Case Study

VIAVI Solutions

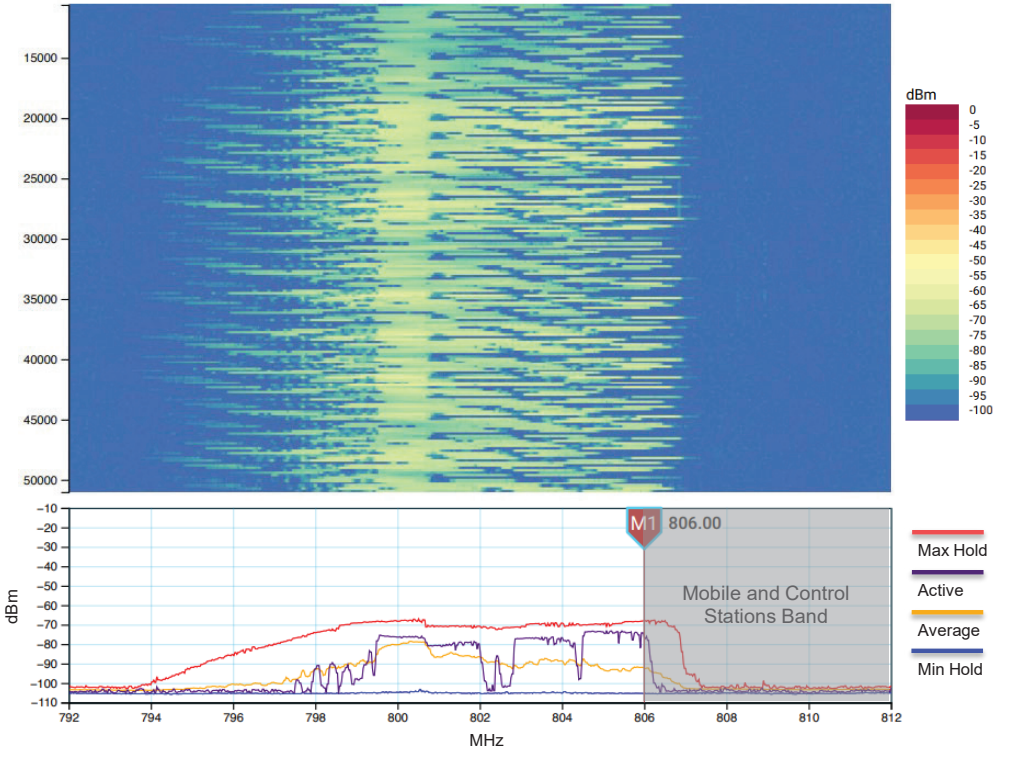
Public Safety RF Interference

RF Viewer | RF Interference Visualization

Public safety radio systems are essential communication infrastructure used by law enforcement personnel, firefighters and emergency medical technicians. These systems operate withing specific portions of the 800MHz frequency band. In these environments, RF interference can disrupt voice, data, or control channels resulting in dropped calls, delayed dispatch information, or complete communication outages during emergencies.

The Challenge

A government agency in Northern California reported the presence of RF interference in their public radio system in the 800 MHz band, impacting the transmission of the mobile and control stations that transmit in the spectrum of 806 MHz to 824 MHz.



RF Interference Analysis

The spectrum and spectrogram analysis above indicate the presence of a frequency-hopping signal across a frequency range of 793.3 MHz to 807.3 MHz, interfering with the mobile and control stations band that starts at 806 MHz. The interference signal was measured with a 30 KHz resolution bandwidth (RBW), with a maximum observed power level of approximately -69 dBm. The spectrogram, and traces clearly shows that the interfering signal is not continuously present on a single frequency; instead, it rapidly changes frequency within the 793.3 MHz to 807.3 MHz frequency range.

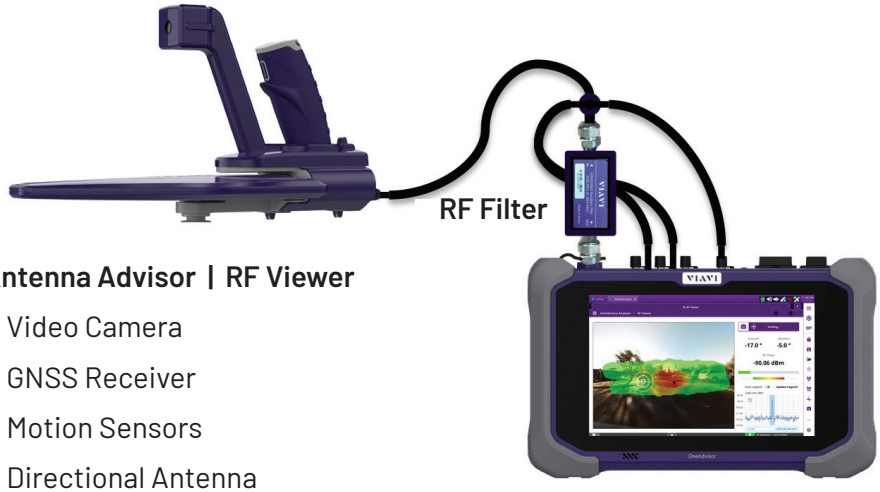
This RF interference test showed the highest measured signal level near a building complex approximately 800 ft from the Public Safety communications tower. This building complex had previously been inspected as part of a prior interference investigation, however the interference source could not be identified. No obvious electronic equipment, radio transmitters, or other devices were observed transmitting at the same frequency.

The Solution

The wireless field instrument used for this case of RF interference analysis and location was the VIAVI OneAdvisor 800 with RF Viewer, which provides real-time visualization of RF signal strength using augmented reality (AR), overlaying RF data directly onto an image of the physical environment.

The OneAdvisor 800 RF Viewer solution has two main components:

- The Antenna Advisor | RF Viewer, which is an antenna system equipped with a directional antenna, global navigation satellite system (GNSS) receiver, motion sensors and a directional antenna
- The OneAdvisor 800 | RF Viewer, which is a real-time spectrum analyzer that measures RF power levels and combines them with the antenna system's directional information to create a heatmap overlaid on the physical environment. Each measurement is spatially referenced by azimuth and elevation, with the color-codes automatically adjusted to represent RF power levels, from green for lower power to red for high power emissions.



Antenna Advisor | RF Viewer

- Video Camera
- GNSS Receiver
- Motion Sensors
- Directional Antenna

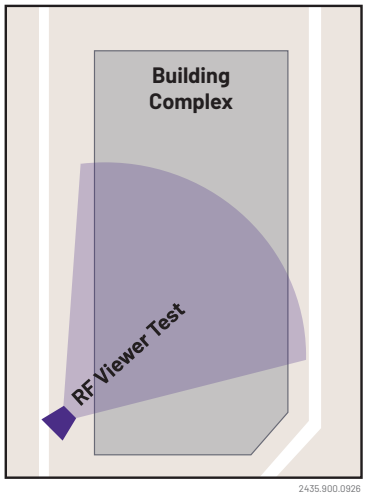
OneAdvisor 800 | RF Viewer

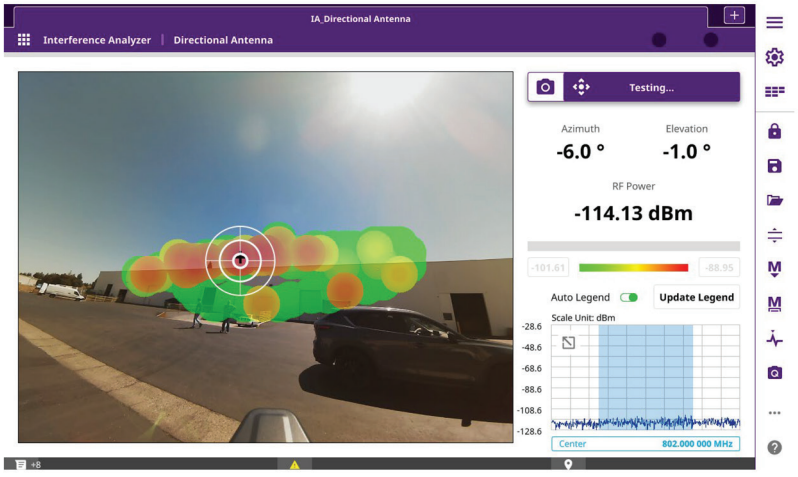
- Environment View
- RF Signal Strength
- Azimuth, Elevation
- RF Tracking Modes
- TDD Auto-Gated Spectrum

OneAdvisor 800 RF Viewer | RF Visualization with Augmented Reality

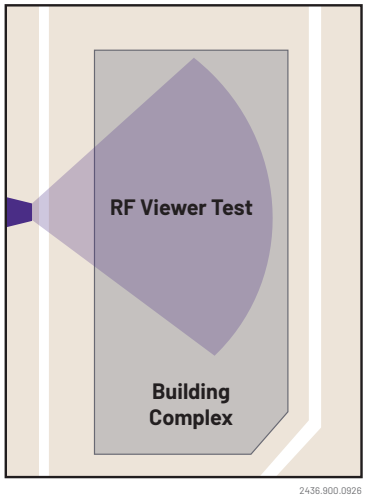
RF Viewer Measurements | Outside the Building

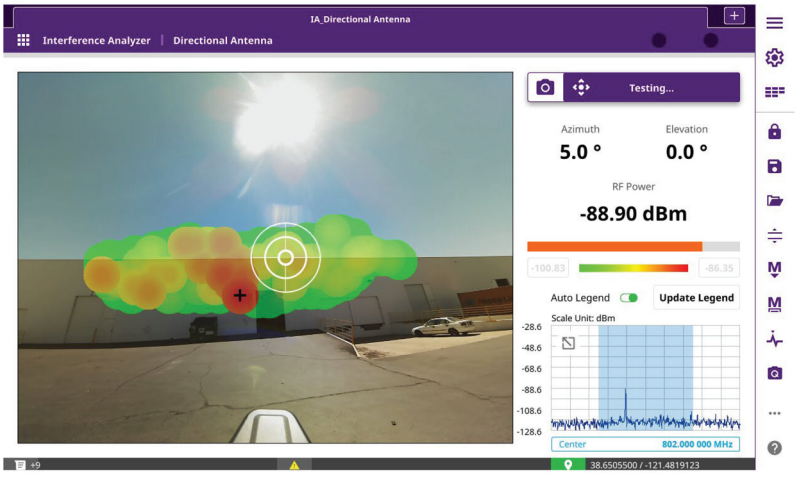
RF measurements were collected from two different locations outside the building complex to confirm the direction and potential origin of the emissions. The RF Viewer measurements indicated that the RF interference was originating from the building complex.





RF Viewer Test | Outside Building Complex

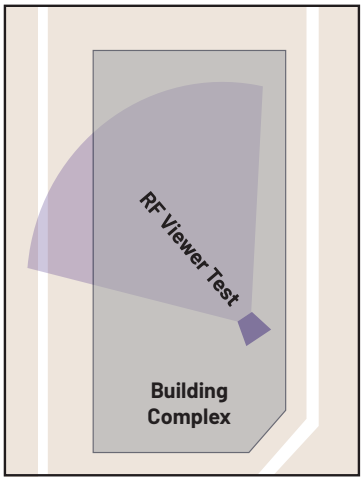


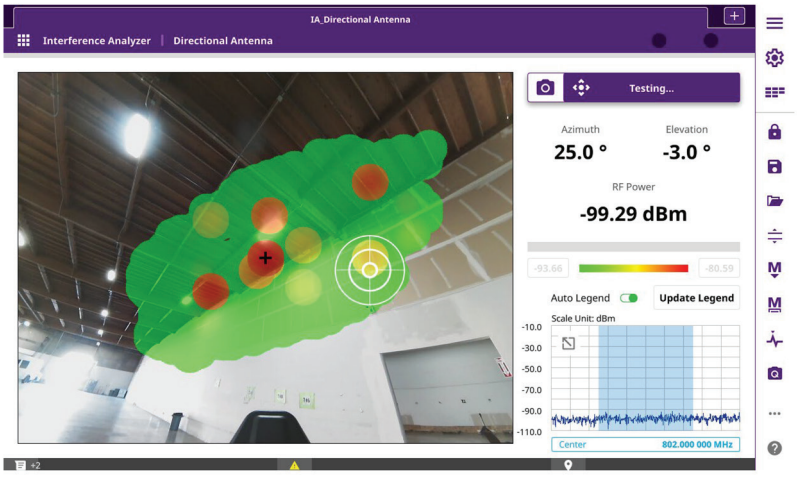


RF Viewer Test | Outside Building Complex

RF Viewer Measurements | Inside the Building

RF measurements were collected inside the building complex to locate the interference source. The RF Viewer measurements indicated that the interference was originating from the rooftop of the building complex.

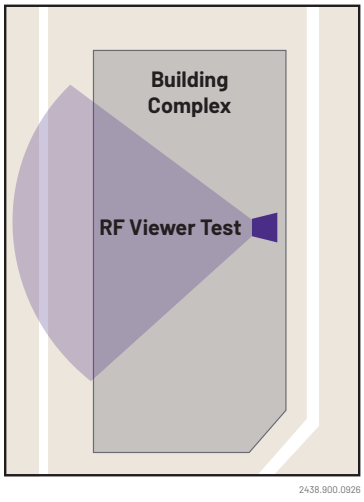


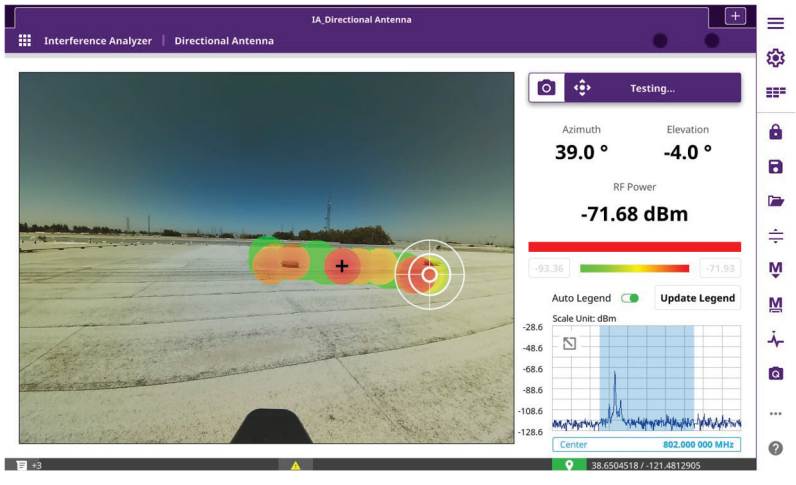


RF Viewer Test | Inside Building Complex

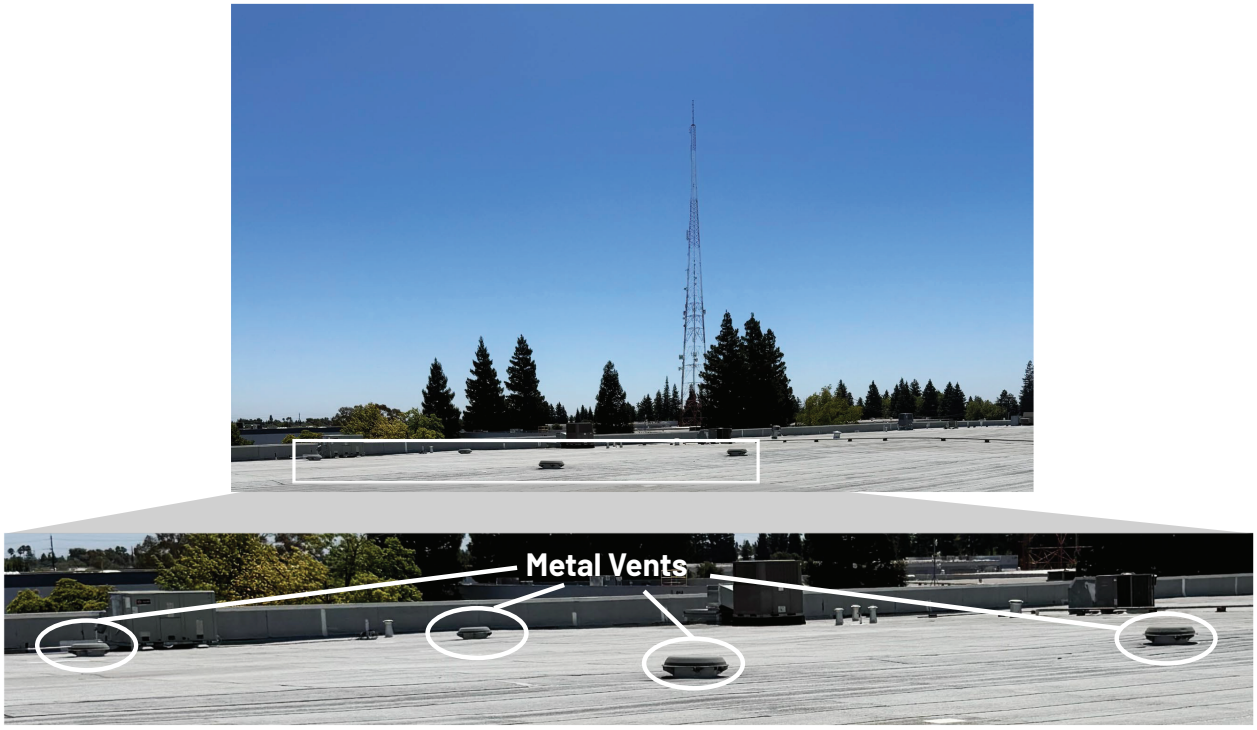
RF Viewer Measurements | Rooftop of the Building

RF measurements were collected on the rooftop of the building complex to locate the interference source. The RF Viewer measurements indicated that the interference was originating from the building's metal vents.





RF Viewer Test | Rooftop Building Complex



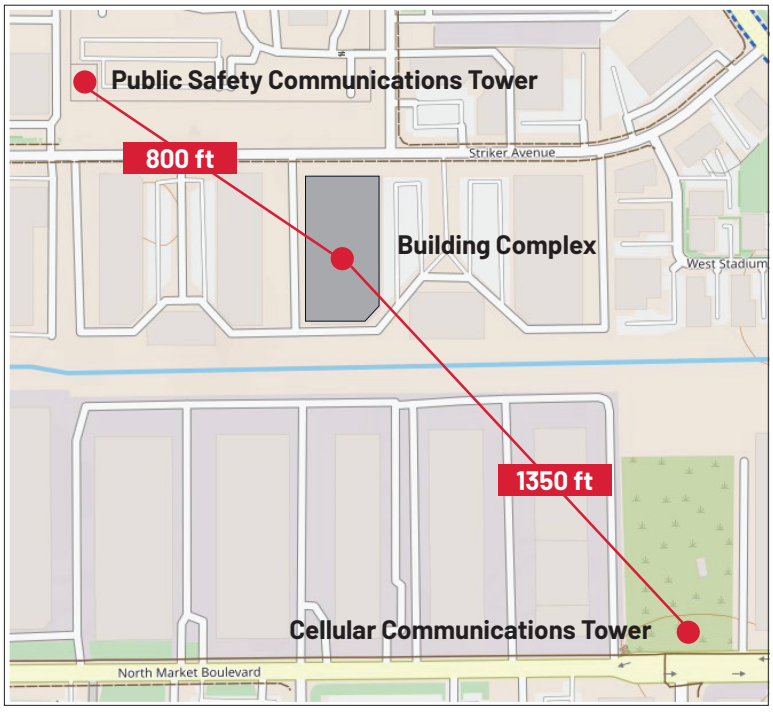
Building's Metal Vents

The metal vents on the rooftop of the building complex were generating passive intermodulation (PIM) signals from the communications towers.

This building complex was located approximately 800 ft southeast from the Public Safety communications tower, during the RF Viewer measurements, another communications tower equipped with cellular antennas was also observed in close proximity of the building complex. This cellular communications tower was located approximately 1350 ft southeast of the building complex.

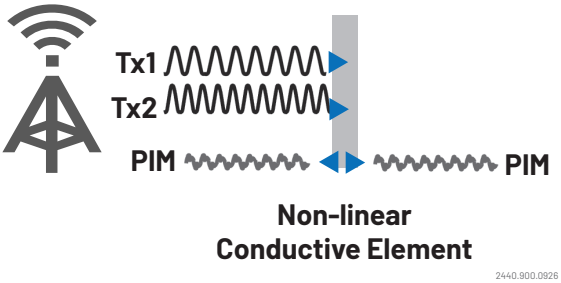
Public Safety Communication Tower View from the Building Complex

Cellular Communication Tower View from the Building Complex

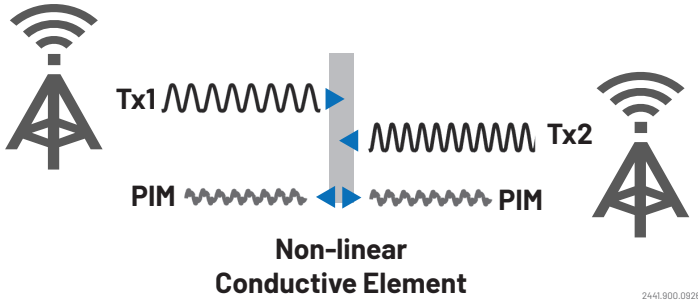


Location and Distance of Communication Towers and Building Complex

PIM generated interferences are created from passive non-linear conductive elements, where multiple RF signals mix and generate new signals as intermodulation products derived from the original RF signals. Some cases of non-linear conductive elements that generate PIM are dissimilar metals, corrosion, oxides, sharp edges, low contact pressure, and vibration among others.



RF signals from one communication tower



RF signals from two communication towers

The intermodulation products are calculated as:

Intermodulation Products $(m + n) = \pm m \times F1 \pm n \times F2$

Where m and n are positive integers, and F1 is the frequency of transmitter 1 and F2 is the frequency of transmitter 2.

For example, the 3rd order intermodulation products are:

IM3 = 2F1 + F2

2F1 – F2

2F2 + F1

2F2 – F1

The following are a few examples of intermodulation products considering different transmission frequencies and the impact of public safety mobile and control transmission.

Tx Type	Tx Frequency	Intermodulation	Tx Mobile
Cellular Band 12B	734 to 744 MHz	IM3: 772 to 802 MHz	806 to 816 MHz
Cellular Band 14	758 to 768 MHz		
Cellular Band 12B	734 to 744 MHz	IM5: 786 to 836 MHz	806 to 816 MHz
Cellular Band 14	758 to 768 MHz		
Public Safety Base Station	851 to 861 MHz	IM5: 773 to 823 MHz	806 to 816 MHz
Cellular Band 5B	880 to 890 MHz		

References

- Federal Communications Commission | 800 MHz Spectrum
- 3GPP TR 37.808 | Technical Specification Group Radio Access Network; Passive Intermodulation (PIM) handling for Base Stations (BS)
- VIAVI RF Interference Visualization | OneAdvisor RF Viewer Application Note

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