research project)? If "YES", include as an exhibit the following information:

A, B and C.

The main reason that S2 Corporation needs authority to transmit at such a broad range of frequencies is due to the fact that the RF spectrum is very sparse in Bozeman, MT. A spectrum collect of 10 GHz can be seen in Figure 1 that clearly shows how sparse the spectrum is.

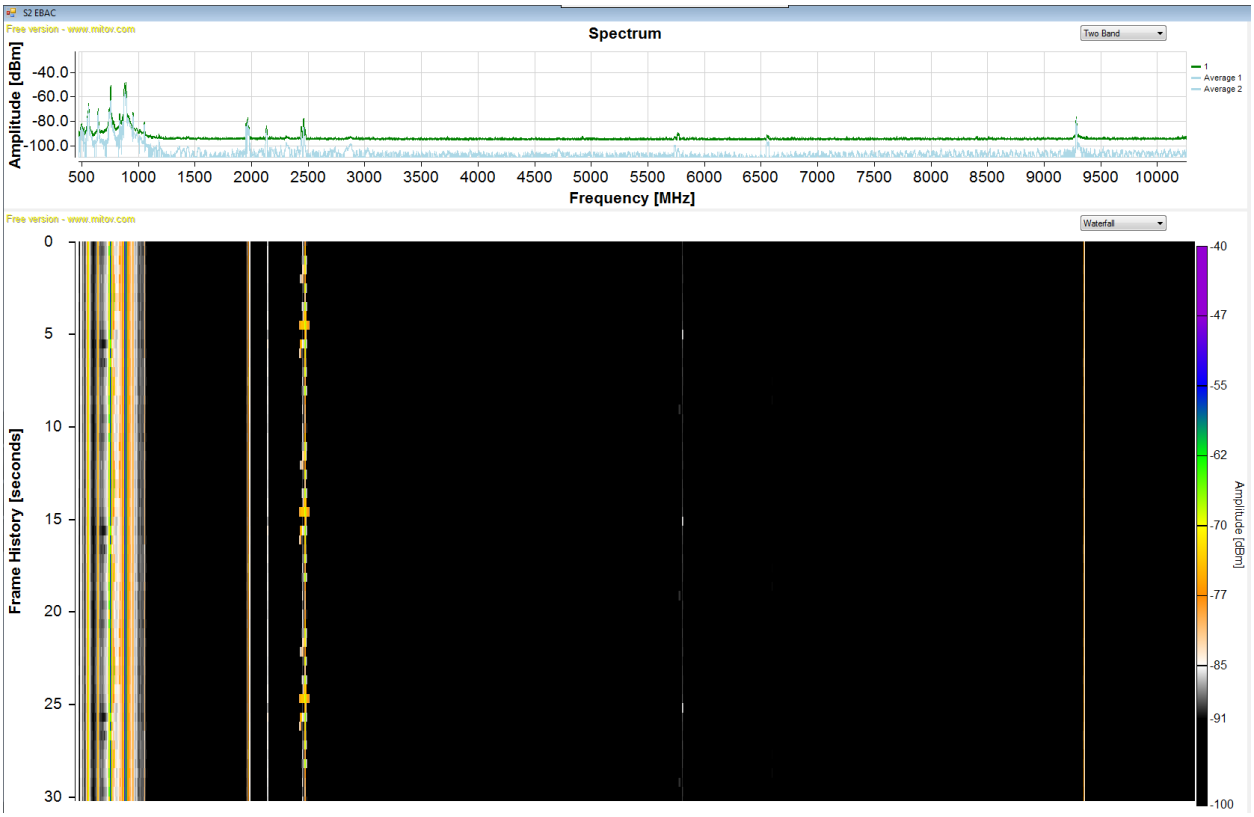

Figure 1 S2 display of a 10GHz bandwidth, 0.5 TO 10.5 GHz, Spectrum collect of Bozeman, MT on February 12TH 2015 in parking lot of S2 Corporation (2310 University Way BLD 4-1) using an omni-directional antenna, 125,000 frequency pixels recorded.(2,000 frequency pixels shown), 30 seconds Time history waterfall 30 (60,000 time pixels recorded).

In order to calibrate and test S2's wideband direction finding techniques S2 needs to generate signals using off-the-shelf signal generators and antennas.

Direction Finding Calibration

The month of February 2015 S2 focused intensely on advancing our direction finding performance, which depended heavily on calibration algorithms using received data thru the full RF path, antenna to S2 receiver. This work was done first in the S2 anechoic chamber, and then outdoors using the S2 EBAC hardware located in the company RV as shown in Figure 2 and

with transmitter RF in the S2 parking lot. This allows us to calibrate in a real-world multipath environment.

Figure 2 Antenna on top of mast on RV and S2 hardware in the garage of the RV. Doing direction finding, see truck in the distance down the road, which is transmitting with FCC approval across a wide band.

To calibrate and demonstrate direction finding S2 had an Federal Communication Commission (FCC) Special Temporary Authority (STA) case number 1083-EX-ST-2014, call sign WH9XDN to transmit outdoors. The outdoor direction finding test setup can be seen in Figure 3.

Figure 3: Outdoor direction finding test setup. The Transmit antenna was located about 375 feet down the road from the S2 travel trailer. The transmit antenna was a 2- 18 GHz WBH2-18N broadband

horn from Q-par. The signal source was an Agilent E8257D signal generator which was controlled from inside the travel trailer via a python script over a Wifi repeater.

The transmit antenna was located about 375 feet down the road from the S2 travel trailer. The transmit antenna was a 2- 18 GHz WBH2-18N broadband horn from Q-par. The signal source was an Agilent E8257D signal generator which was controlled from inside the travel trailer via a python script over a Wifi repeater. The python script insured that we were only transmitting in the authorized frequencies allowed by our FCC STA which controlled the signal generator. The frequencies that S2 was authorized can be seen in green in Figure 4.

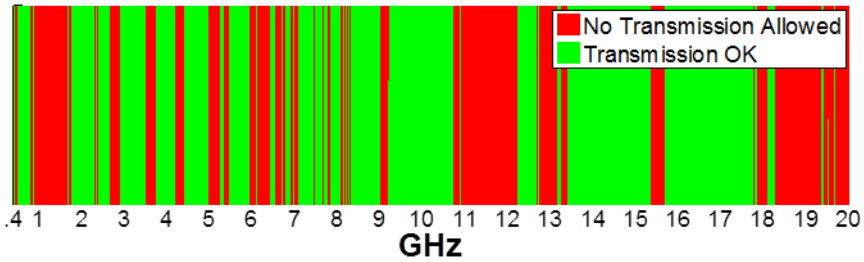

Figure 4 FCC STA allows S2 the authority to transmit in the green areas of this figure.

This current application is requesting frequencies up to 110 GHz. These signals will be generated using a Anritsu 3694B 67 GHz Signal generator for signals up to 67 GHz. In order to generate signals in the 75 to 110 GHz range a Millitech active multiplier is added to the signal generator. Images of both these components can be seen in Figure 5.

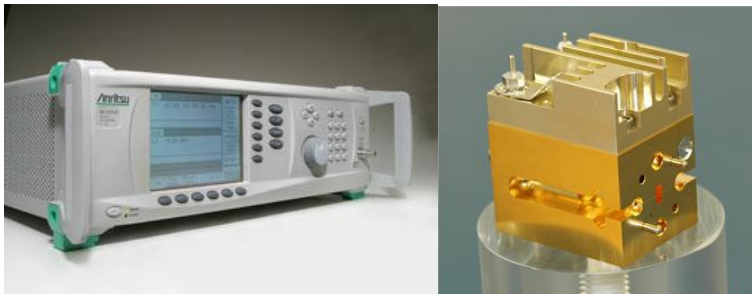

Figure 5 Left: Anritsu 67 GHz signal generator, Middle: Millitech AMC-10-RFHB0 75 to 110 GHz active multiplier needed to generate signals from 75 to 110 GHz (uses an input of 12.5 to 18.33 GHz 6 times multiplication).

We will test and adapt the DF/SM calibration for a range of input pulse types including short pulses, chirped pulses, and modulated pulses.

We will conduct testing in outdoor environments in Bozeman, MT. This will include design, installation, and testing under operating conditions with a calibrated rotation stage for the receive antenna on the mast. We will perform DF on known transmitters in the area including cell towers and radio and TV towers. We will setup Wi-Fi repeaters outside for additional test signals sources. Pending FCC approval, we will generate signals across a number of bands over the 0.5-110 GHz processing band.