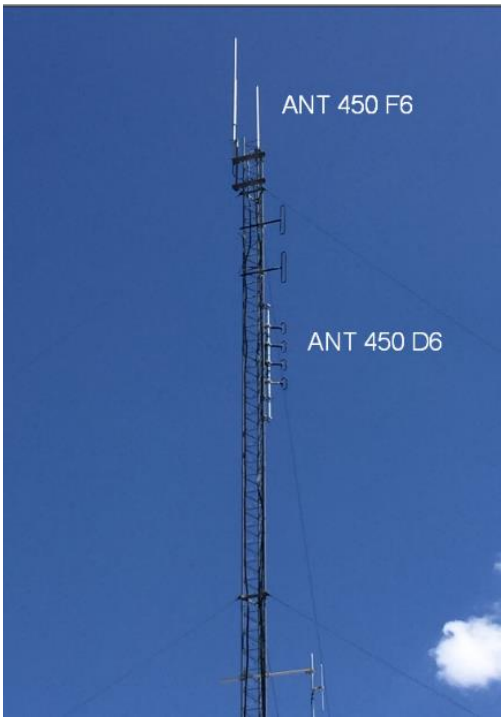
UHF Antenna Downtilt Measurement Using a Drone-Mounted Spectrum Analyzer

See https://youtu.be/VVoeKpKLfwg



Background:

A drone-mounted spectrum analyzer can be used to characterize the radiation pattern of public safety and commercial antenna systems. This white paper describes the use a spectrum analyzer mounted on a drone to characterize signal strength vs. elevation resulting in comparisons of downtilt of two different antenna designs.

The tests were done at an 8200 ft elevation mountain top site in Northern Nevada. The tower hosted two UHF repeater systems, one P25 and the other DMR. The tower and two antennas are show in Figure 1.

The coverage area (Reno/Sparks) site was 12 miles away at 4400 ft elevation. The radiation pattern needed to be 3 degrees below the horizon.

The top antenna was a Telewave ANT 450 F6 fiberglass collinear antenna transmitting a 45 watt P25 signal. The second antenna was a Telewave, 4 folded dipole array, ANT 450 D6 transmitting a 30 watt DMR signal.

The drone was a DJI Matrice 600. Mounted on the drone was a Tektronix RSA306, 9 kHz to 6.2 GHz spectrum analyzer. A ¼ wavelength vertical antenna was used to collect the signals. The signal level into the analyzer was high (-20 dBm) as the measurements were taken 60 ft away from the tower in the azmuth direction of the area to be served (Reno/Sparks). A 10 dB attenuator was used to prevent overload of the analyzer.

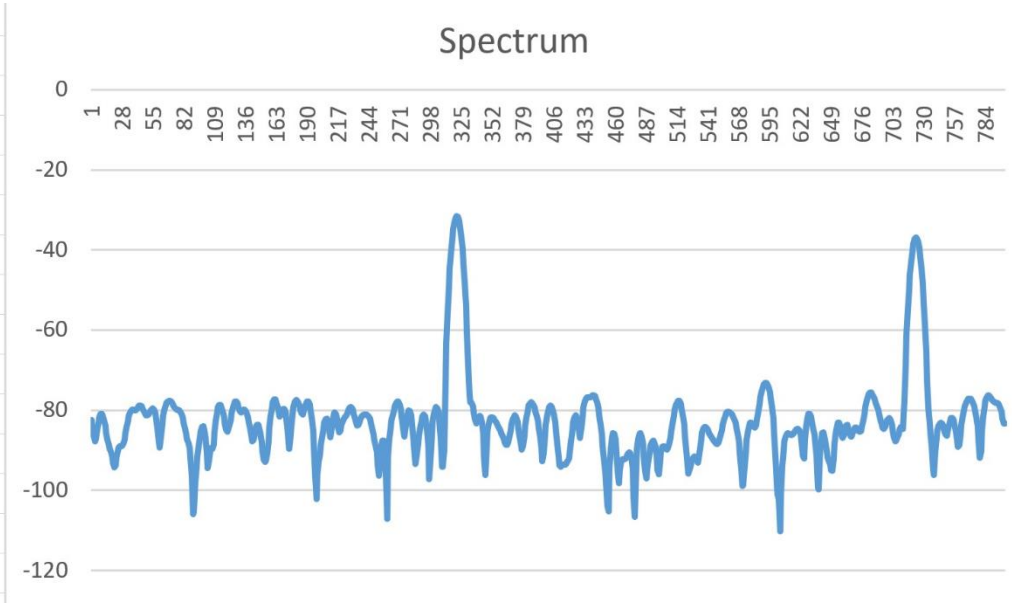
DJI Matrice 600 with spectrum analyzer and vertical antenna

A laser range finder was used to mark a location 60 ft away from the tower in the correct azmuth. The distance of 60 feet was believed to be just in the far field for both antennas.

With the help of an observer, I positioned the drone at the 60 ft distance mark.

Drone Camera view of observer verifying the 60 ft distance marker

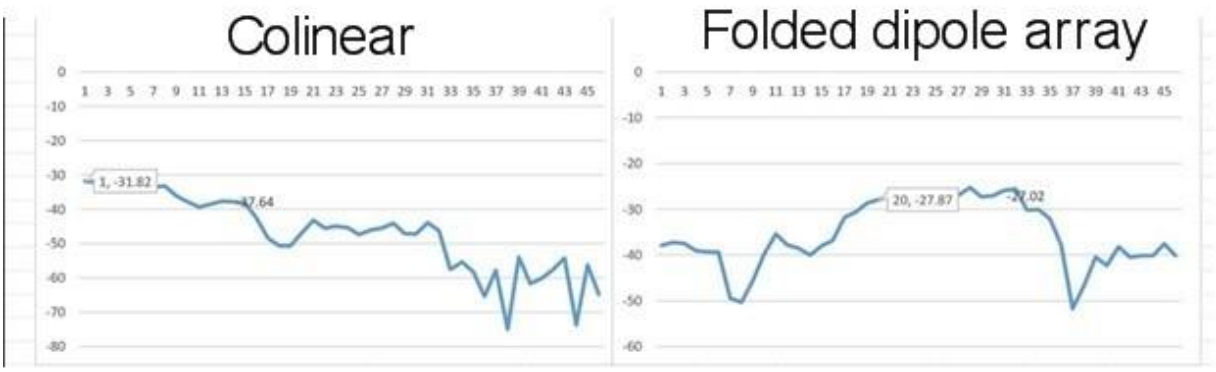
The analyzer was taking spectrum measurements at 1/sec.



One spectrum trace showing the two transmitter signal levels

After a few seconds of measurements, I dropped down 3 feet in elevation, as indicated on the drone controller display, to get the signal level at 3 deg. downtilt. Next, I dropped down across from the ANT 450 D6. Then again dropped 3 feet to check the level at 3 deg.downtilt for that antenna. Graphs below. I put signal strength call outs at the 0 deg and 3 deg downtilt points.

By plotting the signal levels vs. time (elevation) for each of the two transmitter frequencies, the power drop with downtilt can be seen.



The ANT450 F6 colinear antenna dropped 6 dB at 3 deg downtilt. The ANT 450 D6 folded dipole array maintained signal strength to 3 deg. downtilt.

Conclusion

A drone mounted spectrum analyzer can be precisely positioned around transmitter antennas to measure the signal strength in the direction of needed coverage. This information can help refine antenna choice and tower location to optimize system coverage.