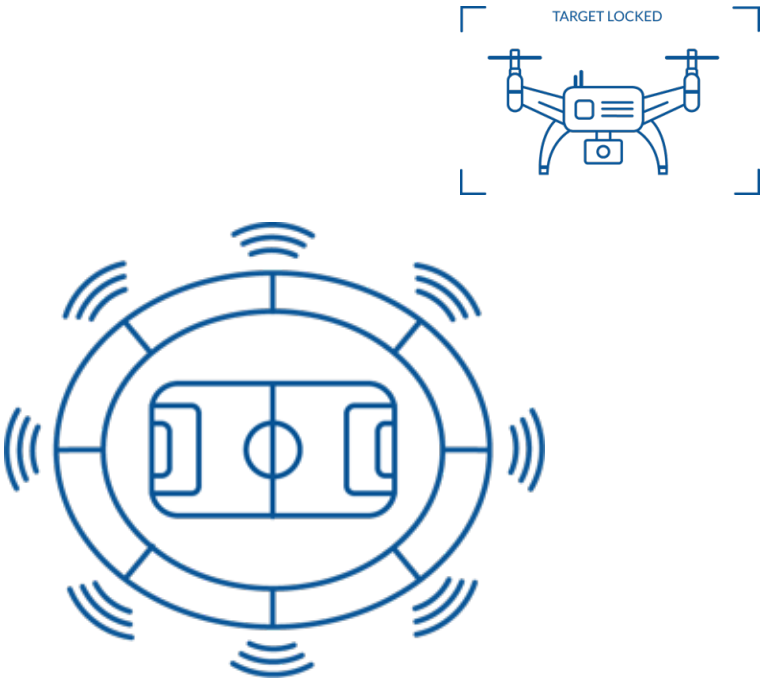
GROUP 1/2 DRONE DETECTION & DENIAL

Static and Mobile Force Protection



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OVERVIEW

The ARTEMIS is a revolutionary technology designed to combat group 1 Commercial-Off-The-Shelf Drones. The proprietary technology will detect and defeat all 2.4 and 5.8 GHz in both Wifi and RC spectrums. Counter to all currently fielded broadband and directional jamming solutions the ARTEMIS uses targeted technology that intelligently interrogates rogue drones while still remaining compliant with domestic laws and restrictions. It has no effect on other frequencies and waveforms in the spectrum.

COMPANY INFO

Vector Solutions, Inc. leverages industry strategic partnerships to provide the most tactically relevant, cutting edge technology to combat group 1 and 2 UAS. Vector is prepared to fully integrate short-range defeat and long-range detect solutions in the development of emerging counter UAS products; and to scale the technology to support multiple platform employment. Our proprietary solutions allow defense against multi-spectrum drone control platforms while not affecting other signals in the spectrum. Together we present the most cost-aware solution to a robust problem set, allowing for wide dissemination and deployment of solution.

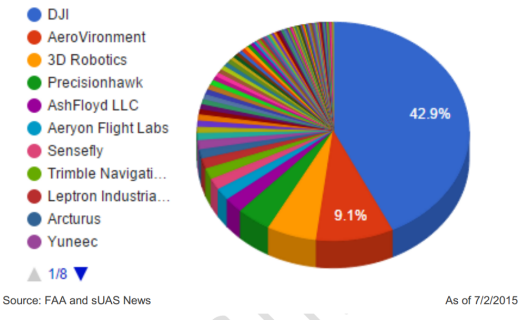
Vector Solutions, Inc. is a service-disabled veteran-owned small business specializing in tactical aircraft and aviation integration. Our team members pride themselves upon being industry leaders in multiple defense and aviation specialties, both air and ground maneuver elements. By leveraging diverse backgrounds we provide subject matter expertise in all facets of tactical aviation and defense measures. Having supported multiple government entities both as prime and sub-contractor, Vector is prepared to rapidly prototype, develop and field integrated counter-drone solutions.

BACKGROUND

Commercial-Off-The-Shelf (COTS) drone technology has become widely proliferated in recent years, with the majority of commercially available products present in group 1, as defined by the department of defense as 0-20 pounds. Control mechanisms are generally found on ISM channels in the 2.4 GHz and 5.8 GHZ, with many hobbyist drones control frequencies in either 433 MHz or 915 MHz.

UAS Group	Maximum weight (lbs) (MGTOW)	Nominal operating altitude (ft)	Speed (kts)	Representative UAS
Group 1	0–20	< 1,200 AGL	100	RQ-11 Raven, WASP
Group 2	21–55	< 3,500 AGL	< 250	ScanEagle
Group 3	< 1,320	< FL 180		RQ-7B Shadow, RQ-21 Blackjack, NAVMAR RQ-23 Tigershark
Group 4	> 1,320		Any airspeed	MQ-8B Fire Scout, MQ-1A/B Predator, MQ-1C Gray Eagle
Group 5		> FL 180		MQ-9 Reaper, RQ-4 Global Hawk, MQ-4C Triton

FIGURE 10 – REGISTERED AIRCRAFT



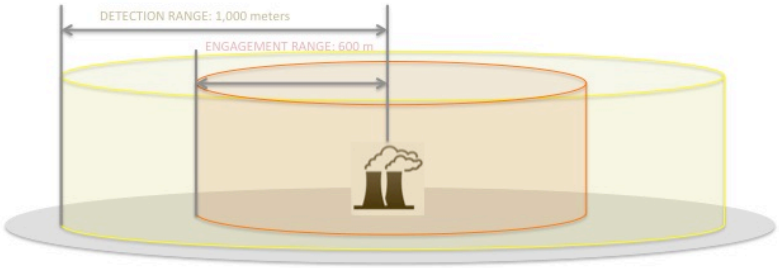
The most proliferated drone manufacturers are DJI, AeroVironment, Parrot, Precision Hawk and 3D Robotics. Recent changes in the market have seen emergence of hobbysist drones and a loss of market share by 3DR.

Ease of use and compatibility with existing hardware make 2.4 GHz WiFi drones the most popular as they can interface with personal electronic devices such as Android and Apple products.

SOLUTION

The ARTEMIS is a small, portable device designed to detect and defeat the majority of commonly proliferated group 1 drone systems (e.g. DJI, Parrot, 3DR, etc). Through passive interrogation of known drone control frequencies, the ARTEMIS identifies potential targets; implements control measures and forces the drone into its pre-programmed loss-of-link profile. Results of interrogation are provided through customizable user interface.

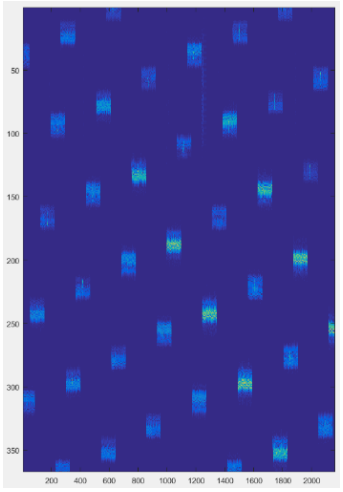
Our proprietary approach eliminates a pilot's ability to control the drone in or around a protected asset by integrating a high speed spectrum analyzer into its detect function. A short video showing some of the drone engagement capabilities can be viewed from the Vector website. We have a number of Provisional Patent submissions relevant to its drone threat management solutions and techniques. The ARTEMIS system passively monitors all communication frequencies around the protected area. Our proprietary detection algorithms will compare all radio frequency activity to a set of drone signal profiles. When a match occurs between a detected communication signal and a drone signal profile, the ARTEMIS system enters intercept mode. ARTEMIS is the only currently fielded solution available that has no impact on Wi-Fi, Bluetooth and Mobile Phones; and that can intercept and disable drones without damaging or destroying them. In the intercept mode the ARTEMIS consumes less than 5% of bandwidth in ISM band.



1. Published Engagement and Detection Ranges within FCC power limitations
2. Multiple networked units may be linked to increase coverage area

DETECTION AND INTERCEPT

• For standard 2.4 GHz drones, ARTEMIS monitors the spectrum for RC profile signals, analyzes and then reformats applicable signals and retransmits at a higher power than the drone's paired controller, effectively assuming Control of the specific drone. ARTEMIS' default "disrupt" command delivers a soft retreat result to avoid damage to the drone. We are currently developing the capability to guide and land the target drones as a configured option.



• For Wi-Fi controlled drones, ARTEMIS monitors the Wi-Fi networks available and looks for specific Organizationally Unique Identifiers (OUI) that define a drone. Two disable options are then available. One is to track the drone then log onto the drone and shut down the Linux computer; the second is to break the connection between the drone and the Wi-Fi network. The latter delivers a soft retreat solution, the former is a destructive disablement.

• Drones operating in 400 and 900 MHz ISM bands are currently targeted through a secondary intercept system, housed in separate casing. The technology replicates 2.4 and 5.8 GHz protocols, but because of the processing and synchronization, they are accomplished in an external unit.

CONFIGURATION

The ARTEMIS is designed as a stand alone unit, capable of defending against a single drone or swarm of drones. Range is limited by power and unit location. However, multiple units can be networked together to increase range and defense mechanisms.

USER INTERFACE/ USER EXPERIENCE

Customizable Application Programming Interfaces are available, with immediate access to a WiFi enabled portal. Current programming allows all customers to receive e-mail or text message alerts of drone presence and intercept.

For customers currently using or able to acquire ATAC user license, Vector has integrated a proprieatary API for Android Terminal Assault Kit (ATAK) plugin.

Our software engineers are able to rapidly interface to existing command and control networks to provide ARTEMIS output information into the user system. Examples of supportable interfaces are MAFIA, PFED Inc II, THS, Killswitch and APAS.

COMPLIANCE

ARTEMIS is forecast for compliance certification through Conformité Européene (CE), with reciprocity for distribution and operation in the United States. For service-oriented contracts, Vector retains the liability of such operations in the US.

DESIGN AND IMPLEMENTATION

ARTEMIS was released to market in September 2016. ARTEMIS will be followed by two enhanced versions: the ARTEMIS 2 in Q3 2017 and the ARTEMIS 3 in Q1 2018. All solutions are modular and can support both commercial and government/military use. Each unit can be configured for US and International uses via settings on the ARTEMIS unit. Our products can be deployed to protect fixed locations and/or mobile assets, and will be delivered with the equipment to support one or both scenarios. The solutions are automated and require no training, expertise or in field support to operate. However Field Support Representatives are available for installation as well as to optimize tactics, techniques and procedures necessary to implement emerging technology. Our extensive research has determined best practices necessary to field the product.

Example detection and engagement data. These examples utilize low power in line with regulatory limits. Increased distances can be delivered in environments where those limits are not applicable.

Drone	Detection Range	Intercept Range	Takeover Range	Detection Period
DJI Phantom 1	2600 ft	1650 ft	X	5s
DJI Phantom 3 Profesional	2600 ft	1625 ft	X	5s
Blade Chroma	2600 ft	1660 ft	X	4s
Parrot AR	2600 ft	X	400 ft	1s

Category 1 – Standard Radio Controlled drones.

Currently the biggest immediate threat to safety and privacy, these operate primarily with a human controller directing a drone using line of sight or FPV outside the line of sight and are unencrypted. The vast majority of these devices use the 2.4 Gigahertz frequency band. Some RC drones utilize encryption or RC protocols with CDMA or DSSS to help prevent the drone being taken over by another operator. Many use FPV to aid control. A portion of these devices (Parrot for example) utilize Wi-Fi as the control connection to enable smartphone use as the controller.

We currently have solutions for all the above threats tested and being commercialized for availability in late Q3 2016 in the ARTEMIS. These solutions target specific RF/RC properties while allowing other RF/RC signals or devices including Bluetooth and Wi-Fi. Our technology does not broadband jam, rather dissects and replicates specific known frequency components to include SSID and MAC. The primary method is to continually, passively monitor the spectrum. When a drone profile signal is detected, it is automatically stripped and monitored until a complete hopping and repeatable profile is acquired. The signal is then pushed through a proprietary adaption process and allocated to the transmission module. The resultant signal provides just enough noise around the baseline input signal to be unreadable by the receiving drone thus delivering a “loss of signal” behavior by the drone. Multiple received drone signals of the same type can be embedded in one adapted disruption signal enabling the solution to handle enhance its swarm handling capabilities.

Category 2 – Autonomous Drones utilizing Waypoints and FPV or telemetry.

These drones operate entirely like an aircraft that has its automatic flight control system engaged in that the waypoints are embedded in the drone’s computer memory and the drone is navigated by comparing the straight line path from its current position to its next Waypoint via GPS. The drone sends either telemetry and or FPV back to the operator for numerous reasons and so these types of drones have a transmission component to their operation. These drones utilize mainly 5.8 Gigahertz for FPV transmission or 433 and 900 megahertz for long distance. We currently have detect capability for these frequency bands and are working on similar Engagement solutions as outlined for Category 1 above. This capability will be included in our ARTEMIS 2 scheduled for commercial availability in Q3 2017.

TECHNOLOGY MATURITY ASSESSMENT

The ARTEMIS is currently assessed at Technology Readiness Level 7. Our prototype has reached planned operational system and is currently available for purchase and dissemination. The system prototype has been demonstrated in actual operational environments .The system performed as expected with the tested air vehicles. The ARTEMIS has been tested in a private 500-Acre test range near San Diego, CA (depicted below). During operational assessment, we have tested against multiple

drone systems, completed static and dynamic intercepts, and determined optimal coverage and overlay design. Vector Solutions will field and test the ARTEMIS in urban, desert and mountainous regions throughout Q4 2016 and Q1 2017.

INTEGRATION ASSESSMENT AND SCHEDULE

ARTEMIS has completed final testing and validation. Low Rate Initial Production has begun and full production is scheduled for December 2016. Vector is currently able to field and integrate into full-scale solutions for domestic and theater applications.

Follow-on products (ARTEMIS 2 and 3) are scheduled for production in 2017. The ARTEMIS 2 is currently being developed and tested. Integration feedback from customer demand can be incorporated into this solution through March 2017.

COST AND AFFORDABILITY ASSESSMENT

ARTEMIS is customizable to meet a customer's specification based on a hierarchy of prevalent threats. However, a baseline model will be produced to meet UUNS or short-cycle sole-sourced contract vehicles. The initial unit cost is estimated to retail at US $95,000 but is subject to manufacturing discounts based upon purchase quantity. Sales come with a 180-day Warranty from date of FOB. Post Warranty period, an annual Maintenance and Support program is available priced at 30% of sales price. This provides a contractor logistics support service where a replacement at the LRU level. It is provided via a swap program for any failed unit or solution component. There is no in-field maintenance or repair scheme required and the system runs a self-test when turned on and indicates an issue to the operator. Maintenance will only be available at authorized manufacturing facilities. No training is required to set-up and operate the solution, or special equipment needed. Optimization assistance and training will be an available option.

MANUFACTURING

The ARTEMIS is designed and final manufacturing is completed in the US with FCC compliant parts. The proprietary software algorithm and associated computing equipment is manufactured in the UK. The total unit is CE compliant and available for distribution in the US.

SPECIFICATIONS

Dimensions	22 x 11 x 5 inches
Weight	<10 pounds (without battery)
Power Consumption	Average-2 W; Peak <65 W
Spectrum (Optional Config) (Optional Config)	2.4 and 5.8gGHz 421-441MHz 915MHz
Power Supply	AC-120/240 DC-12VDC
Power Output during Intercept	100 mW per 100 KHz during frequency hopping
Temperature Range	-40 to 165F
Detection Range	Greater than 900m*
Intercept Range	Greater than 500m*
Concurrent Intercept	Up to 5 drones
Antenna (directional)	
Dimensions	10 x 6 x 6 in
Weight	< 6 lbs

*Limited by FCC power output restrictions for domestic use

ADDITIONAL THREAT ASSESSMENT

Vector Solutions integration experts and FSRs have the ability to rapidly integrate the ARTEMIS into existing infrastructure and emerging technology solutions. While the Vector team remains committed to manufacturing leading counter-drone technology, we are capable of integration into kinetic response mechanisms. Our proprietary detect and defeat software allows stand-alone or integrated solutions.

ARTEMIS is designed to work as a standalone solution or as part of layered threat management system. To that end, ARTEMIS will be able to accept RF signal data from external systems to initiate engagement, and, will be capable of providing detection data to external systems to support capture of the drone controller or drone engagement using non-ARTEMIS means.