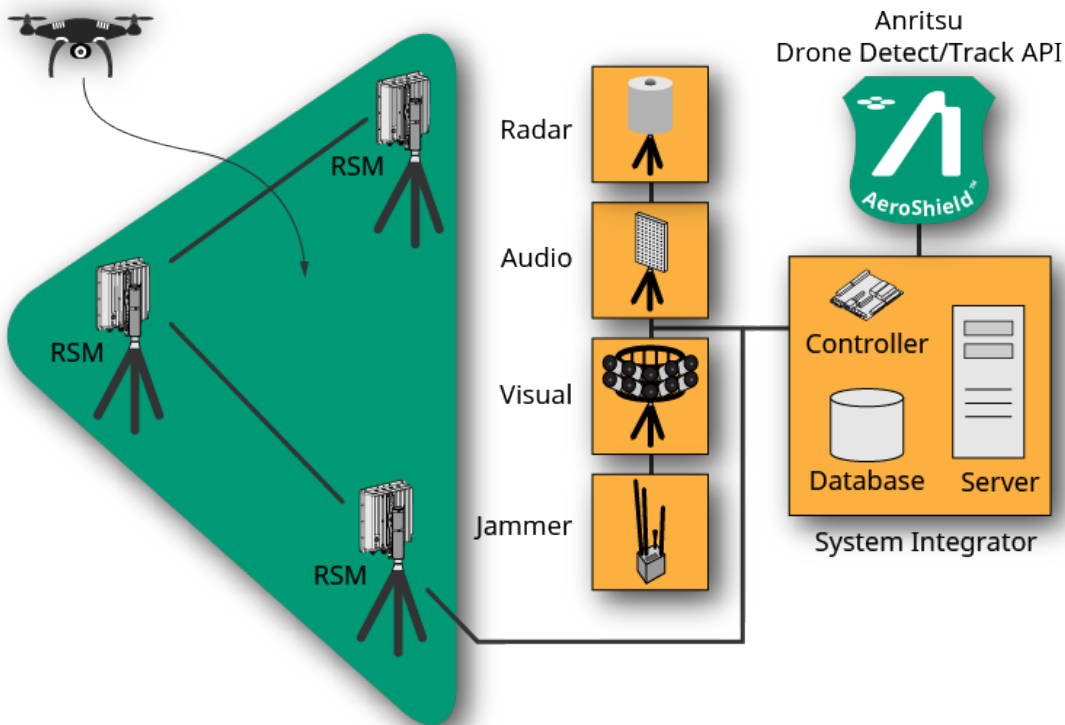


AeroShield™ RF Drone Detect and Tracking Application

Available for C-UAS System Integrators



Supplied by Anritsu

C-UAS Solution shows Anritsu RF contribution highlighted in green

AeroShield RF Drone Application

Introduction

As a counter-unmanned aerial system (C-UAS) system integrator, you understand all too well the growing concern among public organizations, governmental and security agencies, as well as other in the private sector over the increasing proliferation of drones. These drones are able to execute intrusions into secure areas like military bases, airport space, nuclear facilities, and public events. Single sensor solutions (consisting of RF, camera, radar, etc. only) are not sufficient to protect against drone incursions. Some drones may fly "RF silent" using a pre-programmed itinerary that leverages GPS for navigation. An RF detection and tracking solution would not work in this situation, necessitating the use of cameras and radar as the primary means of defense. A multi-sensor approach must be implemented to help provide maximum protection against drone incursions.

Anritsu's AeroShield software is a critical component of any C-UAS multi-sensor solution. AeroShield detects and tracks drone activity using the drone's video transmission. After profiling the spectrum, new signals entering the area are evaluated. Once the signal is validated as a drone transmission, an RF drone detection and tracking application is automatically launched. I/Q files are downloaded from each Anritsu Remote Spectrum Monitor deployed for accurate drone geo-location using TDOA. The AeroShield software then creates a report that details the date and time of the incursion as well as the flight path taken. Flight information can be saved using a TXT, CSV, or KML file (KML files can then be displayed using Google Earth™). Alarms can also be sent via email to alert user(s) of a drone incursion.

AeroShield is quickly integrated into a C-UAS integrator's software dashboard through the use of an application programming interface (API). The API contains all the functions and algorithms required for RF detection and tracking. Along with the API, a demonstration program is available to show AeroShield capabilities prior to the integration effort.

Typical use cases for AeroShield RF monitoring and tracking drones include:

- Federal government and defense
- Utilities
- Stadiums/Arenas for public events
- Border patrol
- Critical infrastructure (nuclear plants)
- VIP Meetings
- Correctional facilities
- Public safety entities
- Airports
- Terrorism/Drug cartel mitigation
- Resorts (protecting individual privacy)
- Corporations



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AeroShield API Overview

The API contains functions required for both drone detection and tracking using RF signals transmitted by the drone video. System integrators use the API to incorporate the drone detection and tracking algorithms into their system-level software. Anritsu's AeroShield RF solution is then combined by the integrator with their own portfolio of sensors. These sensors might include optical, acoustic, radar, or other components to complete a drone mitigation system.

The AeroShield application works with Anritsu's line of Remote Spectrum Monitor receivers to provide a complete RF solution. Spectrum monitor models include the Remote Spectrum Monitor MS27100A, MS27101A, MS27102A, and MS27103A designed for both indoor and outdoor applications. A brief overview of the RF hardware is discussed later in this brochure. More detailed information for each hardware model can be found on Anritsu's website.

Tools for the System Integrator

Various tools and programs are made available to the system integrator to demonstrate the AeroShield application's capability to detect and track drone activity. These tools include the following:

- Drone detection and tracking demonstration program
- Drone detect/track simulator
- Drone track viewer
- API with source code examples

Drone Detection and Tracking Demo

The user interface for the demonstration program is shown in Figure 1. The API provides capabilities for setting up spectrum masks, drone detection, alarming, reporting, and drone tracking. Both online and offline mapping capabilities are provided. A minimum of three Remote Spectrum Monitor hardware units are needed to use the application.

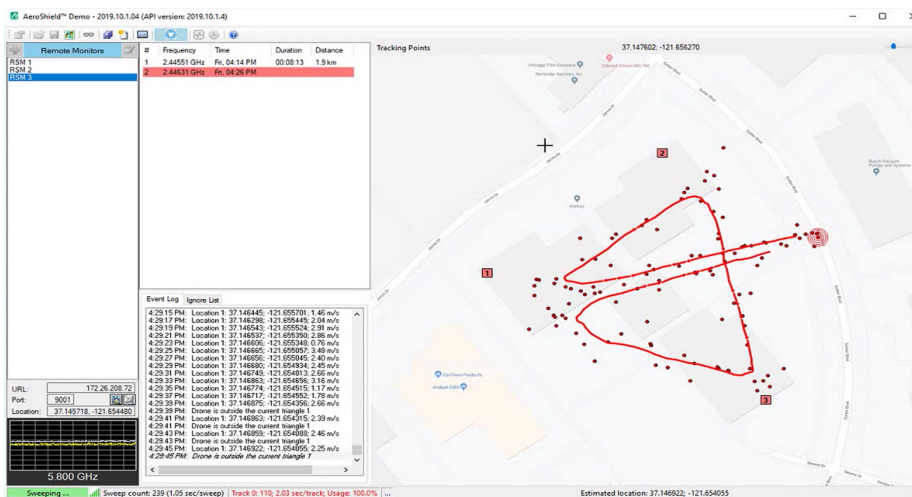


Figure 1. AeroShield Demonstration Program User Interface

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AeroShield API Overview (Cont'd)

Drone Detect/Track Simulator

The user interface for the simulator is presented in Figure 2. Users can place Remote Spectrum Monitor hardware anywhere on a map and simulate drone intrusion into the area covered by the monitors. Users can also vary the duty cycle of the drone signal, add various levels of Square or Gaussian noise, and vary the drone signal amplitude level. Default drone signals are provided with the simulator, however, users may also use their own custom signals if needed. These features provide the simulator with capabilities that can closely match a real RF environment and drone signal.

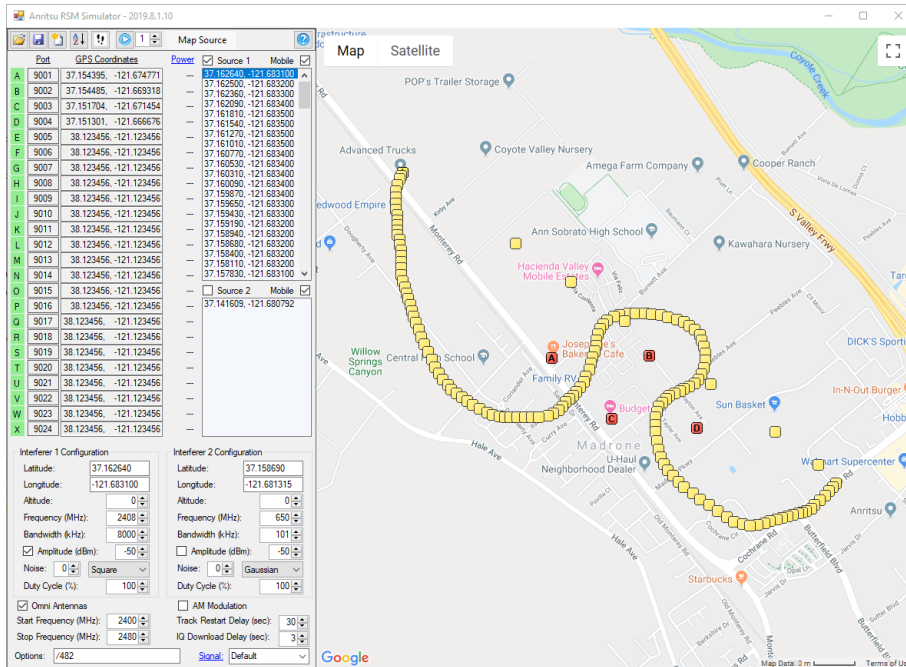


Figure 2. AeroShield Simulator Window

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AeroShield API Overview (Cont'd)

Track Viewer

Track Viewer is a program that allows the user to review a history of tracking events captured by AeroShield. Events can be sorted by date, frequency, duration, or distance. This is a post-processing tool. See Figure 3 for illustration.

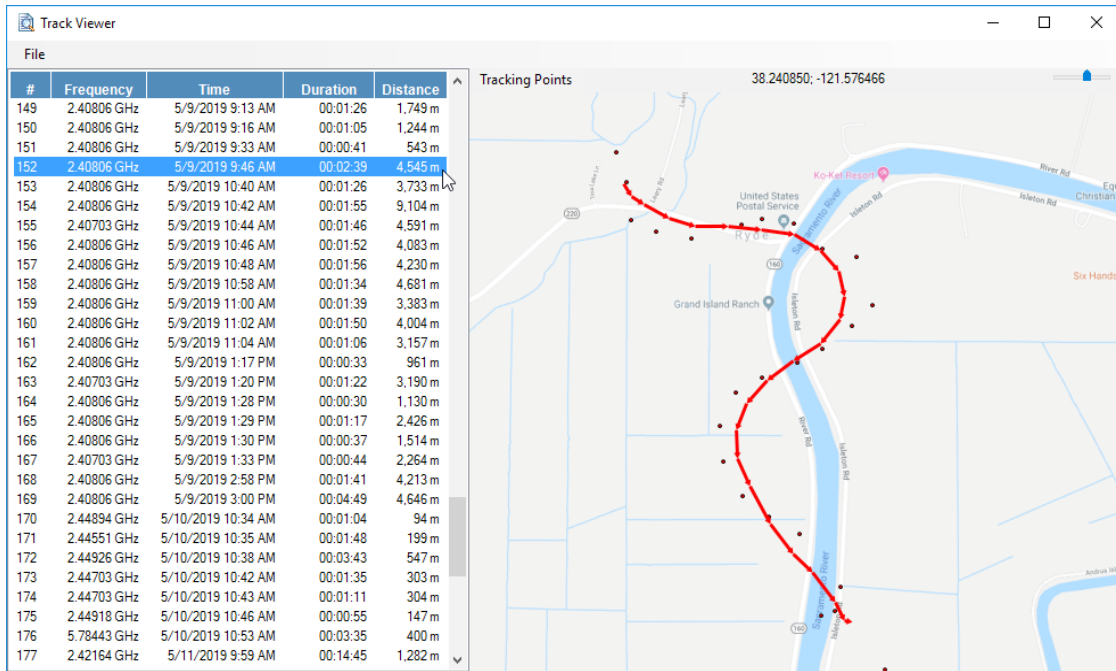


Figure 3. Tracker Viewer Display Example

Application Programming Interface (API)

Details of the AeroShield API can be found in the User Guide. The API provides all the functions and features to control both the AeroShield software and Remote Spectrum Monitor hardware. These building blocks allow the user to detect and continuously geo-locate a drone's RF signal.

In addition to the API, the User Guide outlines use of all features available in AeroShield. A few of these features include the following:

- Installation procedures for both hardware and software
- Use of the demonstration program
- How to setup either online and offline maps
- Setting up and operating the simulator

AeroShield RF Drone Application

AeroShield API Overview (Cont'd)

AeroShield Application — Option 482

Before communications can be established between hardware and software, the AeroShield option must be purchased for each Remote Spectrum Monitor deployed. The AeroShield application initially checks the hardware for the presence of this option. If the hardware is enabled with option 482, communications with AeroShield become possible. AeroShield is typically purchased at the same time as the Remote Spectrum Monitors are ordered or as an upgrade to existing hardware.

AeroShield Application Operation

The AeroShield application works by continuously monitoring the frequency spectrum utilized by the drone video signal. A mask is first created to establish a baseline for spectrum usage absent drone activity. Masks are automatically created for the frequency bands of interest to profile the RF environment. Examples of masks applied to signals in both the 2.4 and 5.8 GHz bands are shown in Figure 4. Any other custom frequency channels may be added by the user.

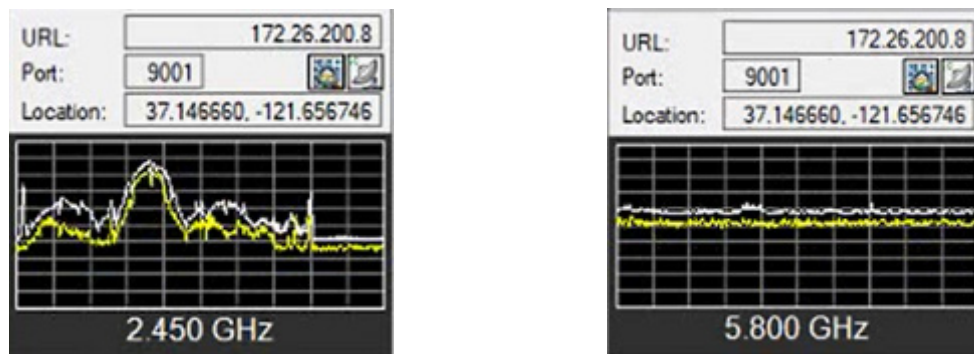


Figure 4. Examples of masks added to both the 2.4 and 5.8 GHz frequency bands

Additional features provided by the AeroShield application include:

- Email alerts sent to user when drone detection is confirmed
- Drone application can also be used in manual mode of operation
- While the drone is tracked, users can simultaneously view the drone position live on a map
- Reports are generated detailing the date/time of the drone incursion as well as its path taken

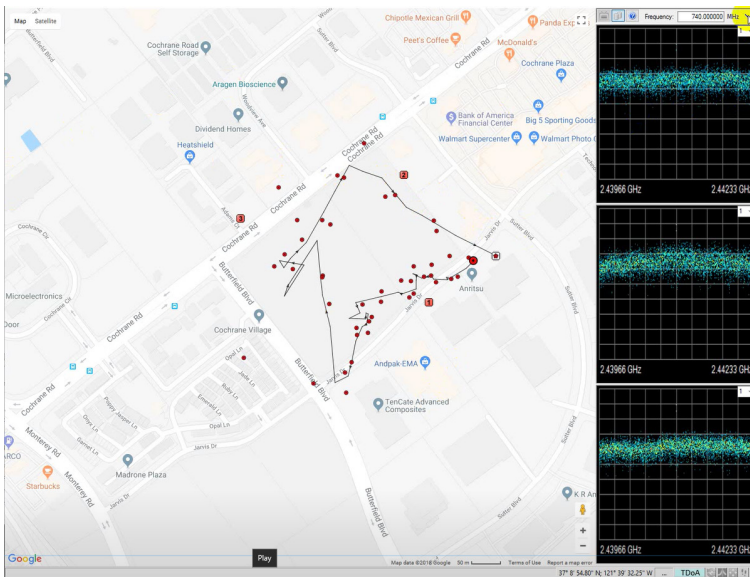
A sample drone flight trajectory is shown in Figure 5. The figure-8 flight path was saved as a Google Earth file.

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Figure 5. AeroShield Drone Flight Path Track (saved as Google Earth file)

A sample report is shown in Figure 6. GPS coordinates are also provided for use in any customer post-processing application. In this example, the drone was flown in a circular pattern.



- Friday, March 23, 2018: 37.1476898193359; -121.656852722168
- Friday, March 23, 2018: 37.1484298706055; -121.655349731445
- Friday, March 23, 2018: 37.1477203369141; -121.657615661621
- Friday, March 23, 2018: 37.1477317810059; -121.657615661621
- Friday, March 23, 2018: 37.1474647521973; -121.656997680664
- Friday, March 23, 2018: 37.1476593017578; -121.658096313477
- Friday, March 23, 2018: 37.1479187011719; -121.658546447754
- Friday, March 23, 2018: 37.1477737426758; -121.658538818359
- Friday, March 23, 2018: 37.1479911804199; -121.658485412598
- Friday, March 23, 2018: 37.1481628417969; -121.658966064453
- Friday, March 23, 2018: 37.1477966308594; -121.658599853516
- Friday, March 23, 2018: 37.1479568481445; -121.658782958984
- Friday, March 23, 2018: 37.1480751037598; -121.658966064453
- Friday, March 23, 2018: 37.1482849121094; -121.659088134766
- Friday, March 23, 2018: 37.148006439209; -121.659065246582
- Friday, March 23, 2018: 37.148006439209; -121.659057617188
- Friday, March 23, 2018: 37.148078918457; -121.659202575684
- Friday, March 23, 2018: 37.1481819152832; -121.659172058105
- Friday, March 23, 2018: 37.1478729248047; -121.659339904785
- Friday, March 23, 2018: 37.1482963562012; -121.659240722656
- Friday, March 23, 2018: 37.1483726501465; -121.659187316895
- Friday, March 23, 2018: 37.1479835510254; -121.659385681152
- Friday, March 23, 2018: 37.1480102539063; -121.659278869629
- Friday, March 23, 2018: 37.1480522155762; -121.659057617188
- Friday, March 23, 2018: 37.1480751037598; -121.658920288086
- Friday, March 23, 2018: 37.1482162475586; -121.658813476563
- Friday, March 23, 2018: 37.147819519043; -121.658737182617
- Friday, March 23, 2018: 37.1476821899414; -121.658584594727

Figure 6. Sample Drone Tracking Report

AeroShield RF Drone Application

AeroShield Features and Benefits

A list of AeroShield parameters and features is shown below. The AeroShield application, together with a minimum of three Anritsu Remote Spectrum Monitors, provides a robust RF solution for the detection and tracking of drones.

- Application continuously scans both 2.4 and 5.8 GHz ISM bands for drone activity (additional frequency channels settable by the user).
- Email alerts sent to users when a drone is detected and tracked.
- Automated spectrum profiling establishes a baseline in order to detect new RF drone signal activity.
- Drone detection and tracking reports provided in various formats (TXT, CSV, KML, and HTML).
- Drone positions plotted on map when measured and provided in a post-processed report. These reports consist of map that plots each drone position tracked along with date, time, and GPS coordinates of each measurement.
- Detection and tracking of the drone leverages its video downlink signal as the RF source.
- Transient RF signals may initiate false positive events. A user-selectable delay is available to mitigate possibility for false positive events.
- Track drone movement in real time on a map – each measurement location is indicated with a red dot then connected by a red line to minimize inherent noise, while a bullseye shows the most recent drone position.
- The operation of the drone detection may be set for either manual or automatic modes.
 - A manual mode is offered for initiating a tracking operation via user input. Users can stop tracking at any time as well as generate a report as needed.
 - For automatic mode, the drone application software will automatically detect, track, and generate a report.
- Both online and offline mapping capabilities are provided.

AeroShield RF Drone Application

AeroShield Operational Parameters

1. A minimum of three Remote Spectrum Monitors must be spaced no more than 500 meters apart in a triangular formation to maximize drone detection functionality (see Figure 7). Up to 24 Remote Spectrum Monitors can be supported for the detection phase to increase area coverage (the number of Remote Spectrum Monitors supported is a function of PC/server capabilities). Actual range is predicated on drone signal strength and environmental factors.
2. AeroShield seamlessly tracks a drone moving through multiple sets of remote spectrum monitors.
3. Tracking accuracy is typically under 25 meters.
4. The number of drone tracking measurements per unit distance is contingent on drone speed. Measurements are conducted every 1-2 seconds, depending on RF environment.
5. An Ethernet, microwave point-to-point, or fiber connection from the Remote Spectrum Monitors to the central server/PC should be used. Use of LTE modems is not recommended due to low uplink speeds offered by many operators.
6. AeroShield supports detection and tracking of one drone. When the application is in tracking mode, no monitoring of the spectrum is performed to detect additional drones entering the area of surveillance.
7. If the drone video downlink signal changes in frequency due to the RF environment, the Remote Spectrum Monitors will automatically stop the tracking process, discover the drone at its new frequency and resume tracking.

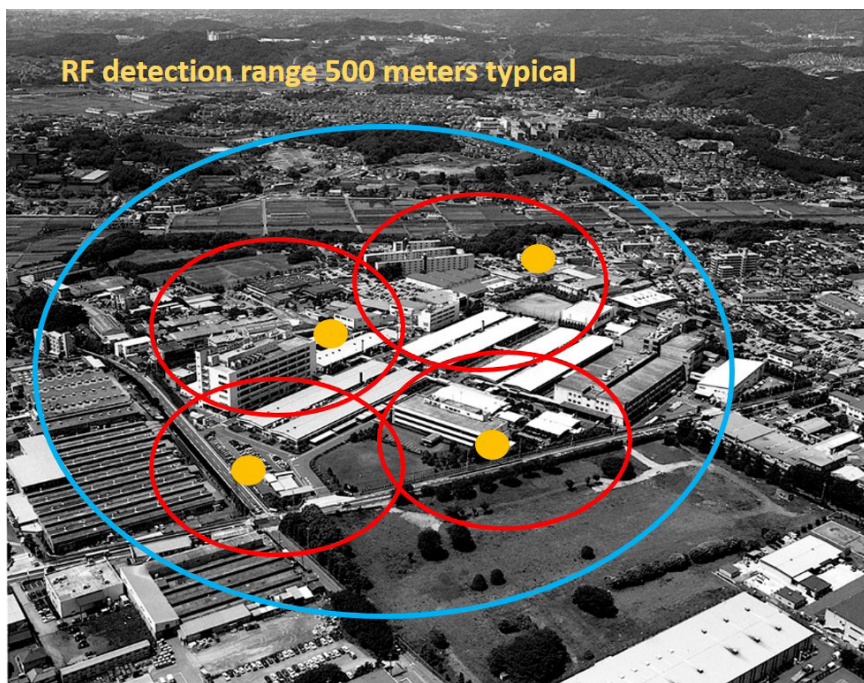


Figure 7. Configuration for drone detection

AeroShield RF Drone Application

Ordering Information

In order to use the AeroShield application, a minimum of three Anritsu Remote Spectrum Monitor must be purchased and enabled with the proper option (option 482).

MS27100A-0482	AeroShield enabled on MS27100A
MS27101A-0482	AeroShield enabled on MS27101A
MS27102A-0482	AeroShield enabled on MS27102A
MS27103A-0482	AeroShield enabled on MS27103A

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11410-01131, Rev. A Printed in United States 2020-01
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