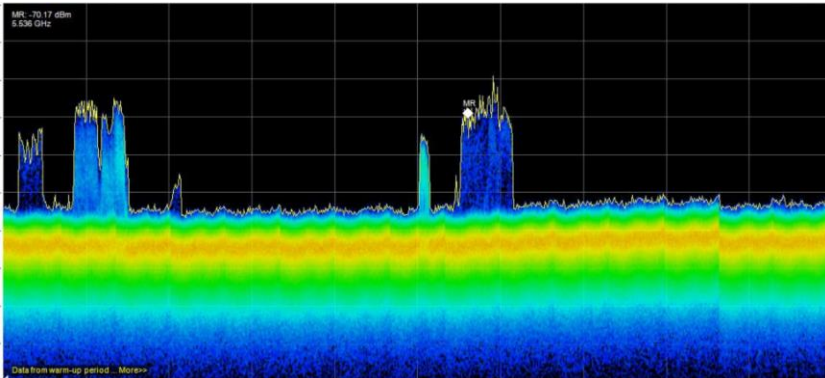


Using Drones to Enhance Spectrum Measurements

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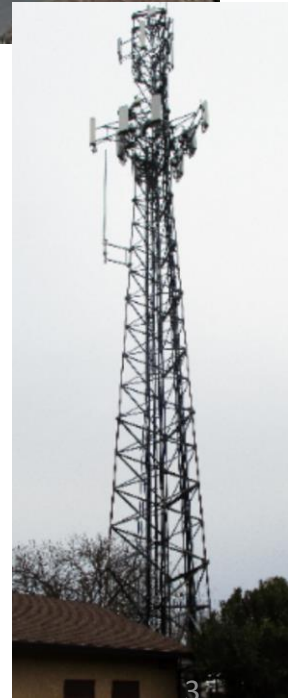
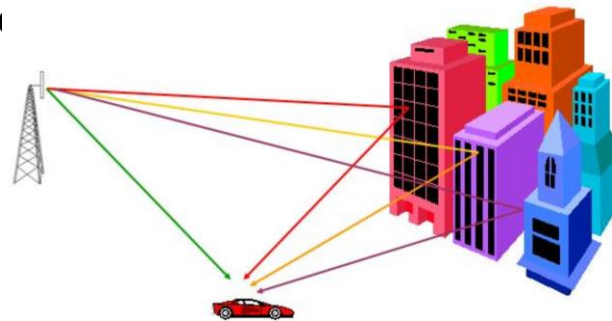


Agenda

- Why Elevate Spectrum Measurements
- FAA Rules / Limitations
- Hardware Overview
- Example Solutions
- New Drone / Spectrum Analyzer Systems
- Logistics
- “Before Drones”
- Summary

Why Elevate Spectrum Measurements

- “See what your Antenna Sees”
 - Rx at 150 ft. No interference on the ground
- Line-of-Site to source
- Measure signal strength in hard-to-access source locations
- RF Environment on ground compromise
 - Inverter Noise
 - AC Noise
 - Cell Phone Signals
- Eliminate Multipath errors



See What Your “Antenna” Sees

- Most Communications today “Line-of-Sight”
- Path loss well known
 - Friis's Equation

$$\frac{P_r}{P_t} = D_t D_r \left(\frac{\lambda}{4\pi d} \right)^2$$

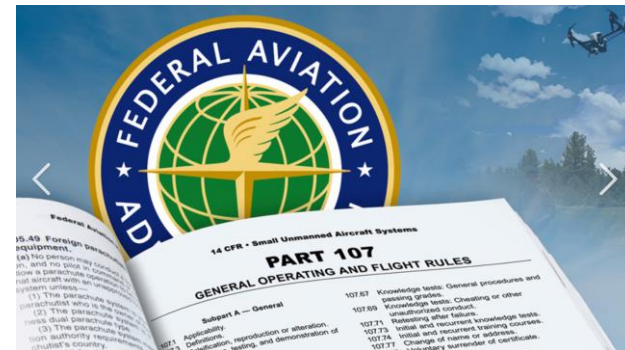
where

- D_t is the **directivity** of the transmitting antenna
- D_r is the **directivity** of the receiving antenna
- λ is the signal wavelength
- d is the distance between the antennas

- Spot Check Coverage Predictions
- For EMF studies complicated by multiple emitters over a wide frequency range and multiple source location.
- “Get in the RF path” to needed locations

FAA Rules / Limitations

- Drone activity regulated by FAA
- 107 Licensed pilot
- Pilot in command (PIC) totally responsible for all outcomes
- Not over people
- Approved airspace LAANC



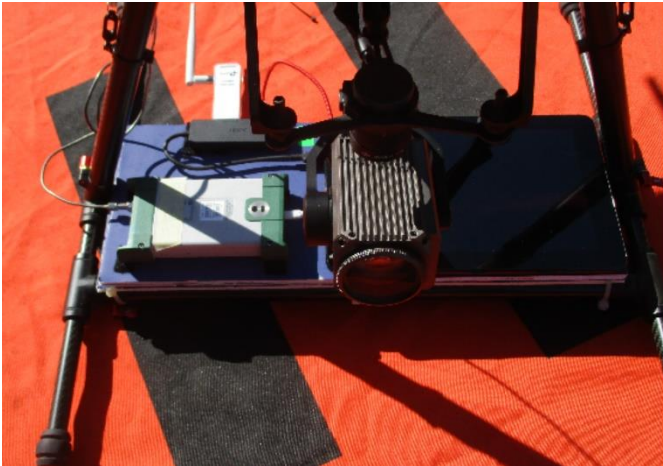
Hardware Overview (payload drones)

- US Manufacturers
 - \$25K vs \$15K
- China DJI
 - \$8 to \$30K
- Freely AltaX
- Wispr drones
- Xcraft
- ...



Hardware Overview

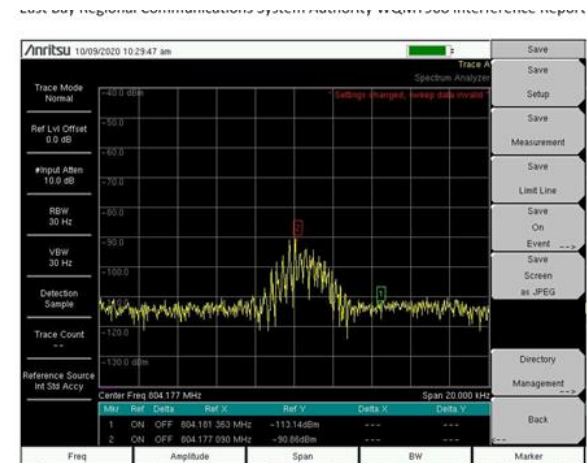
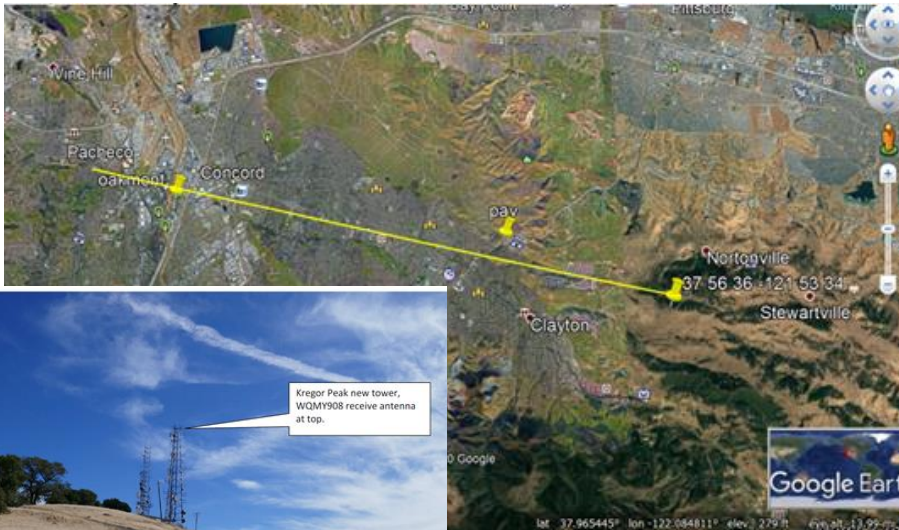
- Safe modifications of aircraft for test electronics
- Spectrum analyzer
- PC
- Antenna
- Misc. Filters



Example

N California Interference

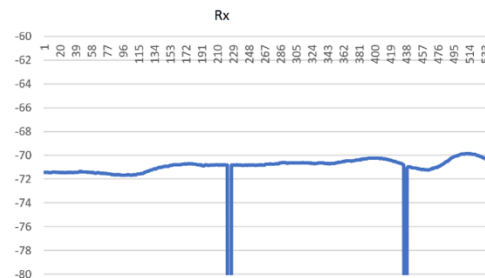
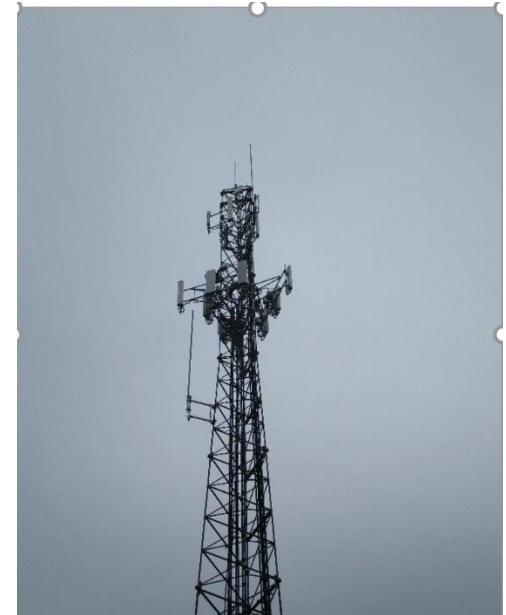
- CSI Telecommunications Consulting Engineers
- FCC
- Into RX Antenna at 150 ft
 - No Signal on Ground
 - Needed bearing from 150 ft



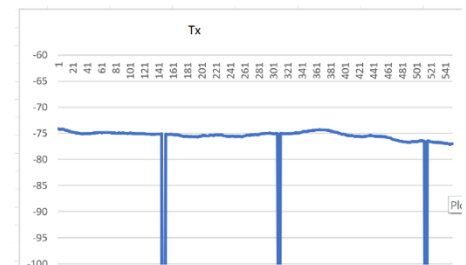
Example

N California PD Antenna Study

- Poor Coverage at Station from 50 W Transmitter 5 miles away
- Separate Rx and Tx Antennas on Cell Tower
- Drone RSSI Measurements showed Antenna Patterns were good but RX Side Mounting Reduced Rx by 5 dB
- Reversed Tx and Rx antennas. Other Rx Receivers Voted System



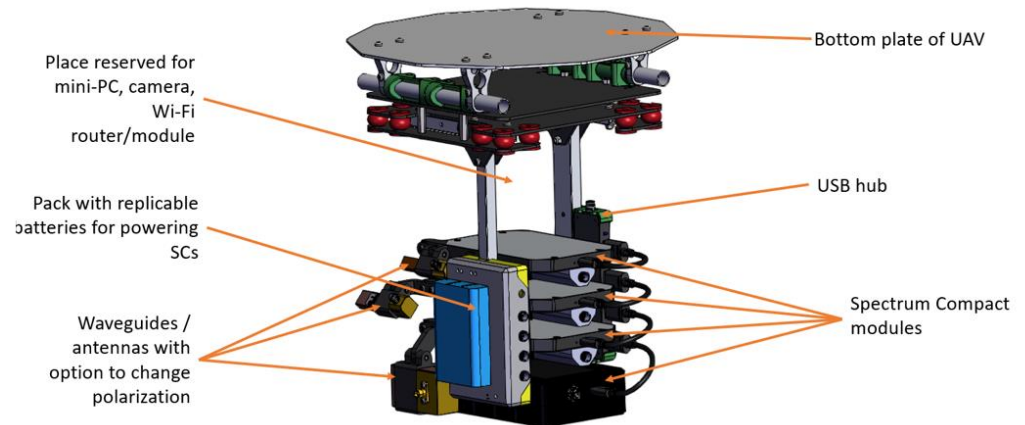
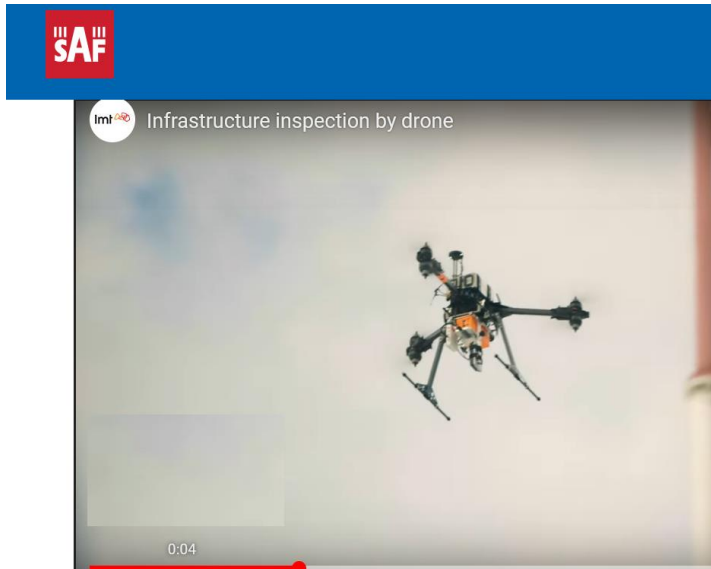
Signal strength vs. height for the Rx antenna



Signal strength vs. height for the Tx antenna

Drone / Spectrum Analyzer Systems

- Microwave / mm Wave
 - SAF Technika
 - 9 kHz to 50 GHz



Drone / Spectrum Analyzer Systems

- Cellular RF Signal Survey
 - Prism
 - Wispr Drone (US)
 - EpicSolutions (Prism)
 - Scanner / spectrum analyzer



The PRISM™ Sensor

The PRISM sensor is a pocket-sized accessory based on our smallest RF transceiver/processor, the [Sidekiq Z2](#). It connects to a commercial smartphone or tablet via USB-C, making a conveniently transportable, complete cellular network scanner and spectrum analyzer. [Learn More](#)

Cellular RF Signal Survey

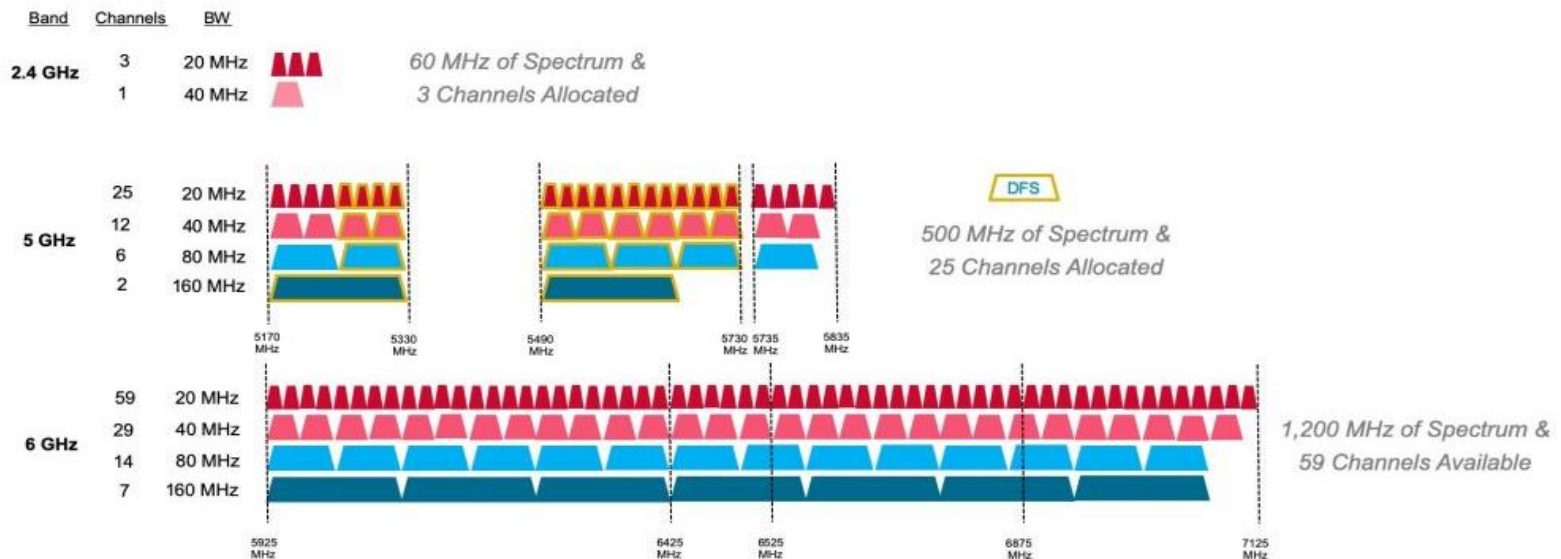


Scanning Receiver | 10 MHz – 6 GHz



WiFi 6E Interference Hunting

- WiFi 6E is an extension of the available frequencies that can be used to transmit WiFi signals



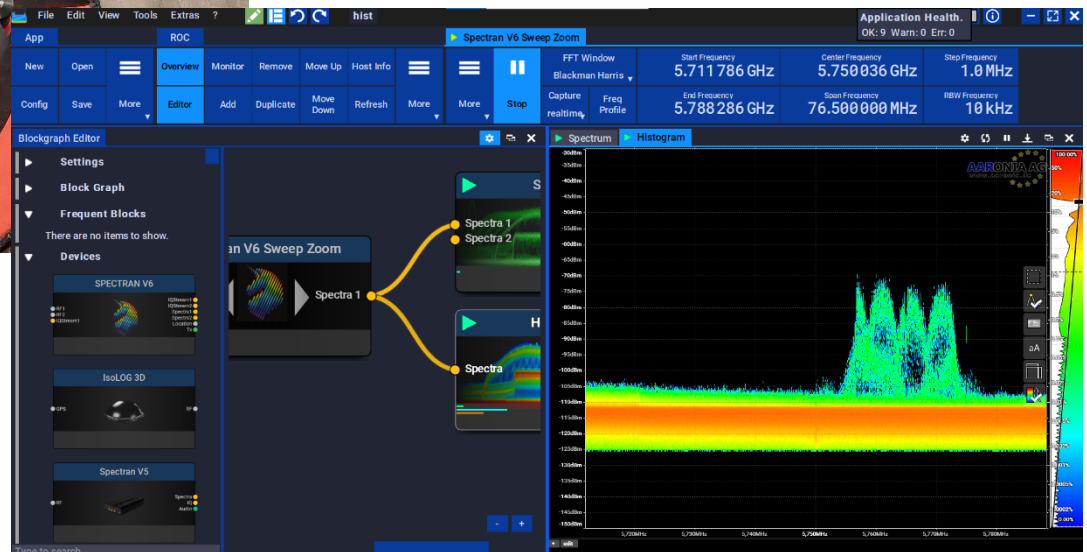
WiFi 6E Interference Hunting

- 10,000 Incumbent Fixed Wireless links
- Automated Frequency Coordination (AFC)
- WiFi 6E Access points will consult a registered database to confirm its operation will not impact a registered user.



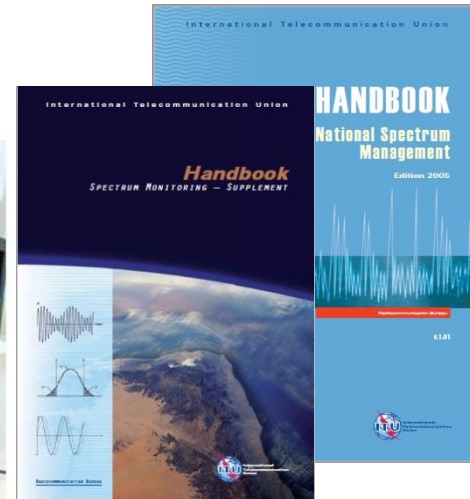
WiFi 6E Interference Hunting

- Aaronia / Spectran Real-Time Spectrum Analyzer



Government Level Spectrum Monitoring and Management

- Tethered Drone System



Government Level Spectrum Monitoring and Management

- Extra resource for mobile System



Wildlife Tracking



Wildlife Tracking

- DJI M300
- Signal Hound SA44
- I5 Tablet PC
- 3 Element 220 MHz Yagi antenna

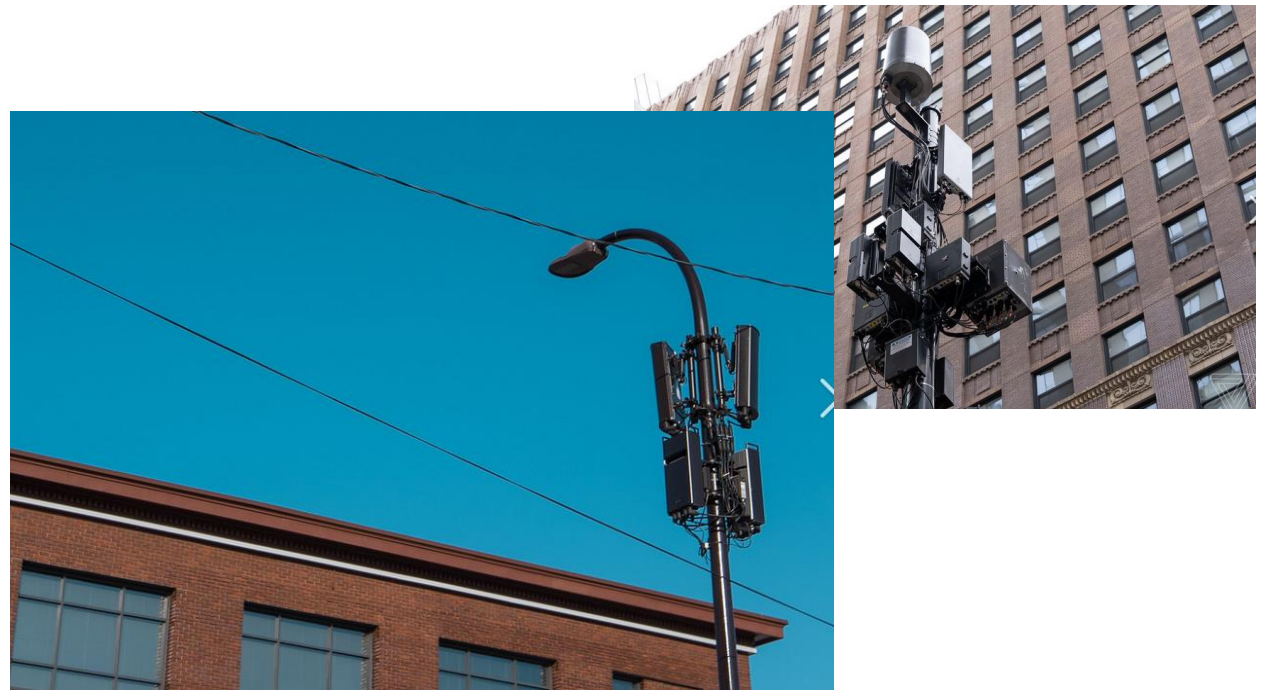


Isotropic EMF Surveys



Isotropic EMF Surveys

- Measurement in path of radiation to predict levels in difficult to access areas



Flight Logistics

- Landowner
- Airspace
 - FAA Approval if needed
 - LAANC
- Weather
- People Management
- Flights are typically straight up rotate and come back down
 - Little wind loading on antenna

“Before Drones”

- Man Lift
 - Slow to move
 - Drone 400 ft +
 - Disturbance
- Maned Aircraft
 - Expense
 - Cant hover
 - Risk
 - Antenna Mounting
- Helicopter
 - Expense
 - Risk
 - Antenna Mounting

Summary

- Rapidly Expanding Applications and Solutions for Drone-based Spectrum Measurements
- Many New “Non Chinese” Drones
- Value of Elevating Spectrum Measurements Proven
- Questions?