



Game of Drones

PUTTING THE EMERGING 'DRONE DEFENSE' MARKET TO THE TEST

DEF CON 25 (2017) – LAS VEGAS, NV



July 29, 2016

Presented by:

- Francis 'tastic' Brown
- David Latimer

Bishop Fox, LLC
www.bishopfox.com

Agenda

OVERVIEW

1. The **Danger Drone** by Bishop Fox
2. Crazy State of **Drone Defense Market**
3. Drone **Legal** Landscape
4. **Future** Is Gonna Be Awesome



No Such Thing as Drone Defense 'Best Practices'

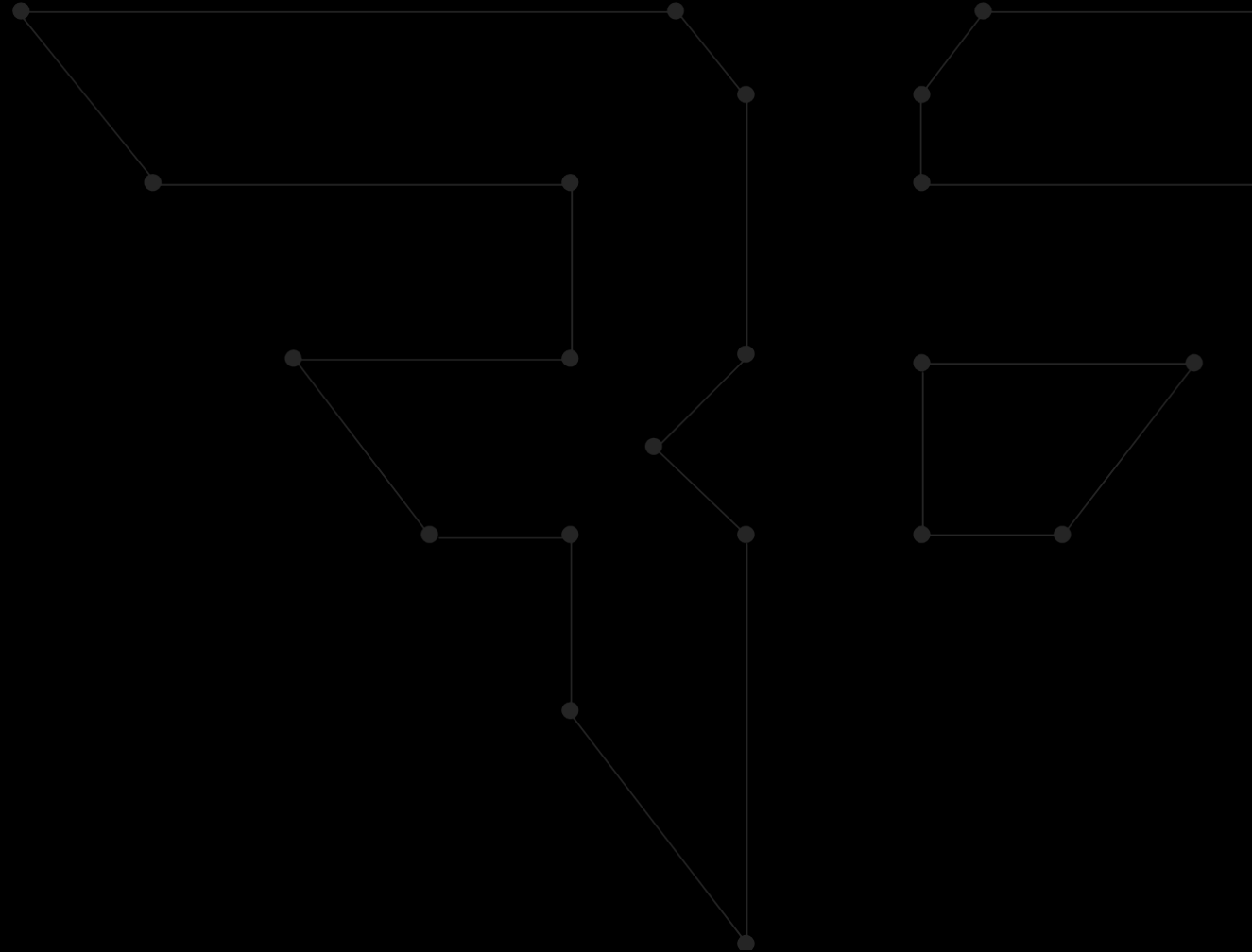
MOTIVATIONS BEHIND THIS TALK

- Companies are beginning to implement **1st generation drone defense** solutions / products
 - Previous proof of concepts have already demonstrated that the threat is real
- There **are no 'best practices'** or proven methods for defense against drones
- **Practical pentesting tools** are needed to test the effectiveness of these new 'drone defense' deployments
 - Separating real countermeasures from **snake oil**
 - Must be cheap, easy to build, and easy to learn how to use **for security professionals**

Why?

DANGER DRONE

FOR PENETRATION TESTERS



Welcome to the Danger Drone

FREE PENTESTING DRONE FROM BISHOP FOX



- <https://www.bishopfox.com/resources/tools/drones-penetration-testers/>



The Hacking Drone for Penetration Testers

© BISHOP FOX



Raffle: <http://tiny.cc/dangerdrone>

Parts – Hacking ‘Over the Air’

HACKING PERIPHERALS – ADD-ON USB EXAMPLES



- Custom 3D printed “3rd shelf” is convenient for attaching hacking USB peripherals:



WiFi Pineapple



3D Printed 3rd Shelf



TP-Link TL-WN722N

Parts – Hacking ‘Over the Air’

HACKING PERIPHERALS – **ADD-ON USB EXAMPLES**



- Wi-Fi
- Bluetooth
- RFID / NFC
- ZigBee
- Software Defined Radio
- Wireless Keyboard Sniffers
- ...



SENA UD100 Bluetooth USB



Bluetooth 4.0 USB Micro Adapter (CSR 8510 Chipset)



Wi-Spy DBx Pro – USB Spectrum Analyzer



WiFi Pineapple Nano



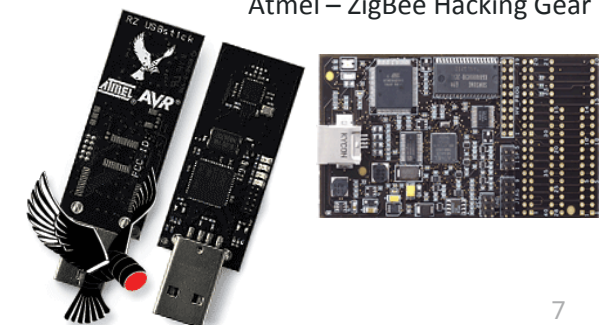
TP-Link TL-WN722N

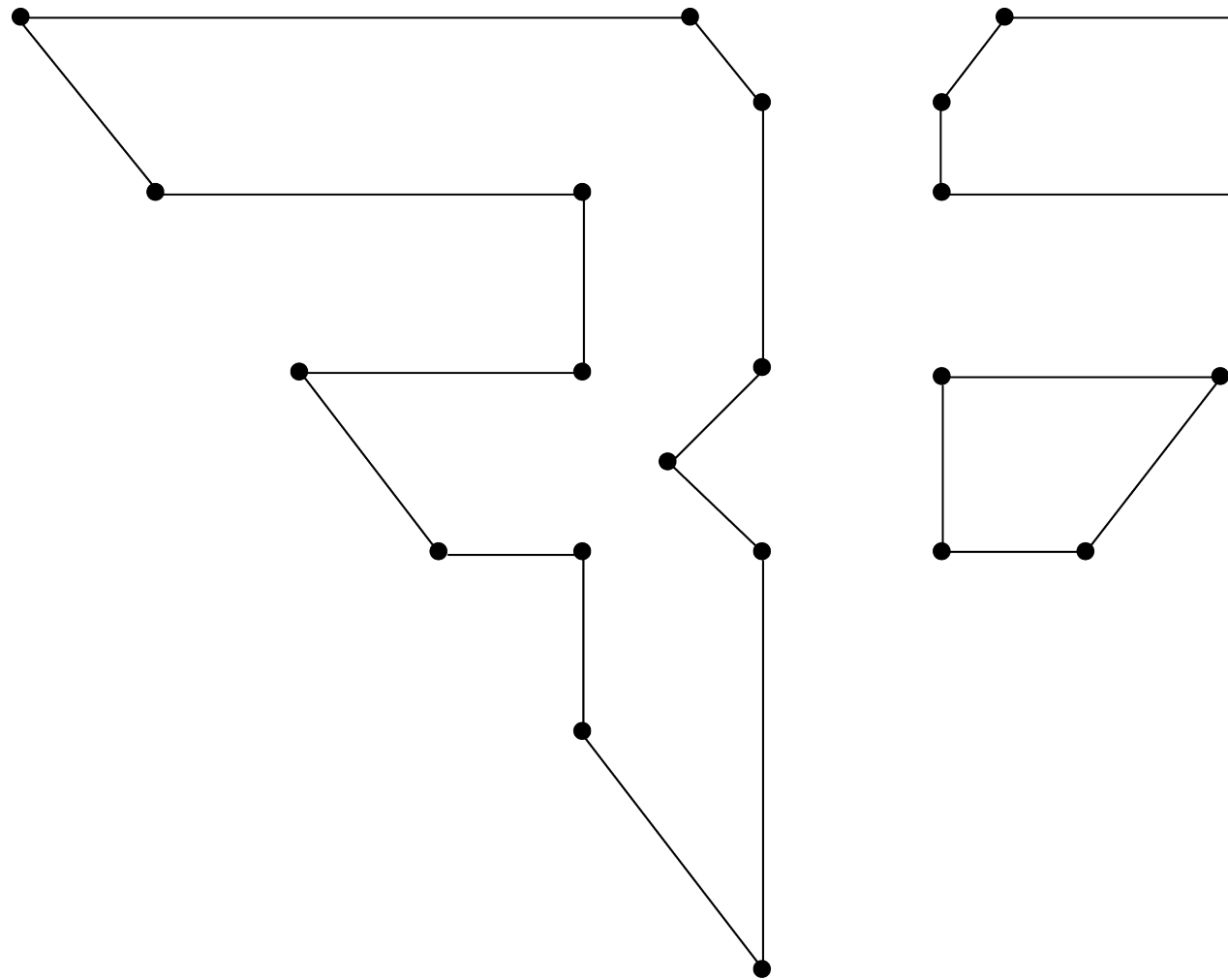


Asus USB-N53 (dual band)



HackRF One: Software Defined Radio





DEMO



DEMO: Exploiting Wireless Mouse via Drone

FLY-BY DRONE EXPLOITATION, HIT AND RUN HACKING

- <http://dangerdrone.io/>



The Hacking Drone for Penetration Testers

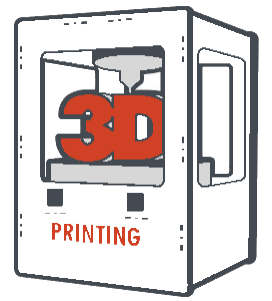


<https://github.com/insecurityofthings/jackit>

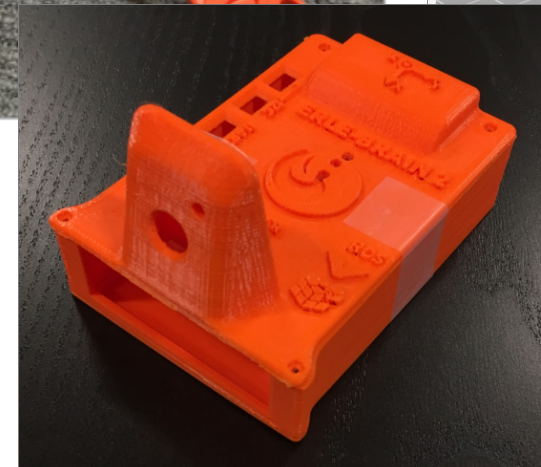
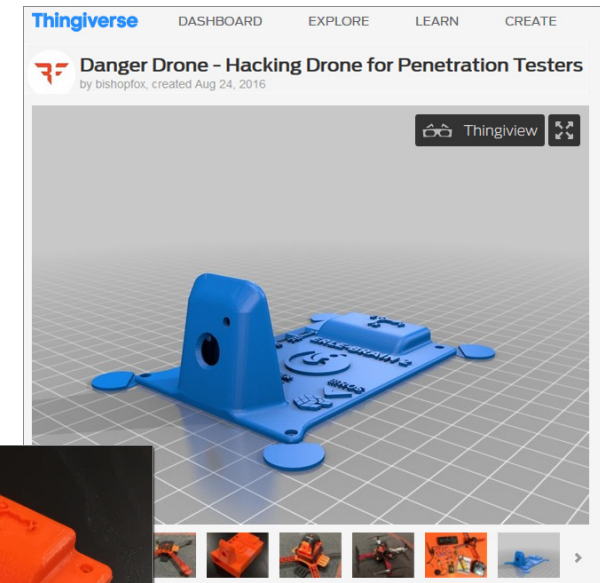
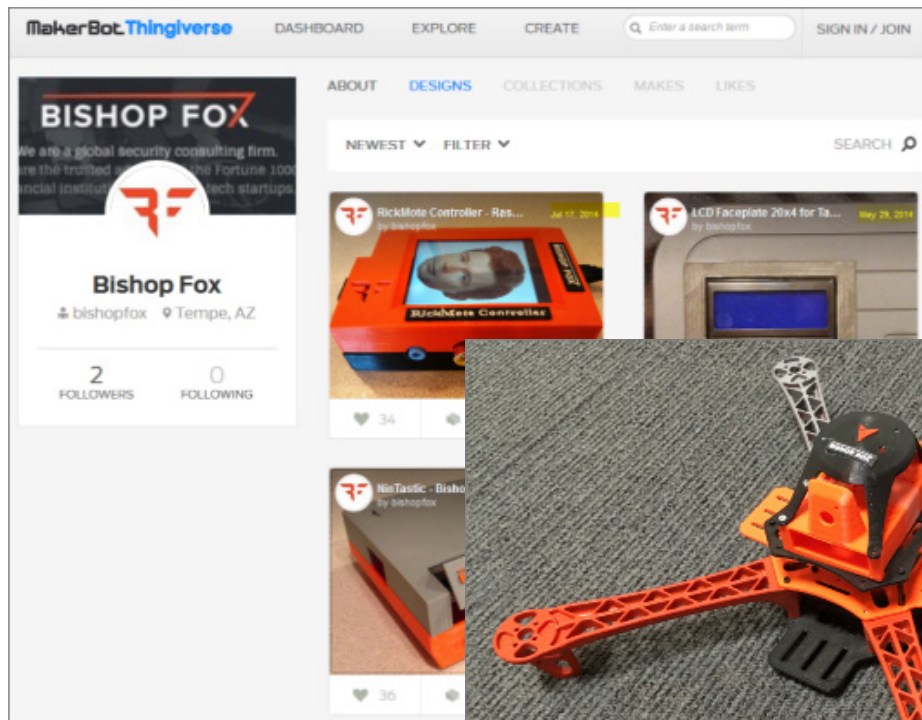
3D Designs

CHEAPER, LIGHTER, AND CUSTOMIZABLE (EXTRA SHELVES / SPACE)

MakerBot Thingiverse

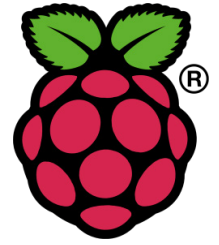


- <http://www.thingiverse.com/bishopfox/designs>



Drone Brain = Raspberry Pi

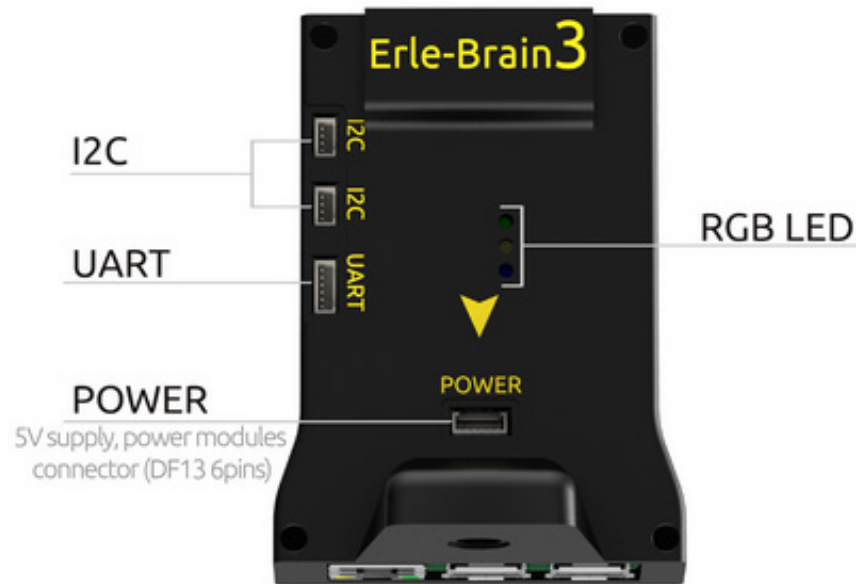
HEAVILY SUPPORTED IN **DRONE** AND **HACKER** COMMUNITIES



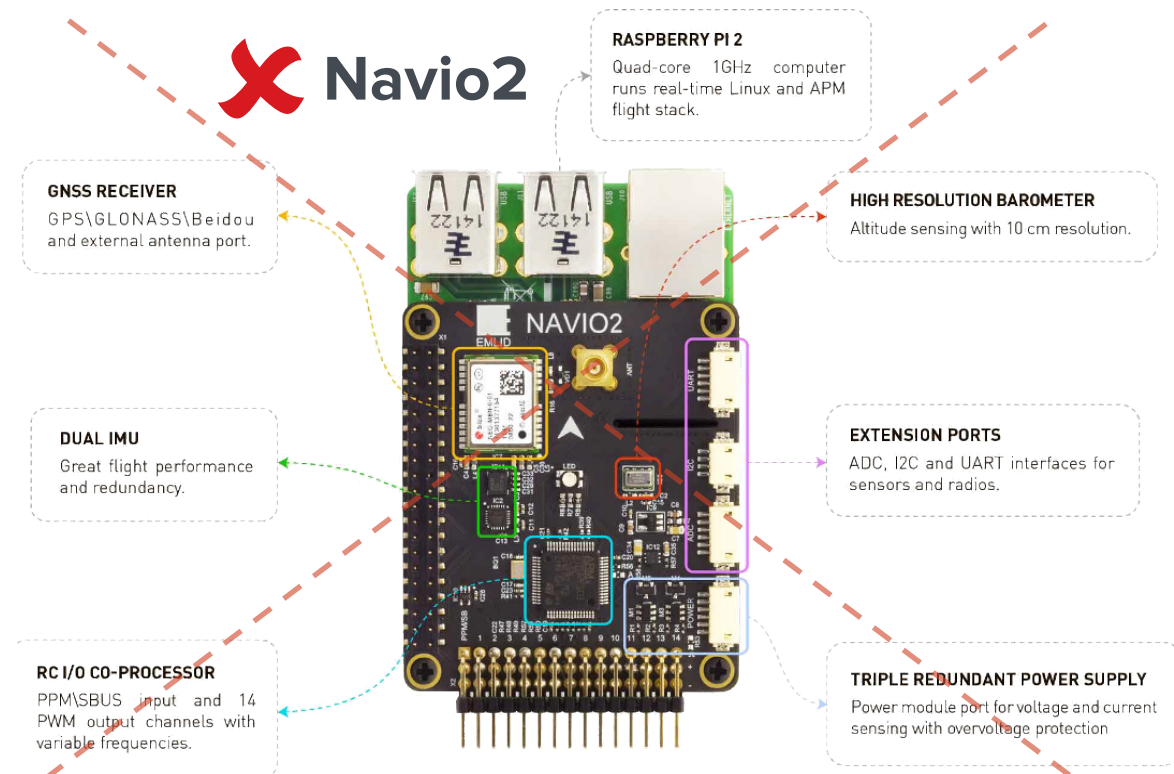
- Raspberry Pi based copters have the obvious appeal of being heavily developed and supported by both the drone and hacker communities.
- The 2 most popular Raspberry Pi based flight controllers are the **Erle-Brain 3** and the **Navio 2**:



Erle-Brain 3



Navio2



Parts and Pieces – Piecemeal

CHEAPER TO BUILD YOURSELF - SLIGHTLY



- Essentially starting with **working / flying Erle-Copter** and then **adding hacking** capability (without breaking flying ability):
 - Adding Hardware – e.g. USB peripherals to Raspberry Pi, shelves
 - Adding Software – e.g. drivers, config changes, installs, etc.

\$490.53

Danger Drone - Individual Parts Costs

#	Description	Cost	Product Link
1	Flight Controller	\$199.00	Erle Brain 2, a Linux brain for robots and drones
2	GPS	\$50.68	Ublox Neo-M8N GPS with Compass
3	RC Controller and Receiver	\$49.00	Turnigy TGY-i6 AFHDS Transmitter and 6CH Receiver (Mode 2)
4	Motors x4	\$45.99	Tiger Motors 6th Anniversary Limited Edition 4x MN2213 Motors + 2 p
5	Telemetry	\$40.88	HobbyKing - HKPilot Transceiver Telemetry Radio Set V2 (915Mhz)
6	Battery (4 cell)	\$39.99	FLOUREON 4S 35C 14.8V 5500mAh Li-Polymer RC Battery Pack (5.98*
7	ESCs x4	\$23.57	Amazon - Andoer 4Pcs Simonk 30AMP 30A SimonK Firmware Brushles
8	Frame (F450)	\$19.99	Amazon.com - RipaFire F450 4-Axis Multi-Rotor Quadcopter Flame Air
9	Power Module	\$14.29	Amazon - Ericoco Power Supply Module w/BEC APM2 2.5 APM Flight C
10	PPM Encoder	\$7.14	HobbyKing - PPM Encoder Module HKPilot 32
Total:		\$490.53	



Bishop Fox – Danger Drone Research – Parts Lists, Assembly, and Config Guidance see:

- <https://www.bishopfox.com/resources/tools/drones-penetration-testers/>

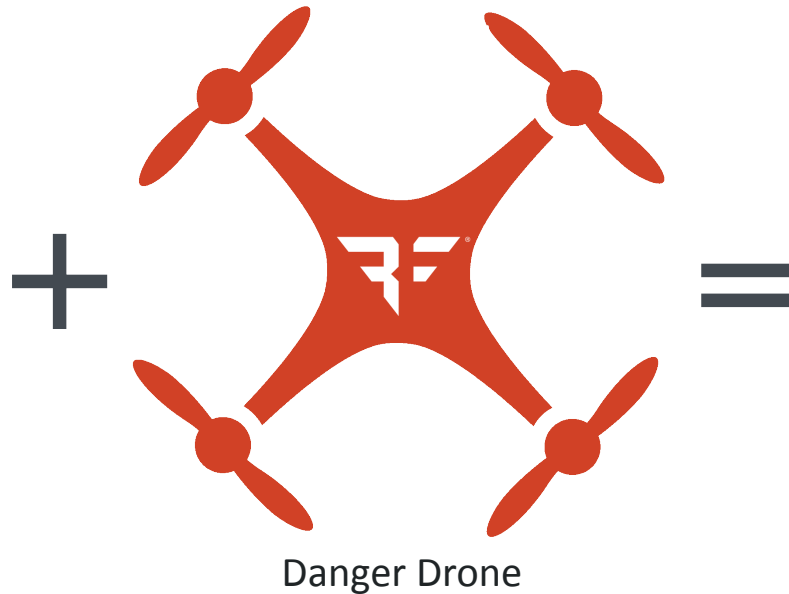
IoT = Target Rich Environment

LOTS OF NEW TARGETS FOR '**OVER THE AIR**' ATTACKS

- Ideal platform to launch '**over the air**' attacks against new IoT products popping up in both the home & office
- Drone hacking threats need to be considered by consumers, security pros, and **IoT product manufacturers**



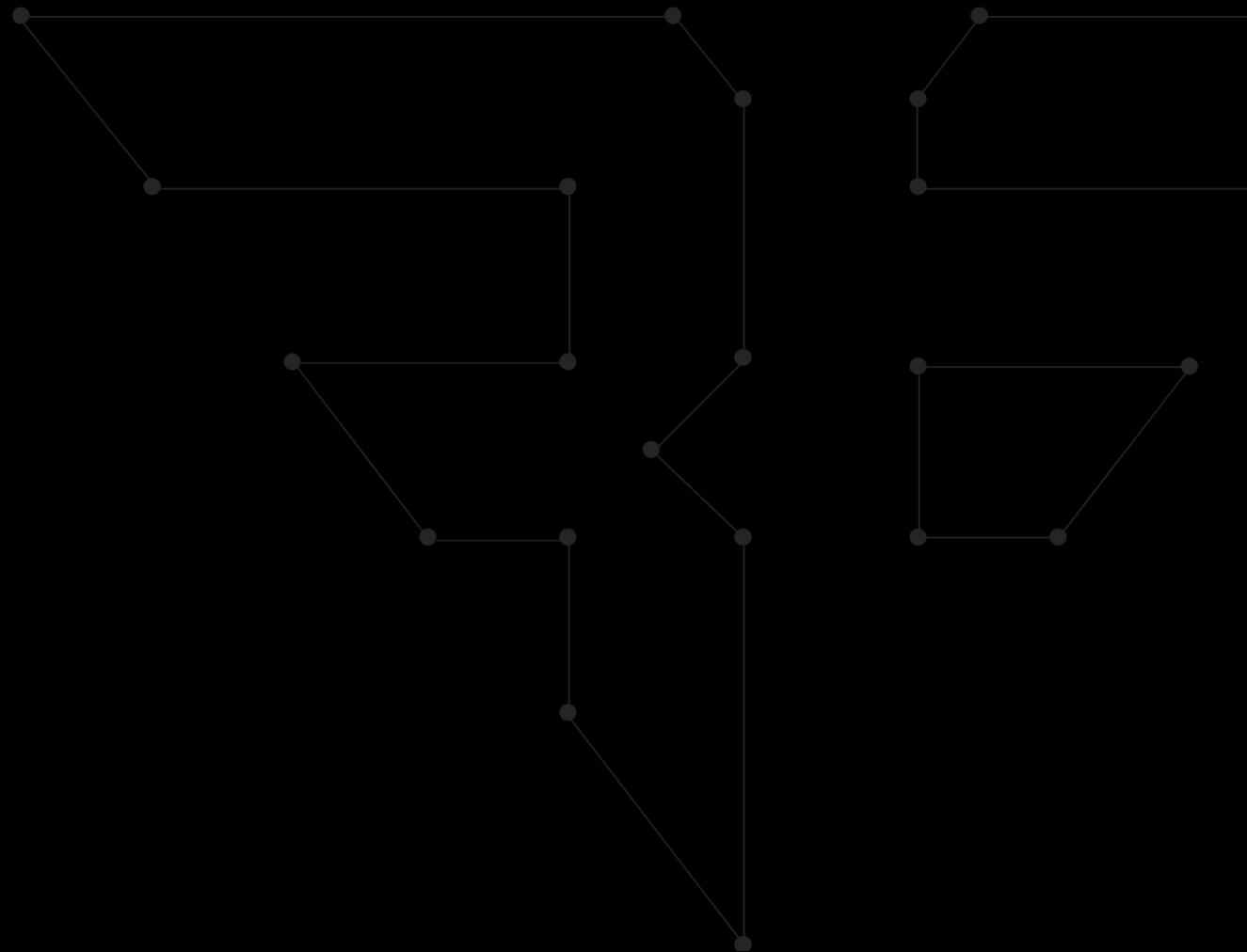
Internet of Things (IoT)



Target Rich Environment

IN THE NEWS

DRONE-STRAVAGANZA



Data Exfiltration Via Drones and Lights

THREATS EVOLVING, NOW DEFENSES NEED TO AS WELL



Feb 2017

Researchers exfiltrate data by blinking the LEDs on the hard drives

February 23, 2017 By Pierluigi Paganini

A team of Israeli researchers has devised a new technique to exfiltrate data from a machine by using a malware that controls hard drive LEDs.

Across the years, numerous studies demonstrated that it is possible to exfiltrate data from [air-gapped networks](#) in [various ways](#) and security experts warned to cover our webcam to avoid being spied by sophisticated malware.

Now a group of researchers from Ben-Gurion University of the Negev's Cyber Security Research Center has devised a new technique to exfiltrate data from a machine by using a malware that controls hard drive LEDs.

"We show that a malware can indirectly control the HDD LED, turning it on and off rapidly (up to 5800 blinks per second) – a rate that exceeds the visual perception capabilities of humans. Sensitive information can be encoded and leaked over the LED signals, which can then be received remotely by different kinds of cameras and light sensors." reads the [paper](#) published by the researchers. "Compared to other LED methods, our method is unique, because it is also covert – the HDD activity LED routinely flickers frequently, and therefore the user may not be suspicious to changes in its activity."

paper: <https://arxiv.org/abs/1702.06715>



LED-it-GO. Jumping the Air-Gap with a small HardDrive LED

Cyber Security Labs @ Ben Gurion University

Subscribe 1,757

200,950 views

Add to Share More

Published on Feb 22, 2017
By Mordechai Guri, Boris Zadov, Yuval Elovici
paper: <https://arxiv.org/abs/1702.06715>

SecurityAffairs.co - Researchers exfiltrate data with drone by blinking the LEDs on the hard drives - 23Feb2017

• <http://securityaffairs.co/wordpress/56583/breaking-news/data-exfiltration-hdd-leds.html>

Military and Drones

THREATS EVOLVING, NOW DEFENSES NEED TO AS WELL



Mar 2017

[The Verge - A US ally shot down a \\$200 drone with a \\$3 million Patriot missile - 16Mar2017](#)

A US ally shot down a \$200 drone with a \$3 million Patriot missile

This will be a bigger problem as more drones show up on the battlefield

by Andrew Liptak | @AndrewLiptak | Mar 16, 2017, 10:13am EDT



MISSILE

**USING A \$3.4 MILLION MISSILE TO DESTROY
A CIVILIAN DRONE IS OVERKILL**

Earlier this week, General David Perkins, the commander of the US Army Training and Doctrine Command (TRADOC) [spoke at the Association of the US Army's Global Force symposium](#), where he discussed the threats that the US military would begin to face in the coming years. One notable example is how a US ally recently shot down a \$200 consumer drone with a Patriot Missile.

Perkins' talk during the symposium focused on the complexity of a military organization in the field, and how the interconnected nature of air, ground, and sea forces can lead to a fragmented response to a threat between the commanders who are in charge of specific areas. He specifically spoke about the necessity for commanders to address threats holistically. He used one specific example of how this occurs on the battlefield: hostile, civilian Unmanned Aerial Systems (UASs). "The gut instinct was," he explains, "that's an air defense problem, because they're in the air."



This drone was used by Iraqi government forces against ISIS in Mosul. It shows the the weapon carriage and arming method, using two attachments. The weapons are maintained safe and could be armed just before takeoff.

"Flying IED's"

Prison Break Thanks to Drone

DRONE-SHANK REDEMPTION



July 2017

[USA Today - Jimmy Causey, escaped inmate, likely used wire cutters dropped by drone - 07July2017](#)

The USA TODAY logo, featuring a blue circle with a white dot inside, followed by the text "USA TODAY" in bold, black, sans-serif font.

Search

Prison officials say escaped inmate likely used wire cutters dropped by drone

Doug Stanglin, USA TODAY Published 2:38 p.m. ET July 7, 2017 | Updated 3:05 p.m. ET July 7, 2017

A mugshot of a man with short dark hair and a beard, wearing a dark blue shirt, against a light blue background.

(Photo: Williamson County, Texas, jail via AP)

A fugitive South Carolina inmate recaptured in Texas this week had chopped his way through a prison fence using wire cutters apparently dropped by a drone, prison officials said Friday.

Jimmy Causey, 46, fled the Lieber Correctional Institution in Ridgeville, S.C., on the evening of July 4th after leaving a paper mache doll in his bed to fool guards into thinking he was asleep. He was not discovered missing until Wednesday afternoon.

Causey was captured early Friday 1,200 miles away in a motel in Austin by Texas Rangers acting on a tip, [WLTN-TV reported](#).

Officers found a semi-automatic handgun, shotgun, ammo, four cell phones and \$47,000 in cash on Causey, who also carried a South Carolina ID.

"We believe a drone was used to fly in the tools that allow(ed) him to escape," South Carolina Corrections Director



Forced to 'Let It Burn'

FIRST RESPONDERS AND EMERGENCY SERVICES NEED DRONE DEFENSES



July 2017

[AZCentral.com - Arrest made in drone flights over Goodwin Fire - 01July2017](#)

The face of the new threat of rogue drones.

azcentral.
PART OF THE USA TODAY NETWORK

Arrest made in drone flights over Goodwin Fire

BrieAnna J Frank, The Republic | azcentral.com Published 3:04 p.m. MT July 1, 2017



(Photo: Yavapai County Sheriff's Office)

A 54-year-old Prescott Valley man suspected of flying a drone that grounded Goodwin Fire firefighting efforts last week has been arrested.

The Yavapai County Sheriff's Office reported Saturday that Gene Alan Carpenter was arrested on charges of endangerment and unlawful operation of an unmanned aircraft.

Carpenter is accused of endangering 14 aircraft and air crews as well as ground fire crews with a "substantial risk of imminent death or physical injury" by flying a drone in the fire's airspace.

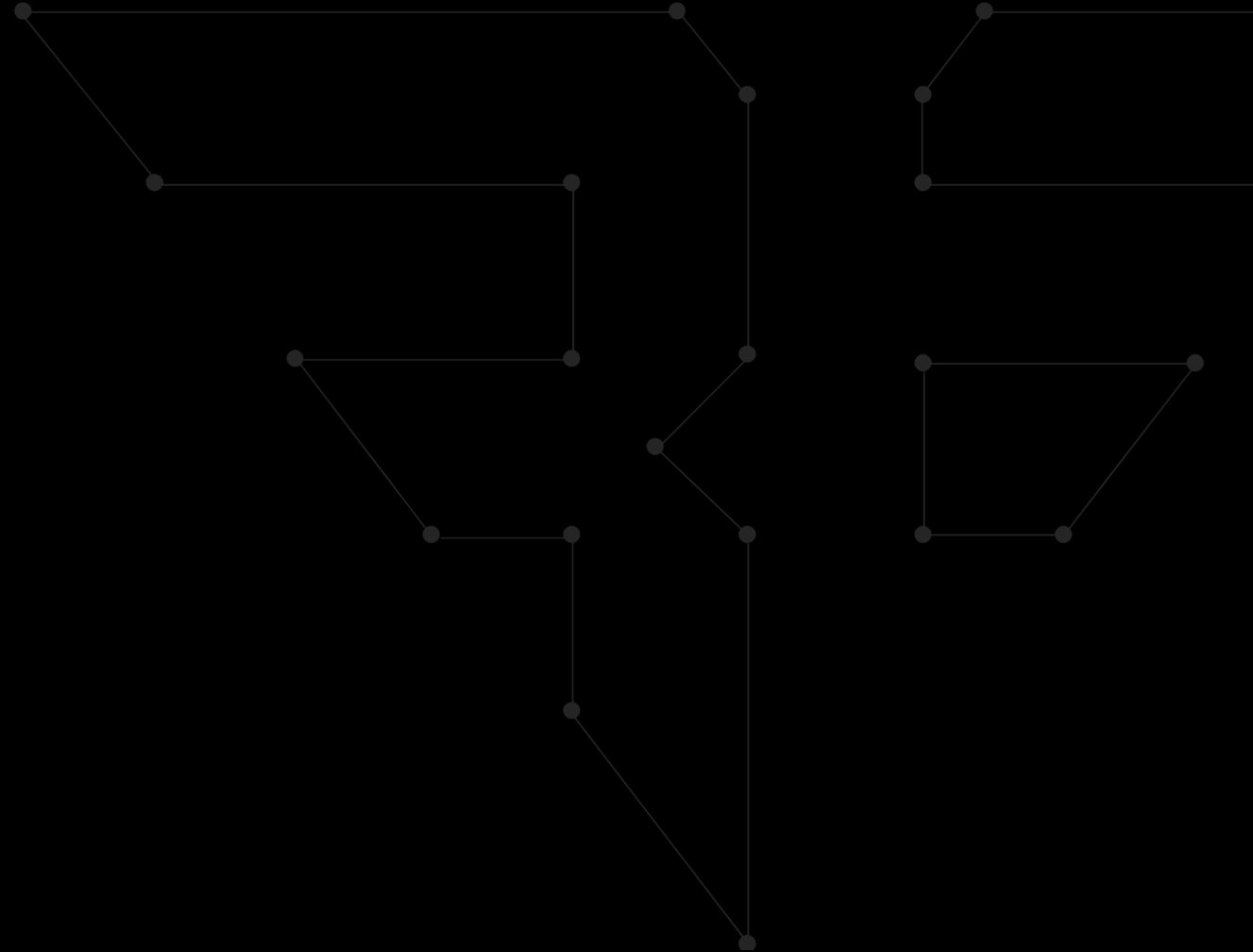
RELATED: Drone forces firefighting aircraft at Goodwin Fire to land

The Arizona Legislature and Gov. Doug Ducey last year passed a law making it illegal for a drone to interfere with emergency or law-enforcement efforts. There are also federal laws regulating drone flights.



DRONE DEFENSE MARKET

EMERGING MARKET OVERVIEW



Drone Defenses - Categories

BY PRODUCT TYPE - EMERGING LEADERS IN 'ROGUE DRONE' DEFENSE



PREDATOR BIRD



DRONE NETTING



DRONE SHOOTING



DRONE SHOOTING



JAMMING



EMP



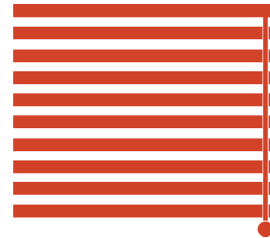
CYBER



GEOFENCING



NO-FLY ZONES



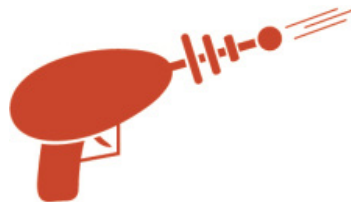
SHUTTERS



CONFETTI GUN



MISSILE



LASER

Examples: Common Drone Defenses

INSIDE LOOK AT WHO ARE CONSIDERED EMERGING LEADERS IN 'ROGUE DRONE' DEFENSE



Eagles Trained to Hunt Drones



Net Cannons



Hunter Drones Shooting Nets



Drones Swooping with Big Nets



Jammer Cannons



Hunter Drones Shooting Nets

Drone and Defenses Markets Growing

EVERYONE WANTS A PIECE OF THAT FUTURE ANTI-DRONE DEFENSE MARKET \$\$\$



[Fortune.com - Drone Sales Are about To Go Crazy - FAA Projects](#)

[Drone Sales To Soar By 2020 - 25Mar2016](#)

- “The FAA believes that 2017 will be the big turning point in drone adoption by businesses, which use them for everything from scanning power lines to inspecting rooftops for insurance companies. Commercial sales are expected to reach 2.5 million, after which sales will increase only slightly for the next few years.” -- Forbes

https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/Unmanned_Aircraft_Systems.pdf

- “Drone sales are expected to grow from 2.5 million this year to 7 million in 2020, according to report released this week by the Federal Aviation Administration... Hobbyist sales will more than double from 1.9 million drones in 2016 to 4.3 million in 2020, the agency said. Meanwhile, business sales will triple over the period from 600,000 to 2.7 million.”

<http://blog.executivebiz.com/2016/03/reportlinker-global-anti-drone-market-to-reach-1-14b-by-2022/>

ReportLinker: Global Anti-Drone Market to Reach \$1.14B by 2022

Posted By: Ramona Adams on: March 17, 2016 In: Industry News, News

Print Email



MarketsandMarkets' new report on the global counter-drone systems market states that the anti-drone industry is projected to reach \$1.14 billion by 2022 and achieve a 23.89 percent compound annual growth rate from 2017 to 2022.

ReportLinker said Monday counter-drone systems, particularly

Exhibit 7: Recent Anti-Drone Funding

Date	Company	Type	Amount	Total Raised
2/1/16	Advanced Protection Systems	Grant	\$750k	\$1.0m
4/20/16	SkySafe	Seed	\$3m	\$3.0m
5/17/16	Dedrone	Series A	\$10m	\$12.9m
6/22/16	DroneShield	Venture	~\$5.3M USD	~\$6.3M USD
8/22/16	Quanergy Systems	Series B	\$90M	\$135.3m
8/24/16	ApolloShield	Seed	\$500k	\$120k
11/18/16	Airspace Systems	Seed	\$5m	\$5.0m
1/15/17	Advanced Protection Systems	Grant	\$500k	\$1.5m
2/2/17	SRC, Inc.	US Army Contract	\$65M	-
2/13/17	Dedrone	Series B	\$15m	\$27.9m

Source: Crunchbase.com; Angelist.com; Company reports; Oppenheimer & Co. Inc.

Drone Defenses Gone Wild

INSIDE LOOK AT WHO ARE CONSIDERED EMERGING LEADERS IN 'ROGUE DRONE' DEFENSE

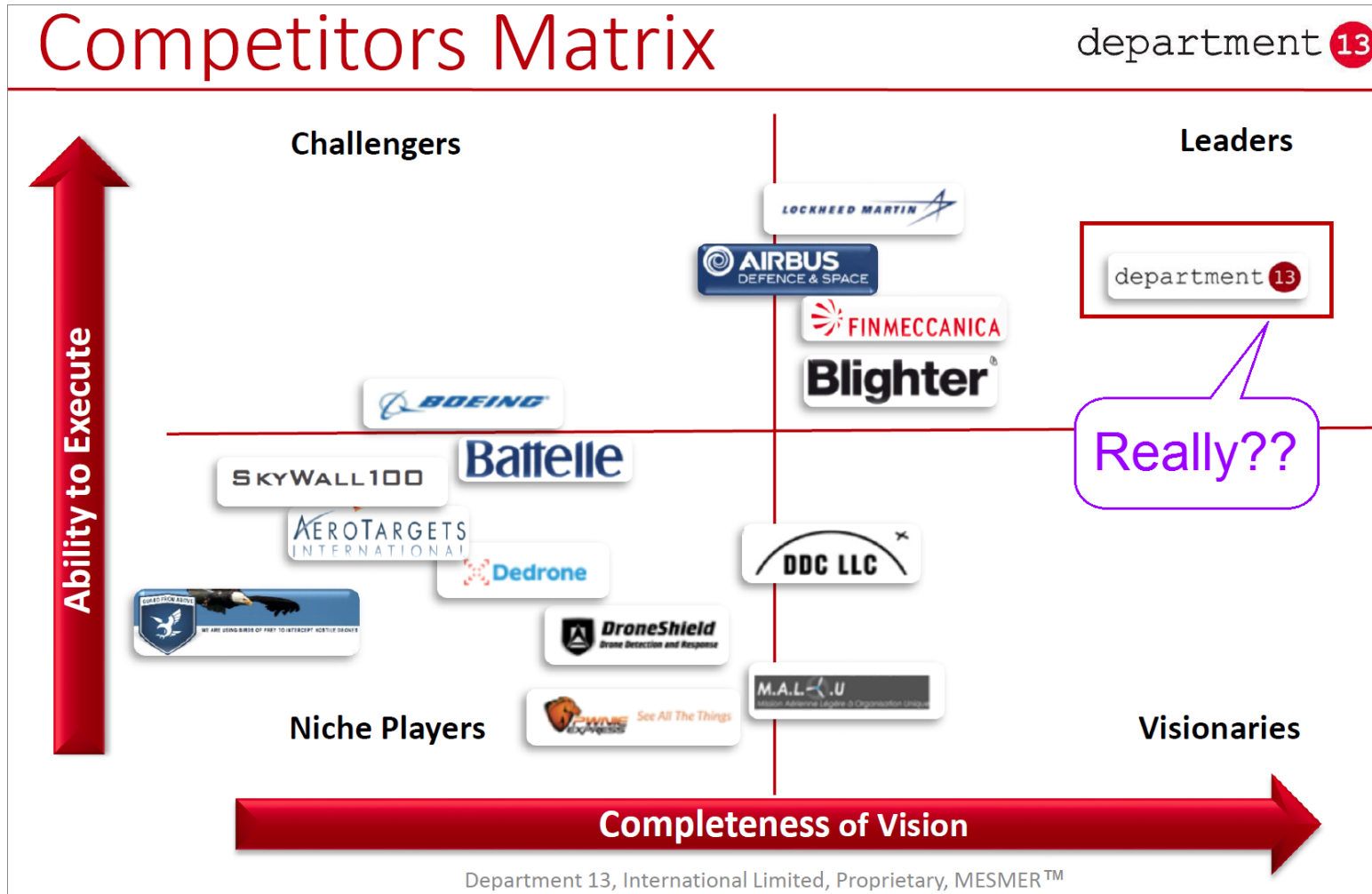


3DEO Rogue Drone Detection and Mitigation	CTS Technology Drone Jammer Gun	Fortem DroneHunter (formerly Excipio)	Mesmer Department 13-Counter Drone Systems	SAAB Group Giraffee AMB Radar
Aaronia Drone Detector	DDC LLC Domestic Drone Countermeasures – Detection Systems	Gryphon Sensors Skylight	Michigan Tech Robotic Falconry	Search Systems SparrowHawk Phase One
Adsys Controls Inc Sat32-Aerial Surveillance	DeDrone.com Hardware Products – Advanced Drone Detection	Guard From Above Birds of Prey	Microflown AVISA Skysentry	Sensofusion Airfence
Advanced Protection Systems (APS) DetectDrones.com	DeTect DroneWatcher	H.P. Wüst Direct Digital Synthesis SWEEP signal generators	Mistral Solutions Sky Archer	SESP Group Drone Defeater
AeroTargets International Gnat Counter-UAS	Digital RF Cell Block	Hensoldt.net Xpeller-Counter UAV System	OpenWorks Engineering SkyWall	SkyJack Samy.pl-Raspberry Pi drone
American Airspace Systems One Touch Interceptor TI	DIY Drone Net Gun	HIGH + MIGHTY SKYNET	ORELIA Drone Detector	SkyNet Drone Defense
ApolloShield Anti Drone Systems (Formerly AirFence)	Dronatec D-FENCE UAV Counter Measure	Israel Aerospace Industries (IAI) ELTA Systems – Drone Guard	Patriot Missiles	SkySafe
Aveillant Gamekeeper 16U – Counter-UAS Holographic Radar	Drone Defense UK Dynopis E1000MP Jammer	Kelvin Hughes Limited SharpEye SxV Radar	Poly Technologies Silent Hunter Laser Weapons System	SkyTracker by CACI
BigUrb Tactical Net Gun	Drone Defense UK Net Gun X1	Leonardo Finmeccanica Selex ES Falcon Shield	Quanergy Systems Q-Guard	Snake River Shooting Products Drone Munition
Black Sage UAVX	Drone Go Home (DGH) Drone Detection & Containment Solutions 27	Liteye Systems AUDS Counter UAV System	Radio Hill Block 3 Dronebuster and Dronebuster	SpotterRF A2000 Radar – UAVX
Blighter AUDS (Anti-UAV Defense System)	Drone Labs, LLC DroneDetector.com – Multi-sensor	Lockheed Martin ALADIN/ATHENA/ICARUS	Rafael Iron Beam	Squarehead Technology DiscovAir
Boeing Compact Laser Weapons System	Drone Shield DroneGun	MAKE Build a Raspberry Pi Drone Gun	Raytheon Phalanx CIWS	SRC, Inc. Silent Archer
C Speed LLC LightWave Radar	DroneCatcher DelftDynamics	Maldrone First Backdoor for Drones	Rheinmetall Oerlikon Skyshield	TCI International Blackbird
CerbAir DroneWatch	DroneDefender Battelle	Malou Tech Drone Interceptor MP200	Rinicom SKY PATRIOT	Thales SQUIRE
Chess Dynamics Ltd AUDS Anti-UAV Defense System	DroneShield – Acoustic detection, alerts and digital evidence collection	MBDA Laser Effector	Rinicom and METIS Aerospace SKYPERION	The Net Gun
China's \$19k Drone Jamming Gun	Elbit Systems ReDrone – Detection and Neutralization	MC2 Technologies Scrambler 300	ROBIN Radar Systems ELVIRA	Tokyo Police Drone
CODA Enterprises Net Gun 24	Excipio Net Gun Drone	MCTECH MC-Horizon	Rohde & Schwarz R&S ARDRONIS I	U.S. Navy LaWS AN/SEQ-3 Laser Weapon System (XN-1 LaWS)
				X Products Can Cannon

Drone Defenses:
~86 products
researched

Example: Marketing a Little Ahead of Itself

INSIDE LOOK AT WHO ARE CONSIDERED EMERGING LEADERS IN 'ROGUE DRONE' DEFENSE



Date of PDF:
04 July 2016

Date of v1.0 Product Released:
23 Jan 2017



Department 13 - Mesmer - Counter Drone System - 04July2016 - Slide 9 - Competitor's Matrix

• <http://www.department13.com/wp-content/sharelink/20160704-mesmer---investor-presentation-a5824ff7cc200fd305fee33cbf73c5f1.pdf>

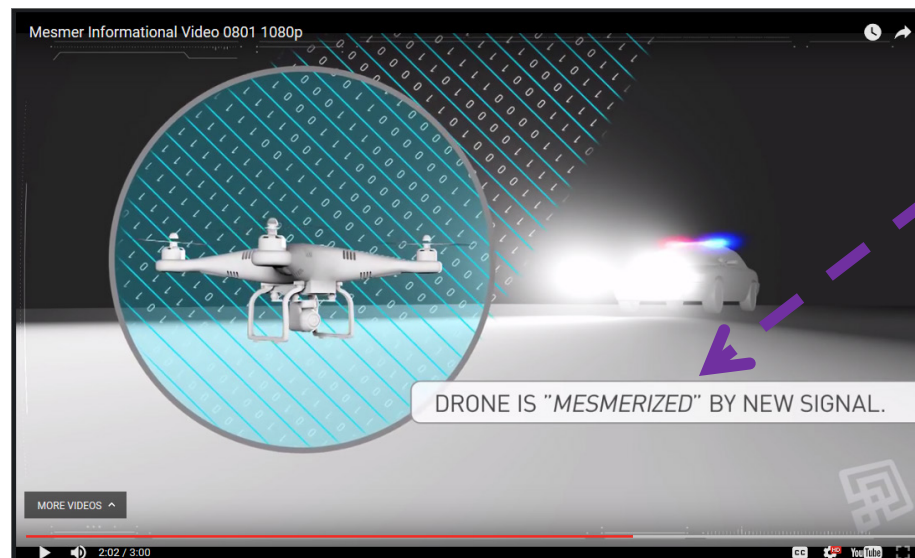
Example: Marketing a Little Ahead of Itself

REMOTELY HACKING DRONES TO DEFEND AGAINST THEM

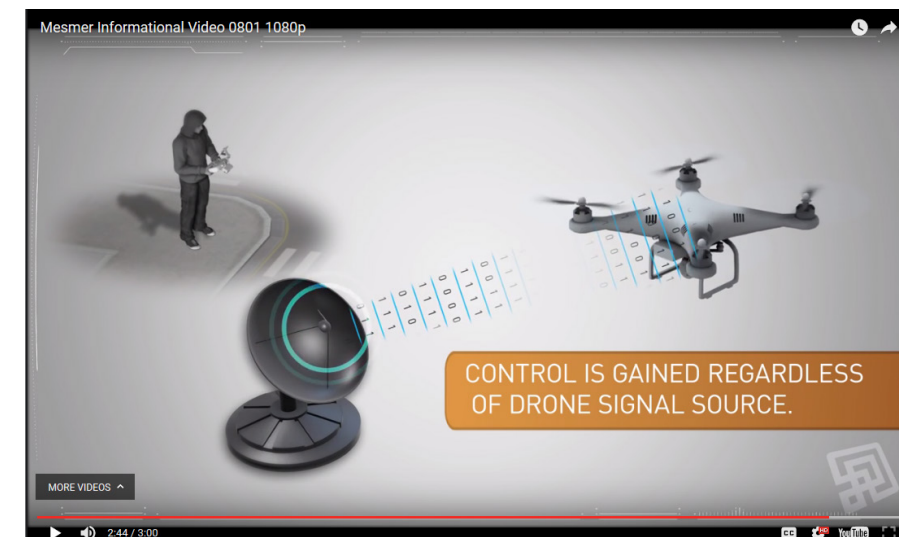
~\$200k



Hijacking command and control signal, or “*mesmerizing*” the drone (as they say)



“Mesmerized”???



Mesmer - Department 13 - Counter Drone System - Hijack Command and Control Signal

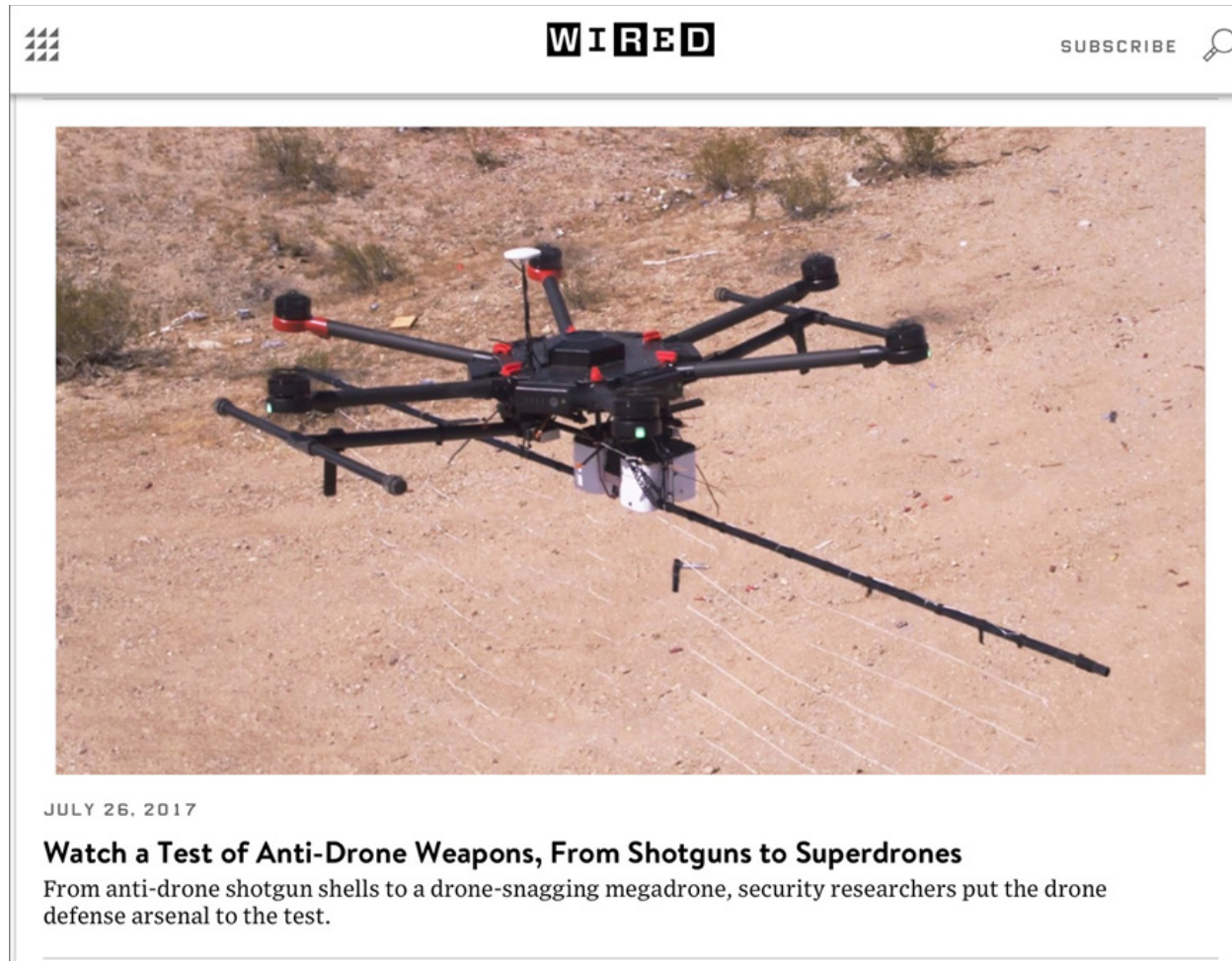
- <http://www.department13.com/products/>

Exclusive Video: Drone Defenses Testing

BISHOP FOX WENT TO THE DESERT TO TEST DRONE DEFENSE PRODUCTS

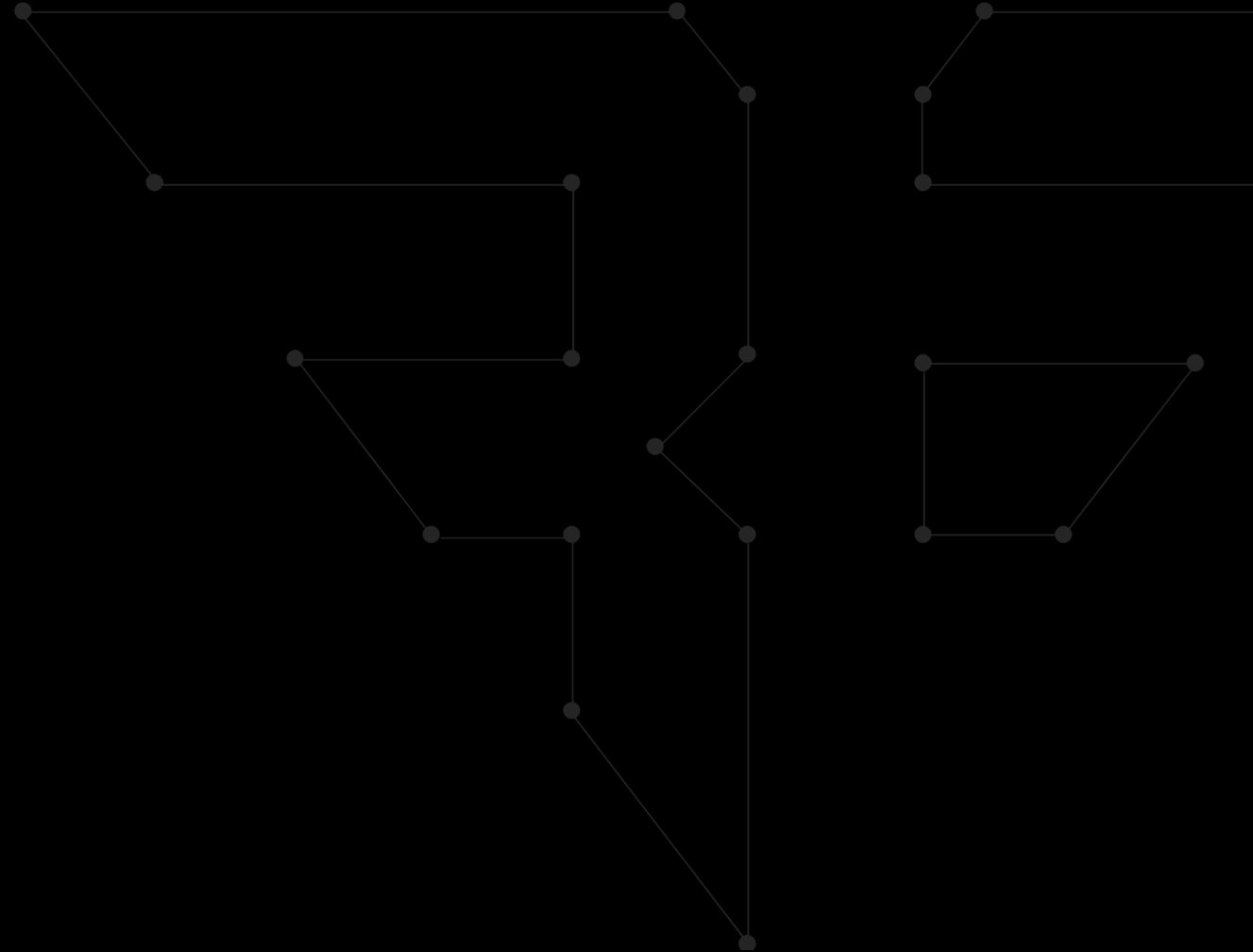


<https://www.wired.com/story/watch-anti-drone-weapons-test/>



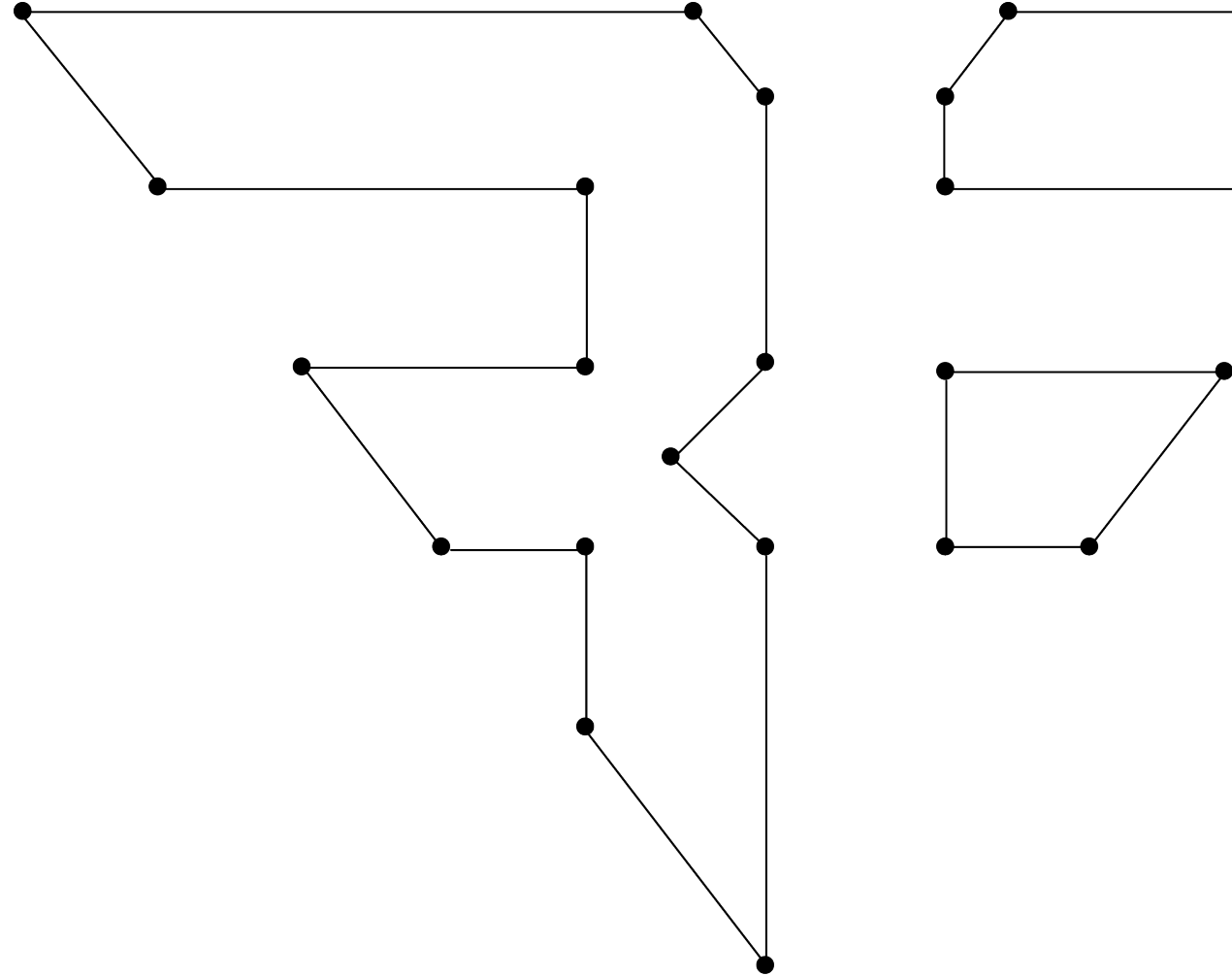
DRONE DEFENSES

THERE ARE NO BEST PRACTICES ... YET





DRONE DETECTION & ALERTING SYSTEMS



Drone Detection and Alerting Systems

LOTS OF WAYS TO FIND ROGUE DRONES

- Acoustic
- Sonic/Ultrasonic
- LIDAR
- Radar
- RF
- Visual/Optical/Video
- Infrared (IR)
- Lasers
- Thermal
- WiFi
- ADS-B (Automatic Dependent Surveillance-Broadcast)
- Holographic Radar
- ...



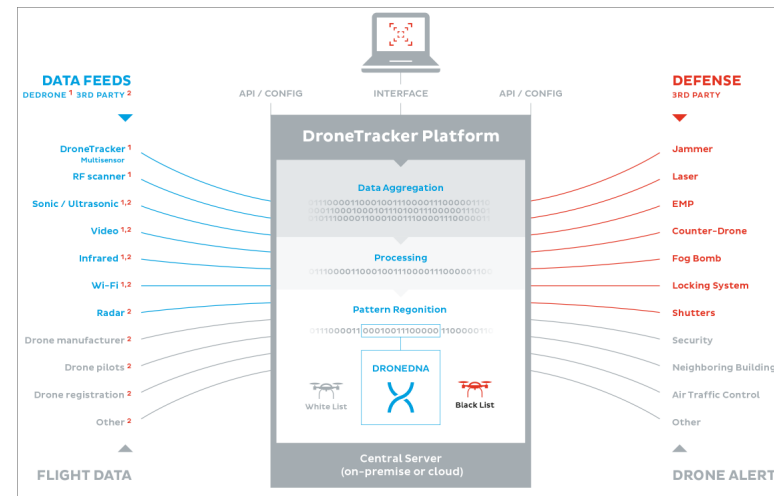
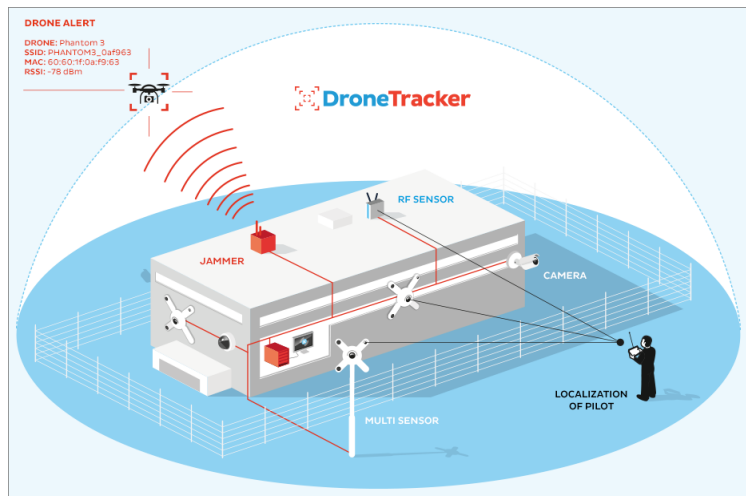
Drone Defenses Gone Wild

NO BEST PRACTICES, SO PENTEST TOOLS NEEDED TO VALIDATE THESE ARE WORKING



[ZDNet- Cisco chairman backs drone security startup \(Dedrone\) in \\$15m Series B round - 14Feb2017](#)

[The Register - Airbus doesn't just make aircraft – now it designs drone killers - 27July2016](#)



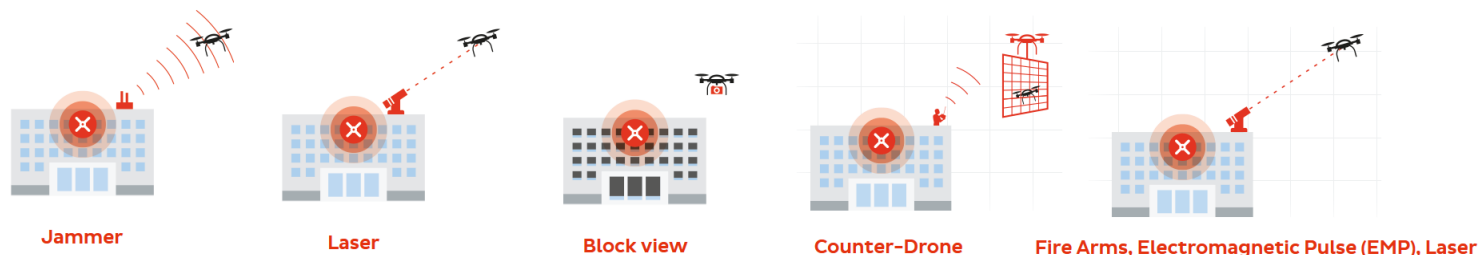
One Software – Many Devices

Scale it to your needs! [Learn more >](#)

 Multi Sensor	 RF Sensor	 Explosion-Protected Camera	 Panorama Camera
 Pan-Tilt-Zoom Camera	 Surveillance Camera	 Jammer System	 Radar System

Automatic countermeasures

Depending on your individual security needs and legal preconditions, you can easily integrate third-party countermeasures into the DroneTracker platform and trigger them automatically via API.



• <http://www.dedrone.com>

Drone Defenses Gone Wild

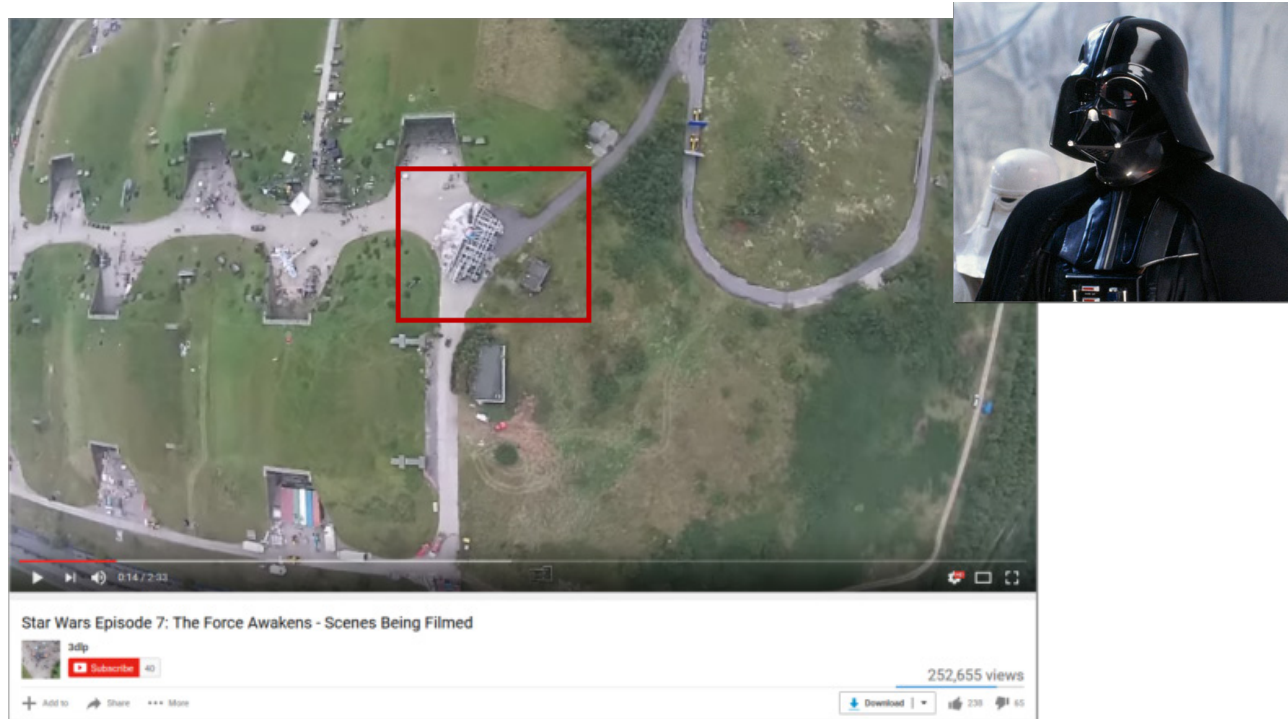
NO BEST PRACTICES, SO PENTEST TOOLS NEEDED TO VALIDATE THESE ARE WORKING



[Gizmodo - The Next Star Wars Movie Has Recruited a Team of Drones to Protect Its Secrets - 22Feb2016](#)

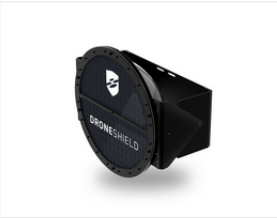
[Motherboard - Star Wars Ordered a 'DroneShield' to Prevent Leaks On Set - 10Sept2014](#)

- *Why monitor a problem if you don't do anything about it, though?*



PRODUCTS



 WIDEALERT SENSOR Broad, Full-Range Drone Detection	 FARALERT SENSOR Far-Reaching Drone Detection	 DRONEGUN Highly effective drone countermeasure
 DRONESHIELD BASEPROCESSOR Drone Detection Without Internet Connection Requirement	 DRONESHIELD USER INTERFACE Continuous, Online Monitoring of Local Drone Activity	 DRONEENTRY Autonomous Detection & Countermeasure

DroneShield – Drone Detection and Response Products

- <https://www.droneshield.com/products>

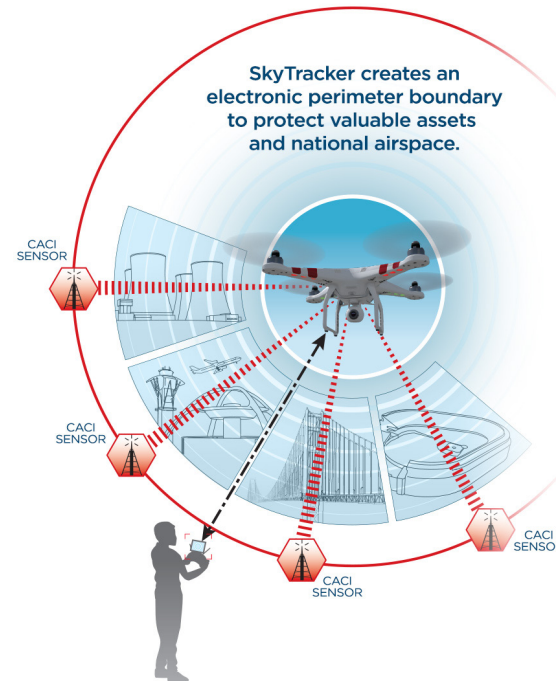
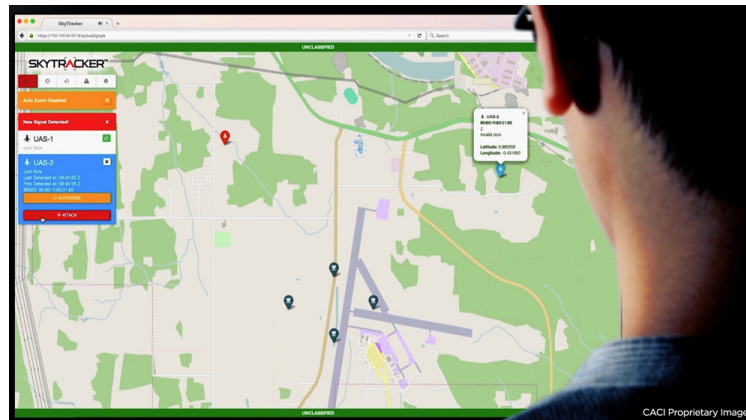
Drone Defenses Gone Wild

DRONE DETECTION AND ALERTING SYSTEMS



[DRONELIFE - What's So Secret About the FAA Contract with CACI? - 06Apr2016](#)

- *"The FAA announced a partnership with CACI, an information services company, and the Department of Homeland Security to create a drone detection system, according to a press release."*



SkyTracker - by CACI - UAS Precision Tracking System

- <http://www.caci.com/skytracker/>

Drone Defenses Gone Wild

DRONE DETECTION AND ALERTING SYSTEMS



AOPA.org - Sensofusion Airfence - Drone fence arriving in Denver - 03Nov2016



DRONE FENCE ARRIVING IN DENVER

November 3, 2016

By Jim Moore

Drones approaching sensitive facilities can be instantly identified and tracked; their operators located; and, if need be, the defense system developed by a company called **Sensofusion** can even force the offending drone to land at a location designated in advance—all without need for human intervention. The essential equipment is roughly the size of a wireless router commonly found in homes and offices, or a set-top cable television box. Add an antenna and a computer, and you're up and running. Soon there will be an **Airfence** at **Denver International Airport**.



The **Airfence** system by **Sensofusion** uses a small electronic device to detect and control drones that enter sensitive areas, and will soon be installed at Denver International Airport. Airfence device photo courtesy of Sensofusion.

Sensofusion – Airfence – Drone Detection and Tracking System

- <https://www.sensofusion.com/>

Drone Defenses Gone Wild

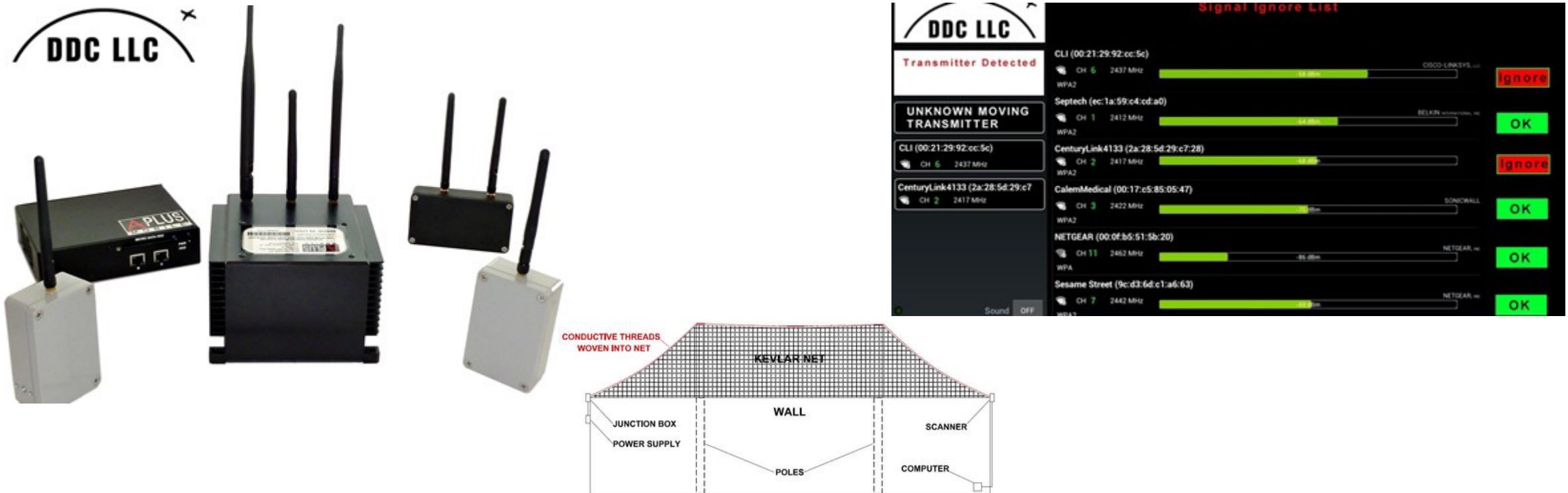
DRONE DETECTION AND ALERTING SYSTEMS

~\$40k



DDC LLC - Domestic Drone Countermeasures - Drone Detection Systems

- The Basic **Personal Drone Detection System** consists of three boxes: a Primary Command and Control Module and two Detection Sensor Nodes. These three boxes **create a mesh network** that can triangulate moving transmitters.



DDC LLC - Domestic Drone Countermeasures - Drone Detection Systems

- <https://www.sensofusion.com/>

Drone Defenses Gone Wild

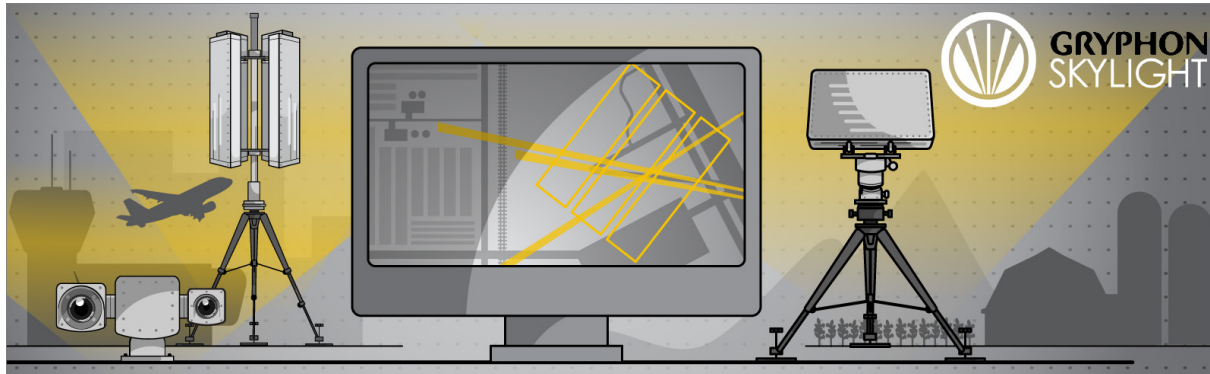
DRONE DETECTION AND ALERTING SYSTEMS

~\$235k



DDC LLC - Domestic Drone Countermeasures - Drone Detection Systems

- The Basic **Personal Drone Detection System** consists of three boxes: a Primary Command and Control Module and two Detection Sensor Nodes. These three boxes **create a mesh network** that can triangulate moving transmitters.



SAMI

SAMI (Skylight Airspace Monitor Interface) is the glue that brings our sensors together to give you a complete airspace picture.

SKYLIGHT SYSTEM MULTISPECTRAL SENSORS



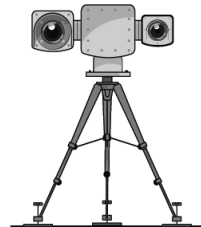
R1400* - PRIMARY RADAR

- Large area, precision surveillance
- Drone security and Detect & Avoid applications
- 10km (sUAS), 27km (General Aviation)
- Low false alarm rate
- Low size, weight and power (SWaP); man transportable



SPECTRUM SENSING (S2)

- Fast target acquisition
- Strong positive confirmation for targets of interest
- Provides line of bearing
- Up to 5km detection range
- Up to 360° coverage



SLEW-TO-CUE CAMERA

- Visual Target Identification
- Optical Tracking
- Thermal and EO lenses
- 3km detection range
- 360° Pan Rotation
- 180° Tilt Rotation



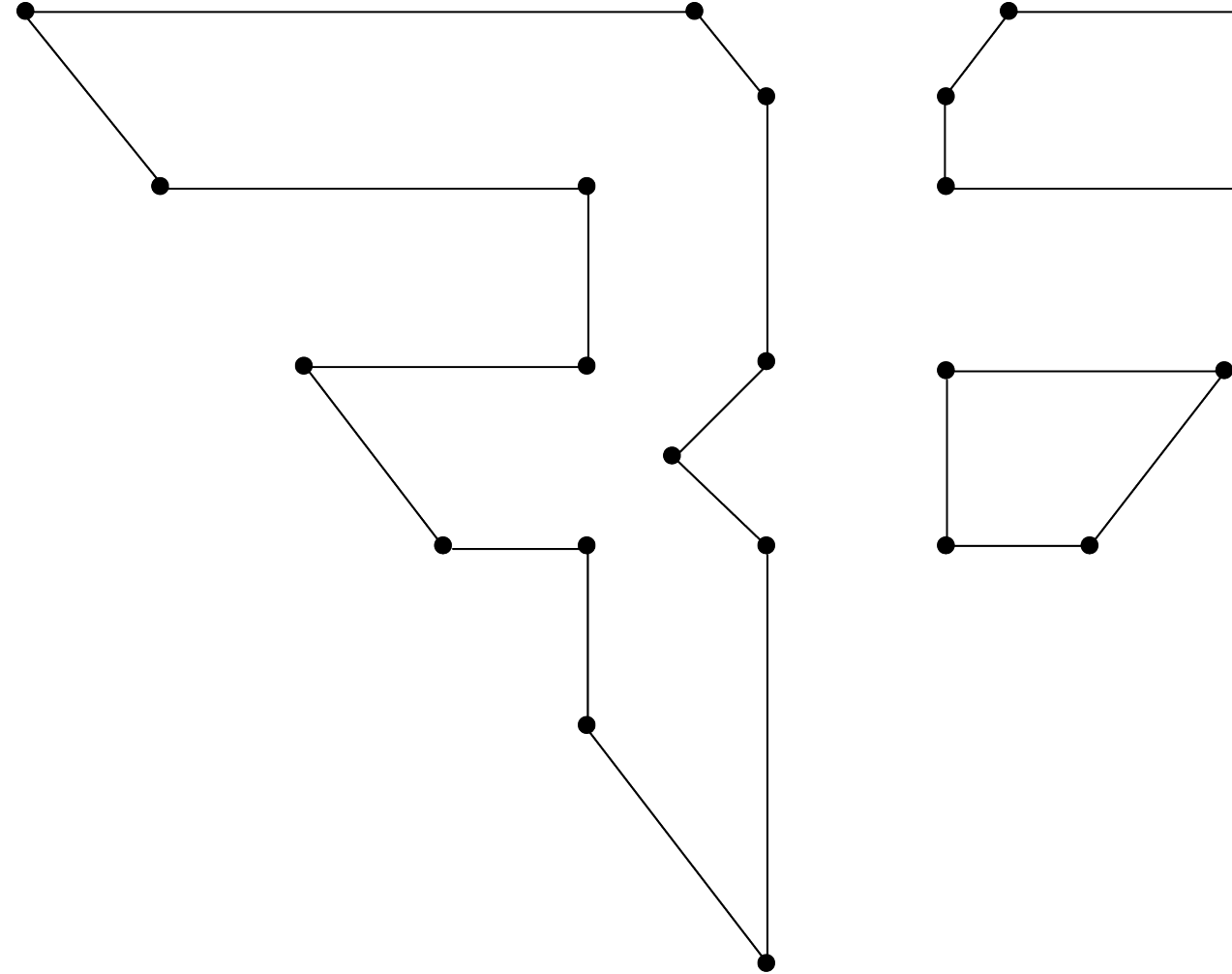
Gryphon Sensors - Skylight - Drone Detection and Tracking

- <http://gryphonsensors.com/products/>



PREDATOR BIRD

EAGLES & FALCONS PLUCKING DRONES FROM SKY



Drone Defenses Gone Wild

FALCONS AND EAGLES TRAINED TO ATTACK DRONES



[The Washington Post - Terrorists are building drones. France is destroying them with eagles. - 21Feb2017](#)

[Fox News - Watch a police eagle take down a drone - 01Feb2016](#)

*"I'd like to spend my security training budget on **falconry** classes, please."* –

Every Security Professional Next Year



Guard From Above - Using birds of prey to intercept hostile drones

- <http://guardfromabove.com/>

Drone Defenses Gone Wild

FALCONS AND EAGLES TRAINED TO ATTACK DRONES



Initial Investment (example) Prices excluding VAT and depending on availability of birds



1 GFA Team (Bird and Birdhandler training):

GFA Bird (365 days specialist training, caretaking and drones)	EUR 98.000,--	USD 104.370,--
GFA Birdhandler Training (20 days)	EUR 25.000,--	USD 26.625,--
GFA Training/Deployment equipment	EUR 4.000,--	USD 4.260,--
Additional advice ((estimate)For example: export/transport)	EUR 20.000,--	USD 21.300,--
Total Investment:	EUR 147.000,--	USD 156.555,--

Long term Investment

- Eagles live around 60-80 years
- Deployable for 40 years

Guard From Above - Using birds of prey to intercept hostile drones

- <http://guardfromabove.com/>



Drone Defenses Gone Wild

FALCONS AND EAGLES TRAINED TO ATTACK DRONES



Life-cycle cost analysis (LCCA) example

Yearly cost per 1 GFA trained Bird of prey for 1 year (365 days):

Bird quarters Construction (Basic)	EUR 2.000,--	USD 2.130,--
Food	EUR 1.000,--	USD 1.065,--
Medical care (Periodic checks and basic care)	EUR 1.500,--	USD 1.597,50
Individual Equipment (yearly)	EUR 1.500,--	USD 1.597,50
Contingencies	EUR 500,--	USD 532,50
Training drones (depending on the client demand: Brand/type)	EUR	USD
Daily caretaking and training (by client staff 365x 1,5 h (547,5 hours))	EUR	USD
Total yearly investment (for 1 bird)	EUR 6.500,--	USD 6.922,50

Guard From Above - Using birds of prey to intercept hostile drones

- <http://guardfromabove.com/>

Defeating Birds of Prey Defenses

FALCONS AND EAGLES TRAINED TO ATTACK DRONES



Detection and response to incoming eagles or falcons.

Detect Incoming Eagles:

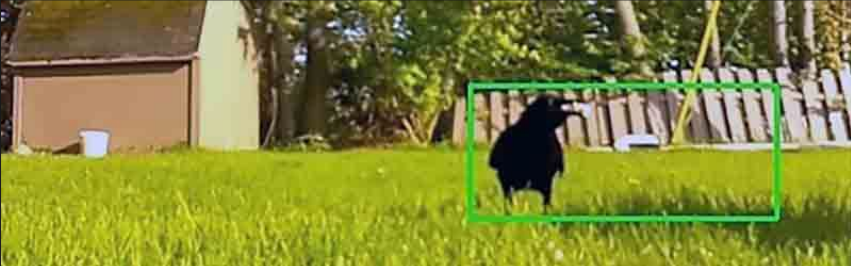


HACKADAY

HACKADAY PRIZE ENTRY: AUTOMATED WILDLIFE RECOGNITION

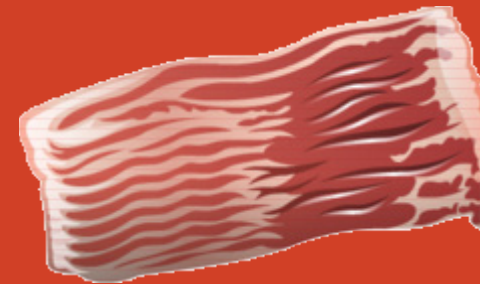
by: [Donald Papp](#) 11 Comments

June 14, 2017



Trail and wildlife cameras are commonly available nowadays, but the [Wild Eye](#) project aims to go beyond simply taking digital snapshots of critters. [Brenda Armour] uses a Raspberry Pi to not only take photos of wildlife who wander into the camera's field of view, but to also automatically identify and categorize the animals seen using a [visual recognition API](#) from IBM via the [Node-RED](#) infrastructure. The result is a system that captures an image when motion is detected, sends the image to the visual recognition API, and attempts to identify any wildlife based on the returned data.

Responses: Carrot or Stick



Bacon Countermeasures

+

OR

Offensive
Countermeasures



Hypothetically, obviously

Drone Defenses Gone Wild

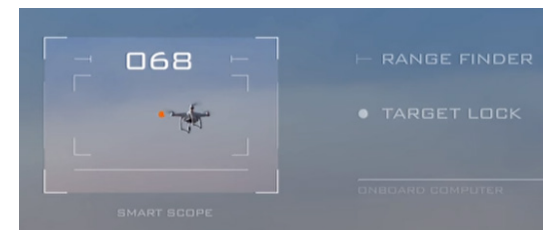
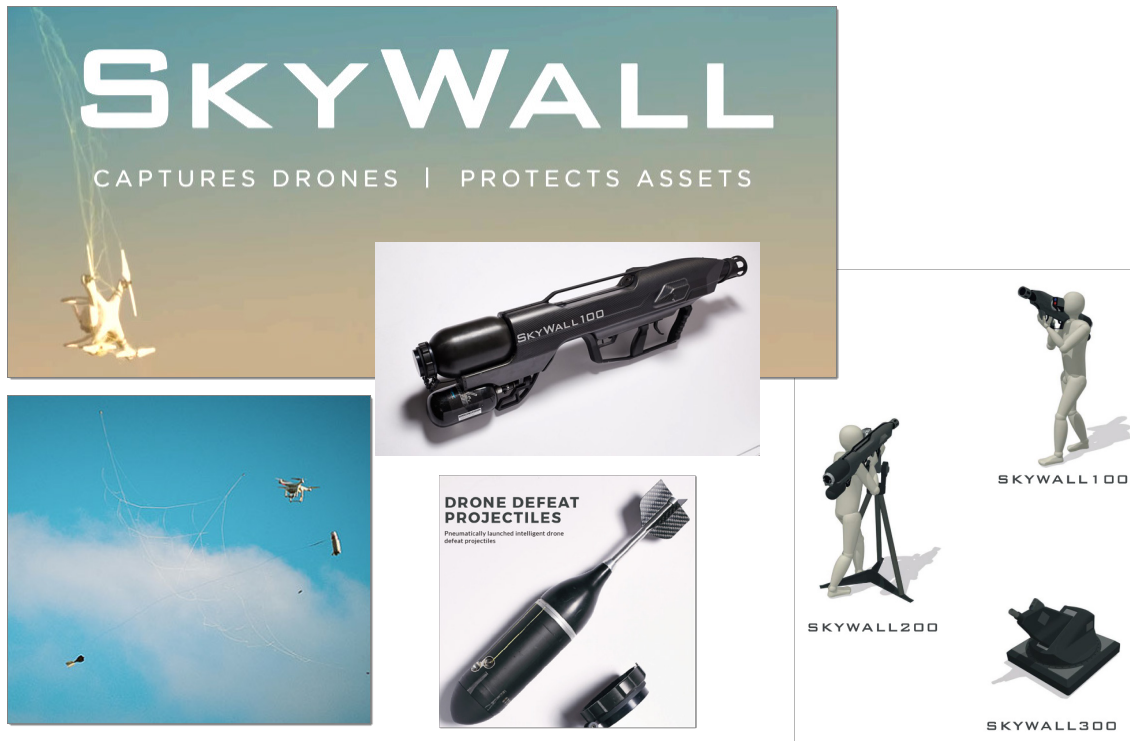
BAZOOKA SHOOTING NETS WITH PARACHUTE AT DRONES

~\$70k - \$80k



[Mashable - SkyWall gun stops drones dead with net, then gives a parachute landing - 05Mar2016](#)

[Popular Science - SkyWall Is A New Anti-Drone Net Bazooka For Police - 07Mar2016](#)



OpenWorks Engineering - SkyWall

- <https://openworksenengineering.com/skywall>

Drone Defenses Gone Wild

DRONE NET GUN - SMALL FLASHLIGHT SIZED



DroneDefence.co.uk - Net Gun X1



Net Gun X1 Operation

The Drone Defence Net Gun X1 is a simple to use, versatile & economical device for Law Enforcement & Security Officers to tackle unwanted drone incursions. With two types of capture net the operator can select the appropriate configuration, dependent on the environment. The Type 1 capture net provides an protective barrier wall, which a drone cannot penetrate. Type 2 allows the operator to attempt the direct capture of a drone in flight.



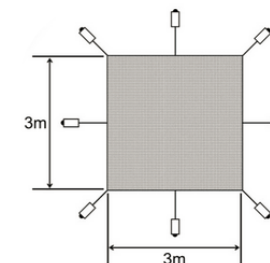
*Depending on capture net type and weather conditions.



Drone Defence - Net Gun X1

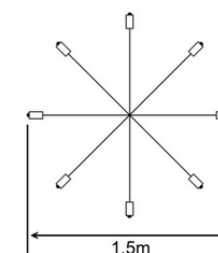
- <http://www.dronedefence.co.uk/net-gun-x1>

Multiple Capture Net Types



Type 1 - Mesh

Effective Range: up to 10m
Net Size: 9 meters squared (3m x 3m)
Mesh Size: 15cm
Deployment Time: 1 second
Velocity: 10 meters per second



Type 2 - Spider

Effective Range: up to 15m
Net Size: 2 meters squared (1.5m radial)
Deployment Time: 1 second
Velocity: 10 meters per second

Drone Defenses Gone Wild

DRONE NET GUN - SMALL FLASHLIGHT SIZED

~\$500



BigUrb - Tactical Net Gun

• <https://www.amazon.com/BigUrb-Tactical-Net-Gun/dp/B01N6VRY9D/>

Drone Defenses Gone Wild

DRONE NET GUN – SMALL FLASHLIGHT SIZED

~\$600 - \$800



Shoots up to ~45 feet

TheNetGunStore.com - Net Guns for Drone Defense - 20Nov2014



TheNetGunStore – Net Gun

- <http://www.thenetgunstore.com/product/the-hero-net-gun/>

DEMO: Defeating Net Defenses with Protective Cage

CHICKEN WIRE FOR THE WIN



Chicken Wire Cage = ~\$15

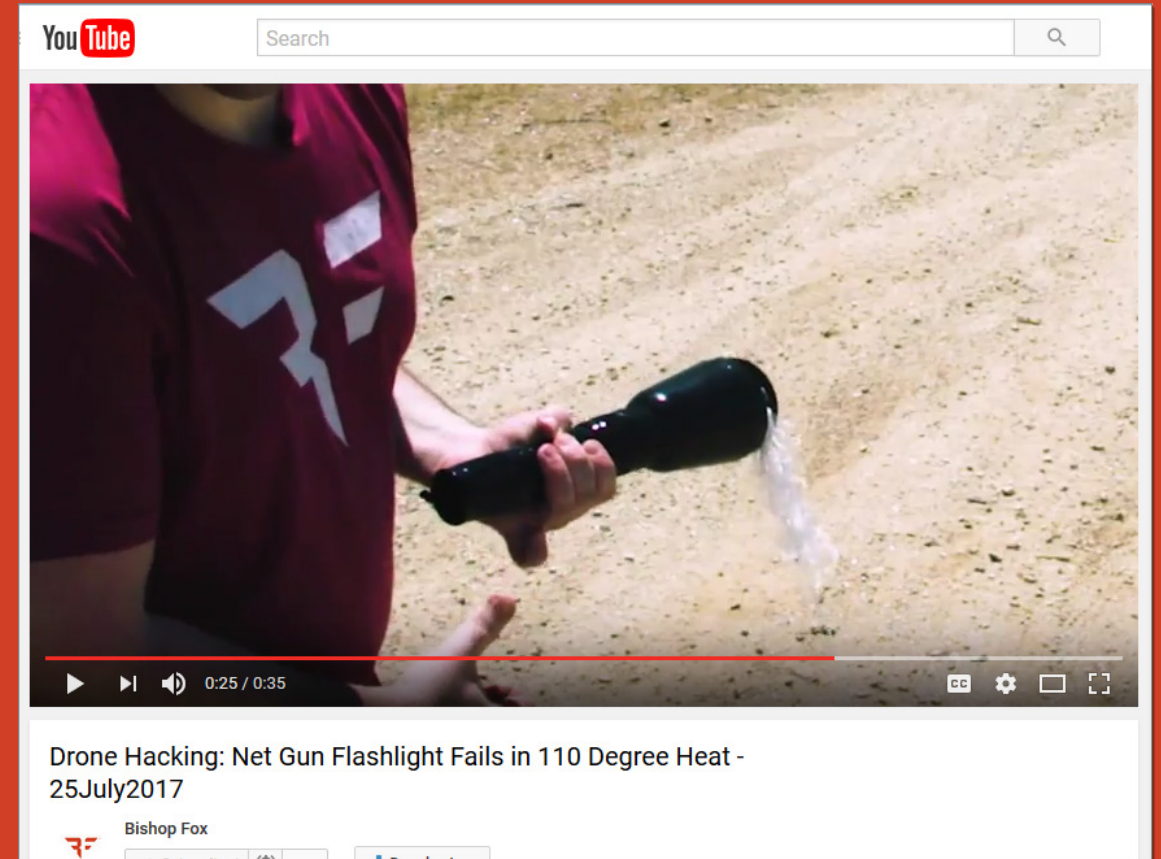
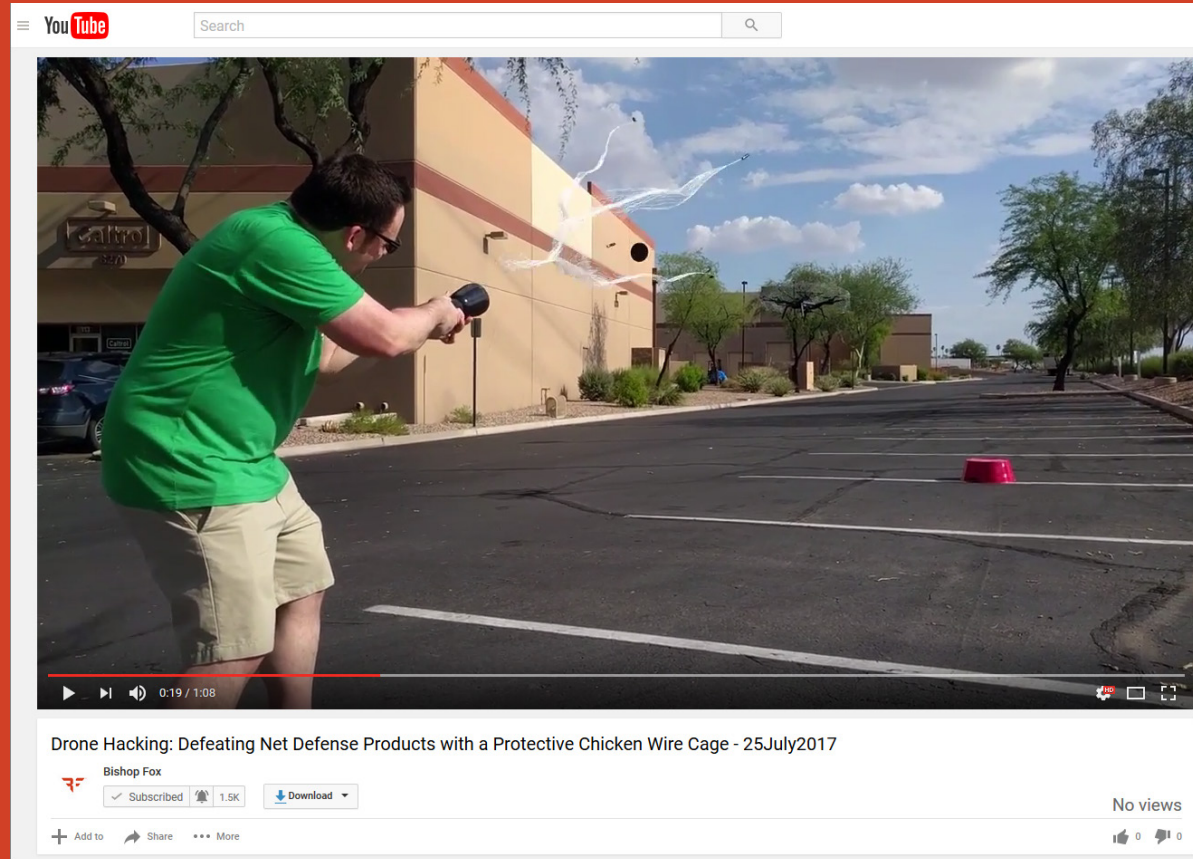
VS.



Flashlight Net Gun = ~\$600-\$700

DEMO: Defeating Net Defenses with Protective Cage

CHICKEN WIRE FOR THE WIN, ARIZONA HEAT FOR THE WIN TOO!



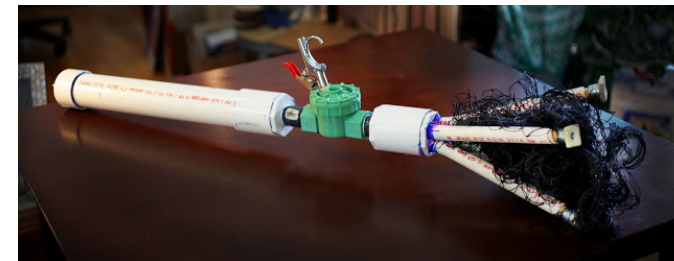
Drone Defenses Gone Wild

DIY DRONE NET GUN

~\$40 - \$75



[LifeHacker - Build a Drone-Catching Net Gun Out of Basic Plumbing Parts - 24Feb2017](#)



DIY Net Gun for Drones - William Osman

- <http://www.williamosman.com/2016/12/diy-net-gun.html>

Drone Defenses Gone Wild

DRONE NET GUN SHOTGUN SHELLS

~\$20 for 3 shells



Advanced Ballistics Concepts - Skynet™ Drone Defense



SKYNET – Drone Defense – Shotgun Net Shells

- <http://store.mibullet.com/skynetdronedefense.aspx>

DEMO: Defeating Net Defenses with Protective Cage

SHOTGUN SHELLS WIN



Chicken Wire Cage = ~\$15

VS.



SkyNet Drone Net Shotgun
Shells (3 pack) = ~\$20

DEMO: Defeating Net Defenses with Protective Cage

SHOTGUN SHELLS WIN

YouTube Search



12 GAUGE SHELL FIRES A NET

SKYNET
DRONE DEFENSE™
Don't be a victim.™

- ✱ Illegal Surveillance
- ✱ Aerial Trespassing
- ✱ Weaponized Drones

WARNING: AMMUNITION. KEEP OUT OF THE REACH OF CHILDREN.

The world's first ground-to-air SKYNET™. This patented two-part system SKYNET will allow any gunsmith with a 12 gauge to defend his or her rights. Specifically engineered for an aggressive launch and takedown of a flying drone, in the event of a shot the SKYNET granules lock to earth slowly and safely.

TO CAPTURE DRONES!

Drone Hacking: SKYNET Shotgun Shells - Drone Net Shell Testing - 25July2017

Bishop Fox

✓ Subscribed 1.5K Download

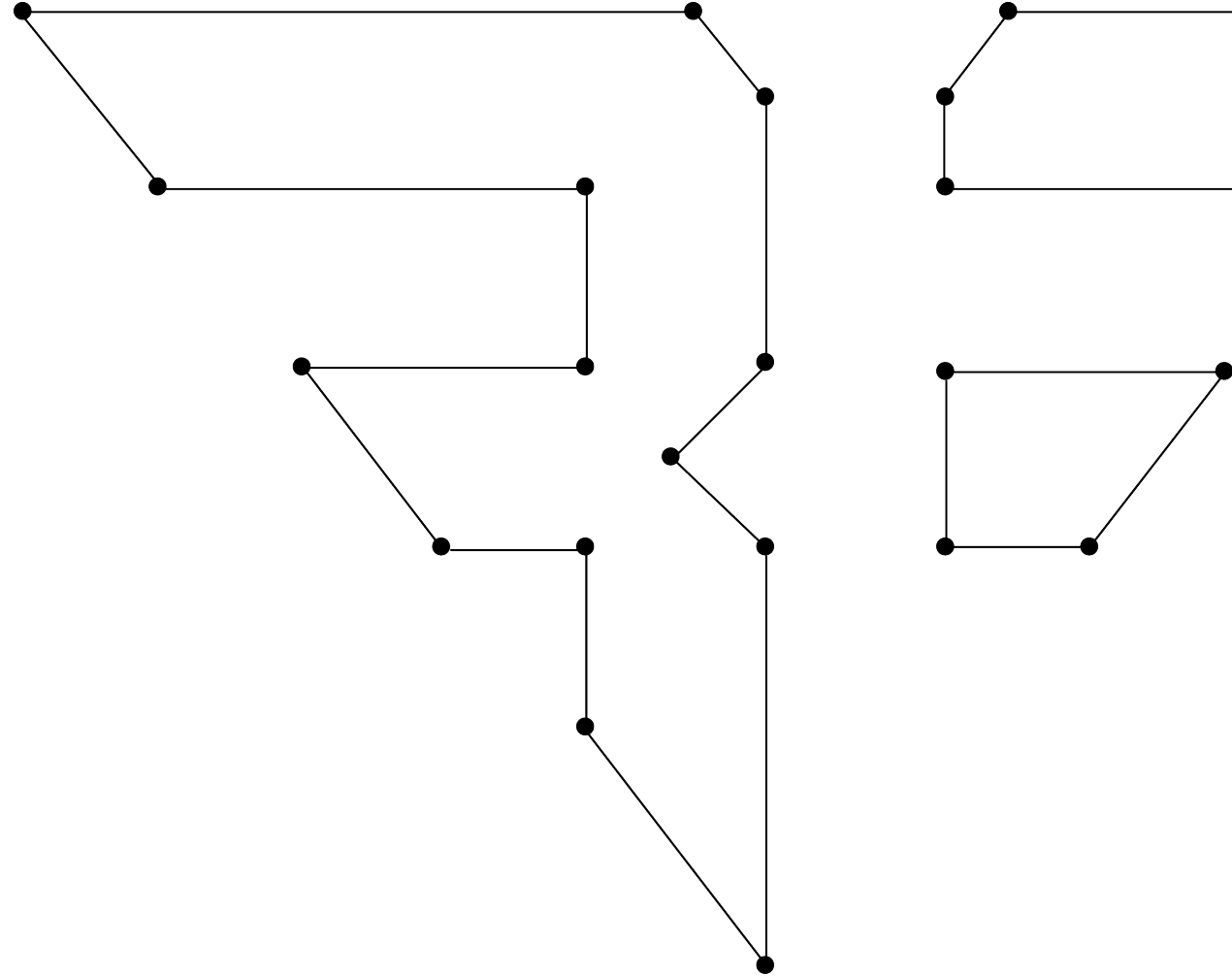
No views

+ Add to Share More



DRONE SHOOTING

DRONES SHOOTING NETS AT DRONES



Drone Defenses Gone Wild

DRONES SHOOTING NETS AT OTHER DRONES

~\$30,000 Euro

*"Hoping to ship first units
by the end of 2017"*



[DroneCatcher - Catching a Drone with a Drone - 19Aug2016 -YouTube](#)

[Security Affairs - The DroneCatcher evolves featuring a new improvement - 04April2016](#)



Specifications

DroneCatcher	Flying system
Dimensions	775 x 755 x 350 mm
Speed	Currently up to 20 m/s 44.7 mph
Operating time	Up to 30 min.
Netgun range	Up to 20 meters 65.6 feet
Weight	< 6 kg



DroneCatcher - DelftDynamics

- <http://dronecatcher.nl/>

Drone Defenses Gone Wild

DRONES SHOOTING NETS AT OTHER DRONES

*“Millions of dollars” in cost –
according to them on phone*



[WSJ - Its Drone vs. Drone as Airspace Systems Takes Flight - 09Mar2017](#)

[Gizmodo - Watch a Drone-Hunting Quadcopter Attack Its Prey - 13Oct2016](#)

[Airspace Systems Inc One Touch Interceptor TI - 22Oct2016 - YouTube](#)

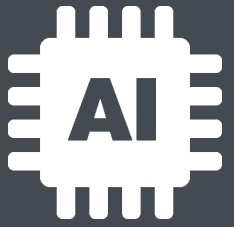


American Airspace Systems - One-Touch Interceptor TI

- <http://airspace.co>

TREND: Defensive Drones Going Autonomous

ONE-TOUCH 'CLEAN THE SKY' SOLUTIONS – AUTO-MAGICALLY FIND AND ELIMINATE 'ROGUE DRONES'



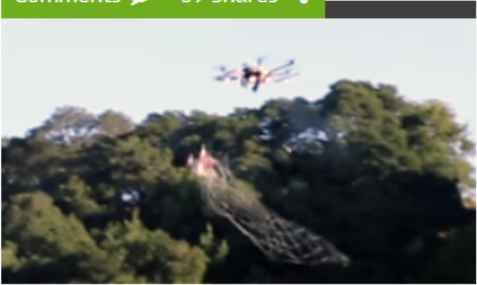
- Most air-to-air drone defenses starting to incorporate **A.I.** and **machine learning** to deploy **automated anti-drone** products
- **One-touch** search-and-destroy **autonomous** drones, i.e. no need to teach your employees how to be **Top Gun's** in order to defend against 'rogue drones'

https://news.developer.nvidia.com/autonomous-drone-hunts-down-rogue-drones-from-the-sky/ 120%

NVIDIA DEVELOPER

NVIDIA Developer - Autonomous Drone Hunts Down Rogue Drones From the Sky - Powered by NVidia Jetson TX1 Board - 18Oct2016

Comments 59 Shares



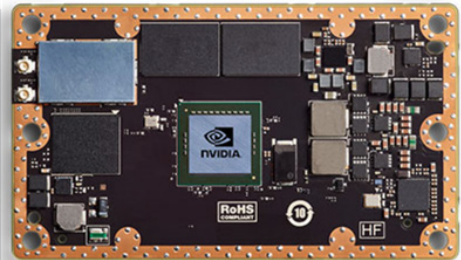
Autonomous Drone Hunts Down Rogue Drones From the Sky

October 18, 2016

Once it classifies the object, the **Jetson-powered Airspace drone** fires a tethered net to capture the other craft from the sky and safely returns it to its landing pad.

Airspace is the only drone security solution capable of identifying, tracking, and autonomously removing rogue drones from the sky.

The start-up is using **GeForce GTX 1080 GPUs** and **DIGITS** to train their **deep learning** model to detect anomalies in the sky and classify rogue drones. Once trained, the drone is equipped with an **Jetson TX1 on-board**, and uses **VisionWorks**, **TensorRT** and **CUDA** to **classify and react to rogue drones in real-time**.



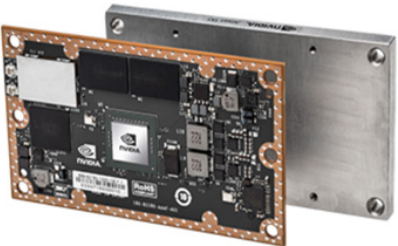
JETSON TX1 MODULE

This AI supercomputer features NVIDIA Maxwell™ architecture, 256 NVIDIA CUDA® cores, 64-bit CPUs, and a power-efficient design. Plus, it includes the latest technology for **deep learning**, **computer vision**, GPU computing, and graphics—making it ideal for embedded **AI computing**.

BUY NOW

NVIDIA Jetson is the world's leading visual computing platform for GPU-accelerated parallel processing in the mobile embedded systems market. Its high-performance, low-energy computing for deep learning and computer vision makes Jetson the ideal solution for compute-intensive embedded projects like:

- > Drones
- > Autonomous Robotic Systems
- > Mobile Medical Imaging



Drone Defenses Gone Wild

DRONES SHOOTING NETS AT OTHER DRONES



[Popular Mechanics - Drone-Mounted Net Cannon Snags Other Drones with Ease - 12Jan2016](#)

[TheNextWeb - Watch Michigan Tech's 'Robotic Falcon' snatch this drone out of mid-air - 13Jan2016](#)



Drone Defenses Gone Wild

DRONES SHOOTING NETS AT OTHER DRONES



~\$3,500 in Nov 2016

~\$47,500 in 2017 (Fortem)



[Net Gun Drone - Excipio | Flite Test - 11Jan2016 - YouTube](#)

- "*Excipio*" is Latin for "*capture*"
- Rebranded "*Fortem - Drone Hunter*" in 2017:
 - <http://fortemtech.com/dronehunter/>



Excipio Aerial Netting System



Theiss UAV Solutions, LLC has released the EXCIPIO, a patent pending non-electronic, non-destructive Anti-Drone system. The EXCIPIO (Latin for "I Capture") is a unique interception and neutralizing system that allows for surgical removal of a potential threat. Though the initial system concept was focused on intercepting and neutralizing an airborne UAS (or "Drone"), the conceptual applications have expanded to include manned aircraft, ground vehicles, people, and animals (whether airborne or on the ground).

The EXCIPIO Aerial Netting System can be mounted to a variety of fixed wing or rotorcraft platforms for use. The EXCIPIO is launched when a threat target has been identified and then flies to intercept the target. When the EXCIPIO has reached the threat target, it fires a net upon the target when commanded by the EXCIPIO System operator. Once the target has been "netted," the EXCIPIO can either release the net with the neutralized target ensnared (utilizing a small drag chute to slow the fall of the neutralized target) or keep the net tethered to the System for the purpose of relocating the net and neutralized target to a desired location before releasing them to the ground.

Please contact us via email for more information, or to order the EXCIPIO Aerial Netting System.

Excipio - Net Gun Drone - thisisuav.com

- <http://www.theissuav.com/researchanddevelopment/>

Drone Defenses Gone Wild

DRONES SHOOTING NETS AT OTHER DRONES



[SPARROWHAWK PHASE ONE - Search Systems](#)

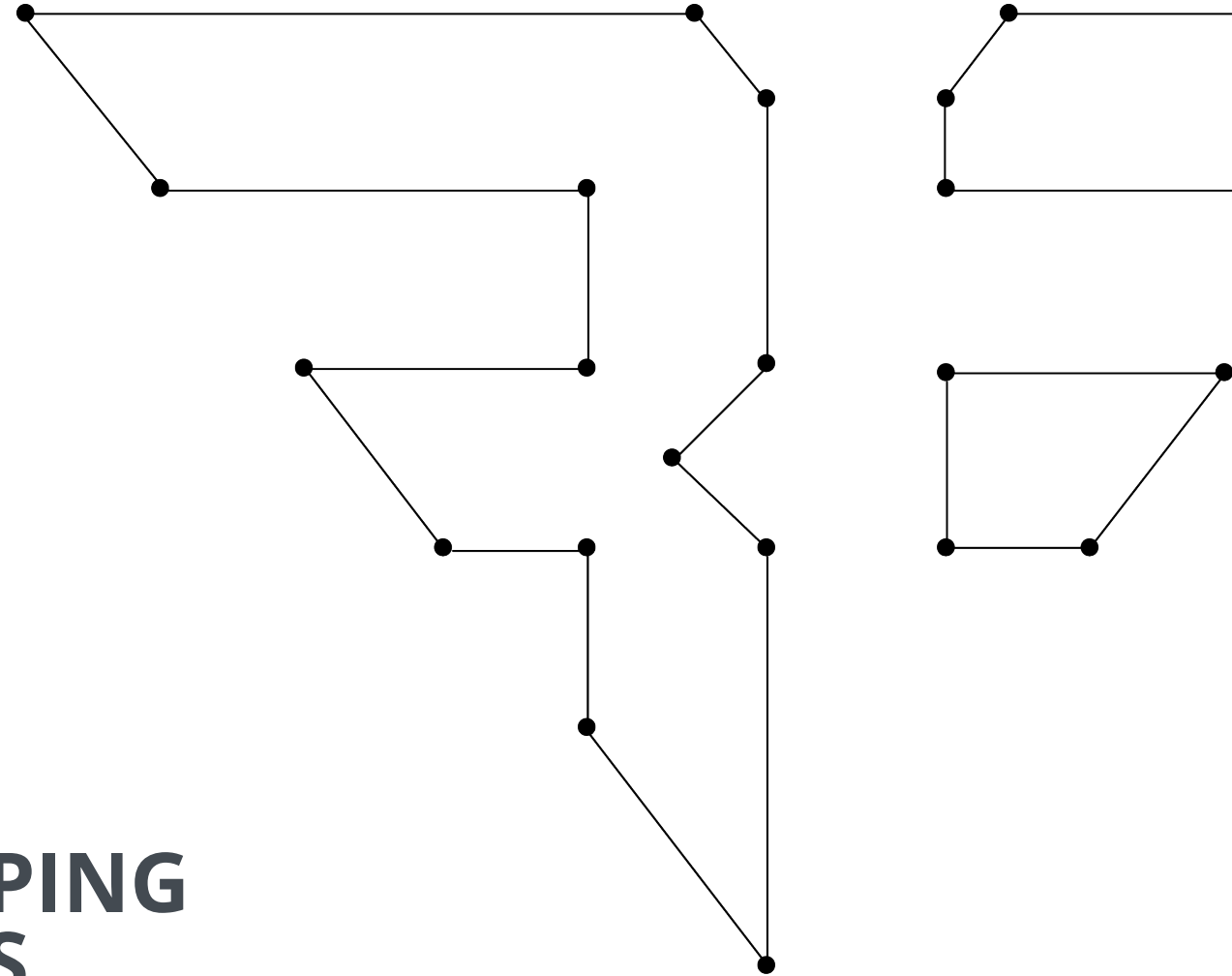
[SparrowHawkFinal_1_1.mp4 - 07Mar2016](#)





DRONE NETTING

DRONES WITH NETS SWOOPING AT AND SNAGGING DRONES



Drone Defenses Gone Wild

DRONES WITH NETS SWOOPING IN AND SNAGGING DRONES



[Tokyo police drones use nets to catch illegally flown devices - 14Dec2015 - YouTube](#)

[Daily Mail Online - Tokyo police reveal bizarre 'UAV drone catcher' - 11Dec2015](#)



Tokyo Police - Drone Interceptor

Drone Defenses Gone Wild

DRONES WITH NETS SWOOPING IN AND SNAGGING DRONES

~\$25,000 Euro



[Popular Mechanics - This Drone Interceptor Captures Your Pathetic Puny Drone With a Net - 11Feb2015](#)



Mission Aérienne Légère à Organisation Unique

Main page Store Articles Contact 

Groupeassmann



Drone Interceptor MPI 200
The drone interceptor MPI 200 neutralizes the intruder with his net. It can capture up to 6 Kg drones. He can drop his net immediately without limit of weight or size of the captured drone. Handy, accurate, he can go to a top speed of over 100 km / h.

[See our offer >>](#)



Drone MP 200
The recognition with guided or f

[See our offer >>](#)

© M.A.L.O.U - Groupe a





Mission Aérienne Légère à Organisation Unique

Groupeassmann

https://web.archive.org/web/20160106162945/http://www.malou-tech.fr/Documentations/OffreMpi200_US.pdf



MPI 200
COMMERCIAL OFFER

06 Jan 2016

Reference	Désignation	Quantity	U.P. (EUROS)	T.P (euros)
MPI 200	INTERCEPTOR DRONE (patent protection) including : - Aluminum frame 1.02 version - Packs of batteries LIPO - Double nacelle for GOPRO and zoom camera with movable axis - Type radio futaba T 14 with battery charger - Transmitter/receiver 5.8 Ghz - Management video screen - Rezel Immersion with micro SD for	1	25 000.00 €	25 000.00 €



Malou Tech - Drone Interceptor MPI 200

• <http://groupe-assmann.fr/malou-tech/>

Drone Defenses Gone Wild

DRONES WITH NETS SWOOPING IN AND SNAGGING DRONES

<http://searchsystems.eu/gallery.html>

[sparrowhawk_2.mp4 - 07Mar2017](#)



~\$11k =

\$5k drone (DJI M600) +
\$6k attachment (£5k)



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SPARROWHAWK

Counter uav (c-uav) for capture and safe recovery of rogue uav's



OVERVIEW

The **SPARROWHAWK** module is a Counter UAV (C-UAV) system designed to capture, and recover intact, a rogue UAV and its payload safely. **SPARROWHAWK** will stop fully autonomous UAVs up to 20kg, both rotary and fixed wing, and can be re-armed in just a few seconds for repeat sorties. Batteries can also be swapped in seconds, minimising downtime.

The **SPARROWHAWK** system is portable, reliable, quick to deploy and easy to operate. It comprises of the **RESPONDER** multi-copter UAV, weighted entanglement net, parachute, safety interlocked deployment system, EOIR camera aiming and target selection module.

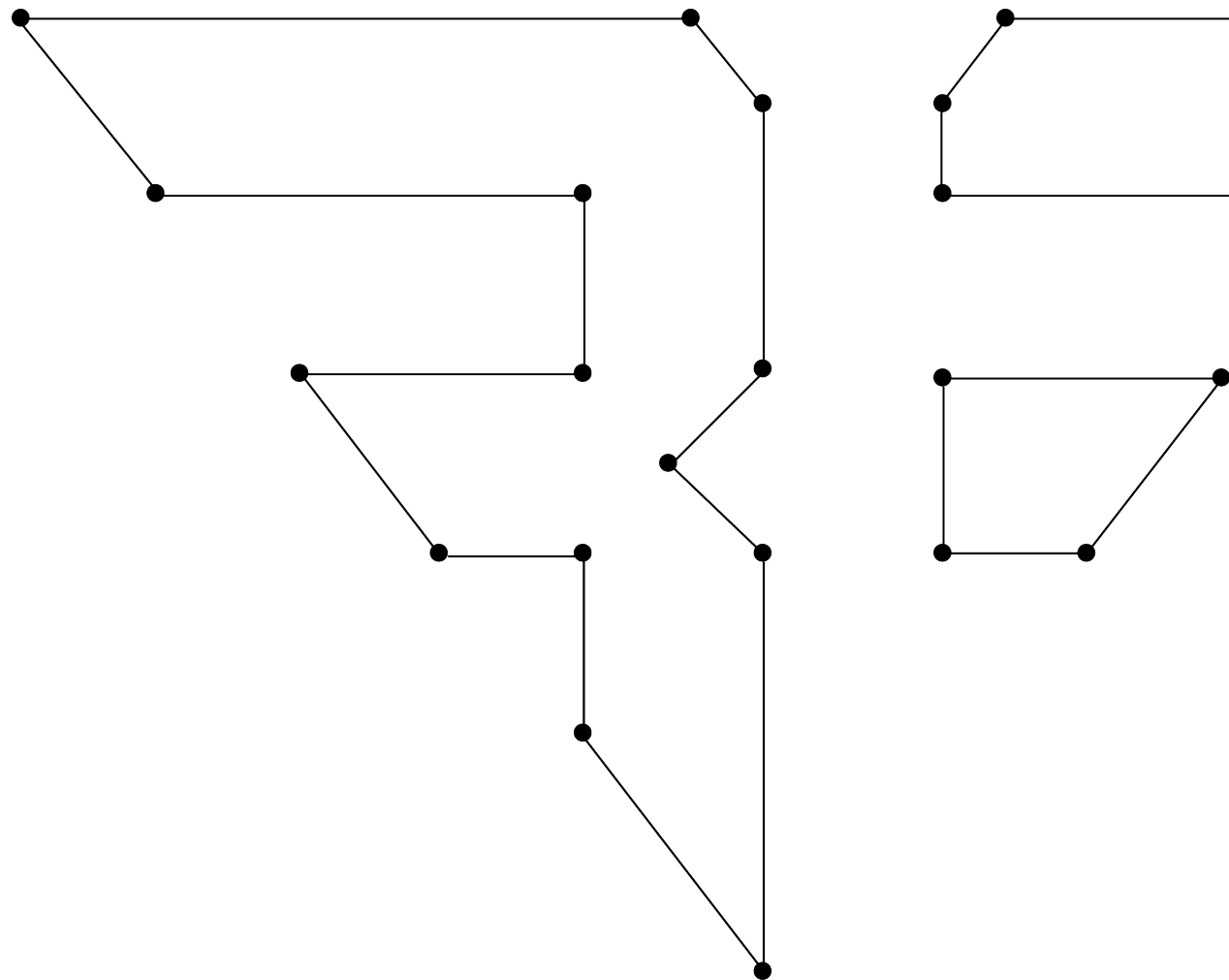
SPARROWHAWK operates with **RESPONDER'S** enhanced video relay and remote monitoring stations so both the pilot and observer/ commander at the scene and remote personnel can monitor an incident even in poor light conditions.

Transmitting via COFDM with optional encryption, the video relay is secure and reliable, giving operators the confidence to know that **SPARROWHAWK** will provide the images they need for assessment and decision making.



DRONE NETTING

DEMO



DEMO: Testing the SparrowHawk v2 Prototype

AIR-TO-AIR COMBAT DRONE DEFENSE WITH LARGE NET FOR SWOOPING

YouTube

Search



Drone Hacking: Testing the SparrowHawk v2 - Air-2-Air Drone w Swooping Big Net - 25July2017

Bishop Fox



JAMMING

**CANNONS SHOOTING JAMMING
SIGNALS OR EMPS TO KNOCK
DRONES OUT OF SKY**



Drone Defenses Gone Wild

CANNONS SHOOTING JAMMING OR EMP SIGNALS TO KNOCK DRONES OUT OF SKY

"10's of thousands of dollars"



[Mashable - DroneShield - DroneGun - Here is the anti-drone gun of your Rambo fantasies - 27Nov2016](#)

- DroneGun may **not** be used or offered for sale in the U.S., other than to the government and its agencies. That's because the FCC "prohibits the operation, marketing, or sale of any type of **jamming** equipment."*



DRONESHIELD



Exhibit 2: DroneShield Key Products

https://www.droneshield.com/sites/default/files/JAW_Drop_V27_04-25-17.pdf

Product	Function	Available To:	Pricing	Quick Details
 WideAlert Sensor	Passive Detection	Consumers and Up	~\$6k/yr (base)	180° detection coverage, up to 200m distance
 FarAlert Sensor	Passive Detection	Consumers and Up	~\$6k/yr (base)	30° detection coverage, up to 1000m distance
 DroneGun	Active Counter	Militaries International Federal Agencies	10s of thousands (outright purchase)	2km range; jams 2.4/5.8 GHz, with optional GPS, GLONASS capabilities
 DroneShield UI	Management Software	Consumers and Up	Free (included)	browser-based monitoring and control application
 DroneSentry (in development)	Detection + Counter	Militaries International Federal Agencies	N/A	all-in-one solution comprised of multiple sensors and integrated jamming for manual or automatic activation on detection

Source: Company reports; Oppenheimer & Co. Inc.

We detail late-2016/2017 DroneShield announcements below in Exhibit 3; the recent elevated level of significant news flow was reflected in the financials as 72% of the company's 2016 revenue came in the 4th quarter.

DroneGun – by DroneShield

- <https://www.droneshield.com/dronegun>

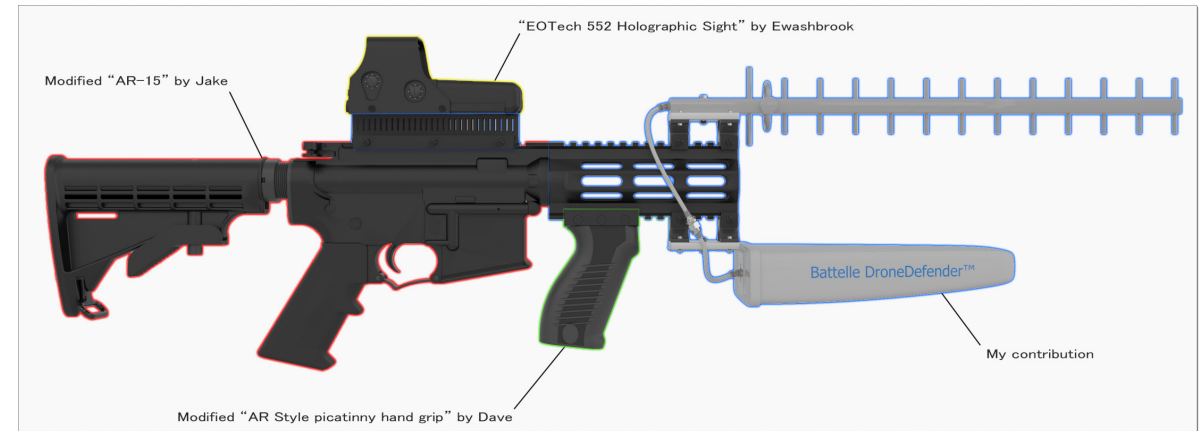
Drone Defenses Gone Wild

CANNONS SHOOTING JAMMING OR EMP SIGNALS TO KNOCK DRONES OUT OF SKY



[Security Affairs - DroneDefender, electromagnetic gun that shoot down drones - 16Oct2015](#)

- Only really work against Wi-Fi controlled drones, **ineffective** against those like the Danger Drone (i.e. **cellular/GPS control**)



DroneDefender – by Battelle

- <https://www.battelle.org/government-offerings/national-security/aerospace-systems/counter-UAS-technologies/dronedefender>

Drone Defenses Gone Wild

DRONE PORTABLE JAMMERS



DroneDefence.co.uk - Dynopis Electronic Counter Measures (ECM)



Dynopis E1000MP Operation

The E1000MP is the ultimate man portable anti-drone solution. It is a safe, simple to operate and can be carried effortlessly by law enforcement and security officers. The device uses focused electronic counter measures to block the drone's control, GPS and video signals while minimizing the impact on other local devices. With a range of up to 1km if you can see the drone then you can stop it.



*Depending on power settings and environmental conditions.



Dynopis E1000MP	Dynopis E200BC
	
Operating Frequencies 433MHz 2.4GHz GPS 5.8GHz	Operating Frequencies 433MHz 915Mhz GPS 2.4GHz 5.8GHz
Operational Range Omni-Directional Antenna - 500m Directional Antenna - 1km	Operational Range Up to 200m Omni-Directional
Weight 14.8kg without antennas	Weight 7kg including antennas
Effect on Drone Return to launch location or land immediately	Effect on Drone Return to launch location or land immediately



Drone Defense - Dynopis E1000MP - Man Portable Drone Jammer

• <http://www.dronedefence.co.uk/dynopis-ECM>

Drone Defenses Gone Wild

CANNONS SHOOTING JAMMING OR EMP SIGNALS TO KNOCK DRONES OUT OF SKY



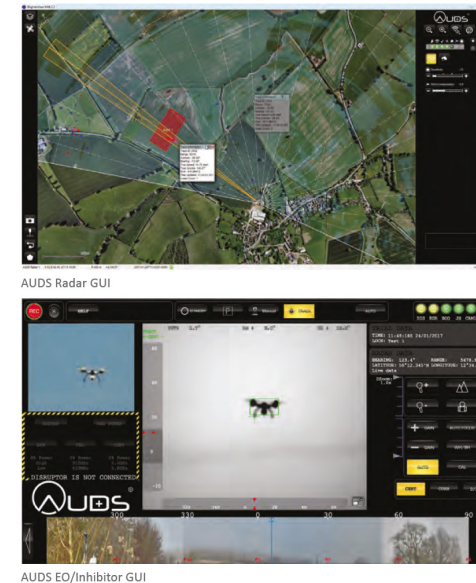
~£800k (~ \$1,037,656.00 USD)

[The Register - FAA to test Brit drone-busting kit \(Blighter\) - 01Jun2016](#)

- “The **Blighter AUDS counter-UAV system** can detect a drone six miles (10km) away using electronic scanning radar, track it using precision infrared and daylight cameras and specialist video tracking software before disrupting the flight using an **inhibitor to block the radio signals that control it**. This detect, track, disrupt, defeat process is very quick and typically takes 8-15 secs.”



Blighter AUDS (shown with Blighter A422 radar with W20S antennas)



Blighter[®]
Surveillance Systems



LITEYE

Blighter - AUDS (Anti-UAV Defence System) – Detect, Track, Disrupt, Defeat

- <http://www.blighter.com/products/auds-anti-uav-defence-system.html>

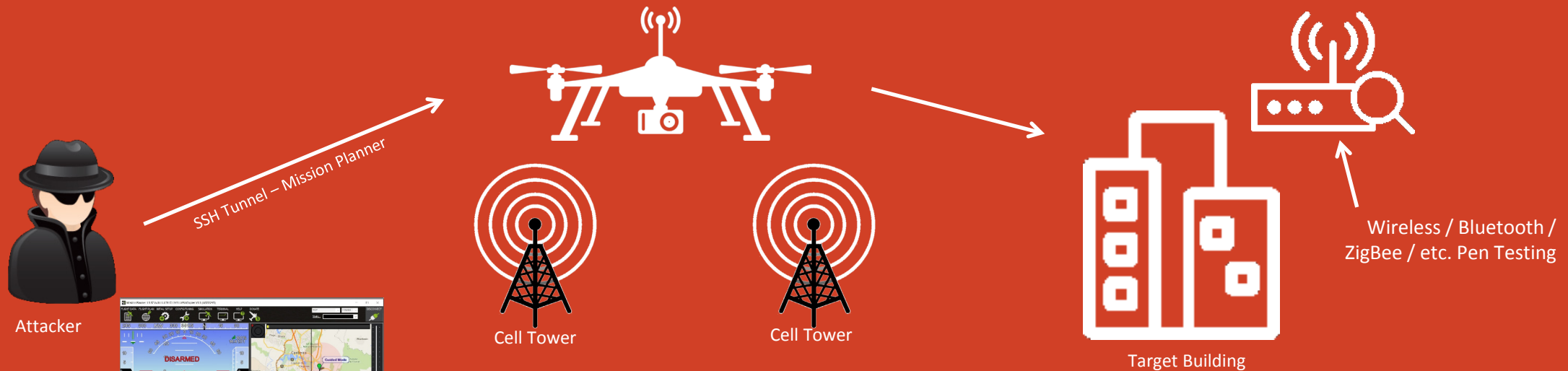
Defeating Jammers

HACKING PERIPHERALS – CELLULAR 3G USB & GPS – SECURE COMMAND & CONTROL



- Remote control over SSH tunnel via 3G USB cell connection. GPS & Cellular signals are illegal to jam (see FCC regulations), making it hard to defend against this type of drone.

- <https://transition.fcc.gov/eb/jammerenforcement/jamfaq.pdf>



Mission Planner



7.2 Mbps
3G USB Modem

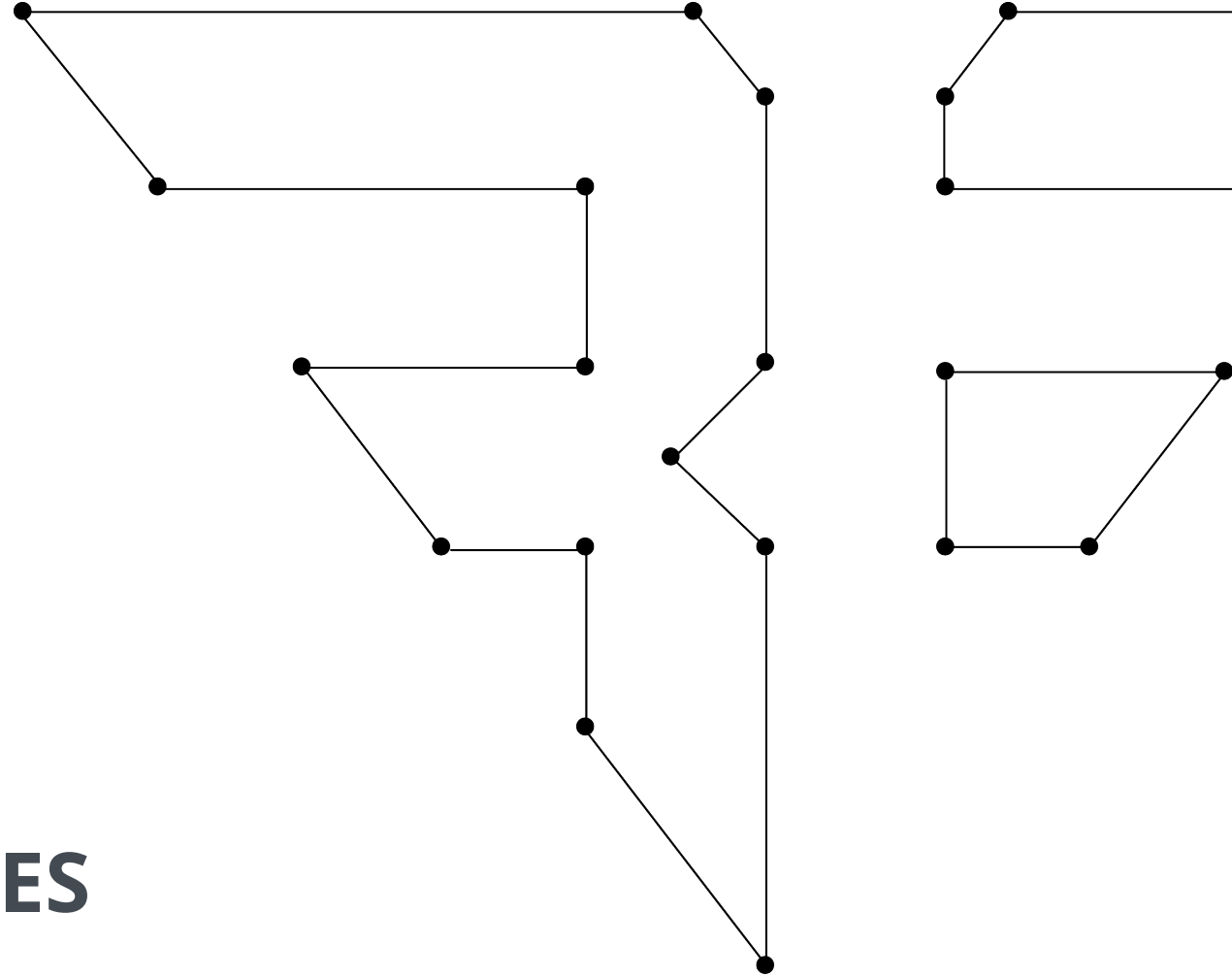
For Android Tablets and Windows Laptops



* **Note:** be sure to check upcoming FCC regulations about needing to keep drone within line of sight while flying.



REMOTELY HACKING DRONES TO DISABLE THEM



Drone Defenses Gone Wild

REMOTELY HACKING DRONES TO DEFEND AGAINST THEM

~\$311k



[Popular Science - Defense Company Unveils Anti-Drone System - 17Sept2015](#)

[Falcon Shield - 01Oct2015 - YouTube](#)

- “The **material is vague on how exactly it stops small drones**, but a video of the system shows the hypothetical threat: a quadcopter dropping a bomb in a stadium. The video then rewinds to show the same attack, foiled by Falcon Shield after mysterious beams take over the drone.”



Leonardo-Finmeccanica - Selex ES - Falcon Shield

- <http://www.leonardocompany.com/en/-/falcon-shield-launch>

Drone Defenses Gone Wild

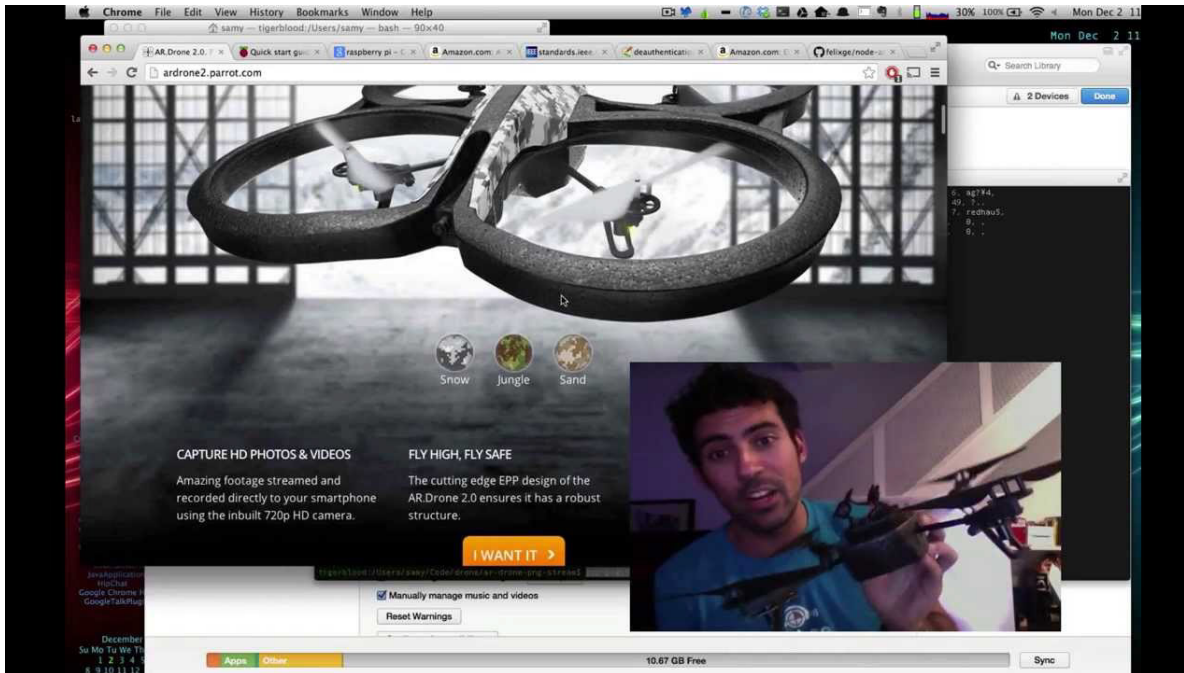
REMOTELY HACKING DRONES TO DEFEND AGAINST THEM



[Threatpost - How to Skyjack Drones for \\$400 - 03Dec2013](#)

[SkyJack - autonomous drone hacking w/Raspberry Pi, aircrack & Javascript - 03Dec2013 - YouTube](#)

- Raspberry Pi drone that autonomously seeks out, hacks, and takes remote control of other drones



SkyJack - Samy.pl - Raspberry Pi hacking

- <http://samy.pl/skyjack/>

Drone Defenses Gone Wild

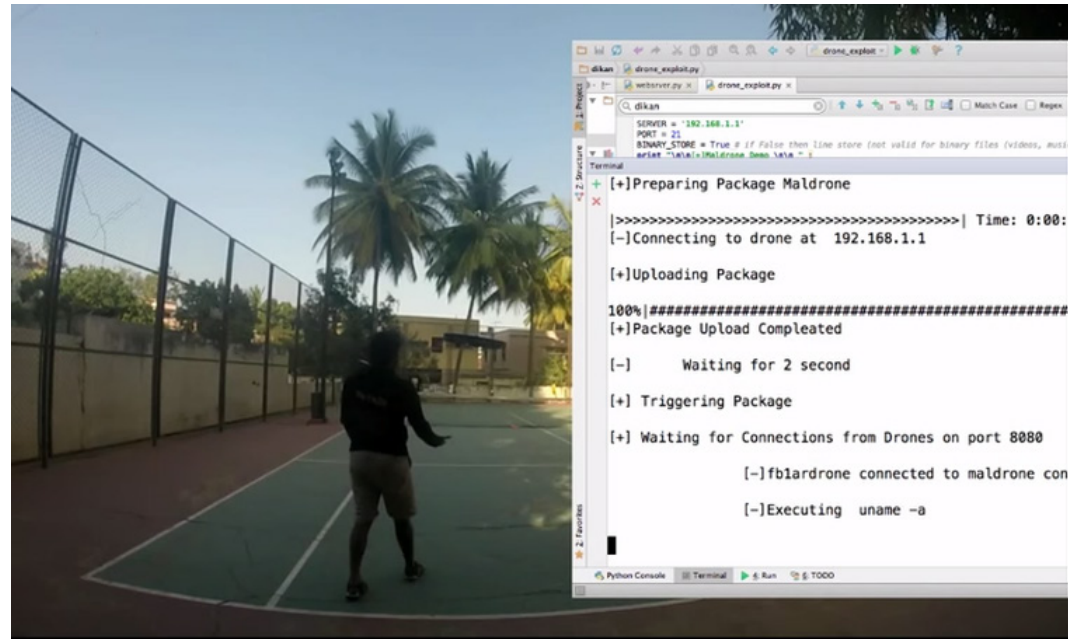
REMOTELY HACKING DRONES TO DEFEND AGAINST THEM



SecurityAffairs.co - A hacker developed Maldrone, the first malware for drones - 27Jan2015

[First Backdoor for Drones. Maldrone aka Malware for Drones - 26Jan2015- YouTube](https://www.youtube.com/watch?v=1a1a1a1a1a1)

- “Security expert Rahul Sasi has discovered and exploited a backdoor in Parrot AR Drones that allows him to remotely hijack the UAV with the malware Maldrone.”



Maldrone – the First Backdoor for Drones

- <http://garage4hackers.com/entry.php?b=3105>

Drone Defenses Gone Wild

CANNONS SHOOTING JAMMING OR EMP SIGNALS TO KNOCK DRONES OUT OF SKY



[DRONELIFE - Anti-Drone Gun Uses Raspberry Pi - 11 May 2016](#)

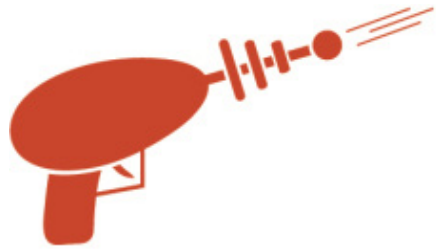
- Only really work against Wi-Fi controlled drones, **ineffective** against those like the Danger Drone (i.e. **cellular/GPS control**)

Make:



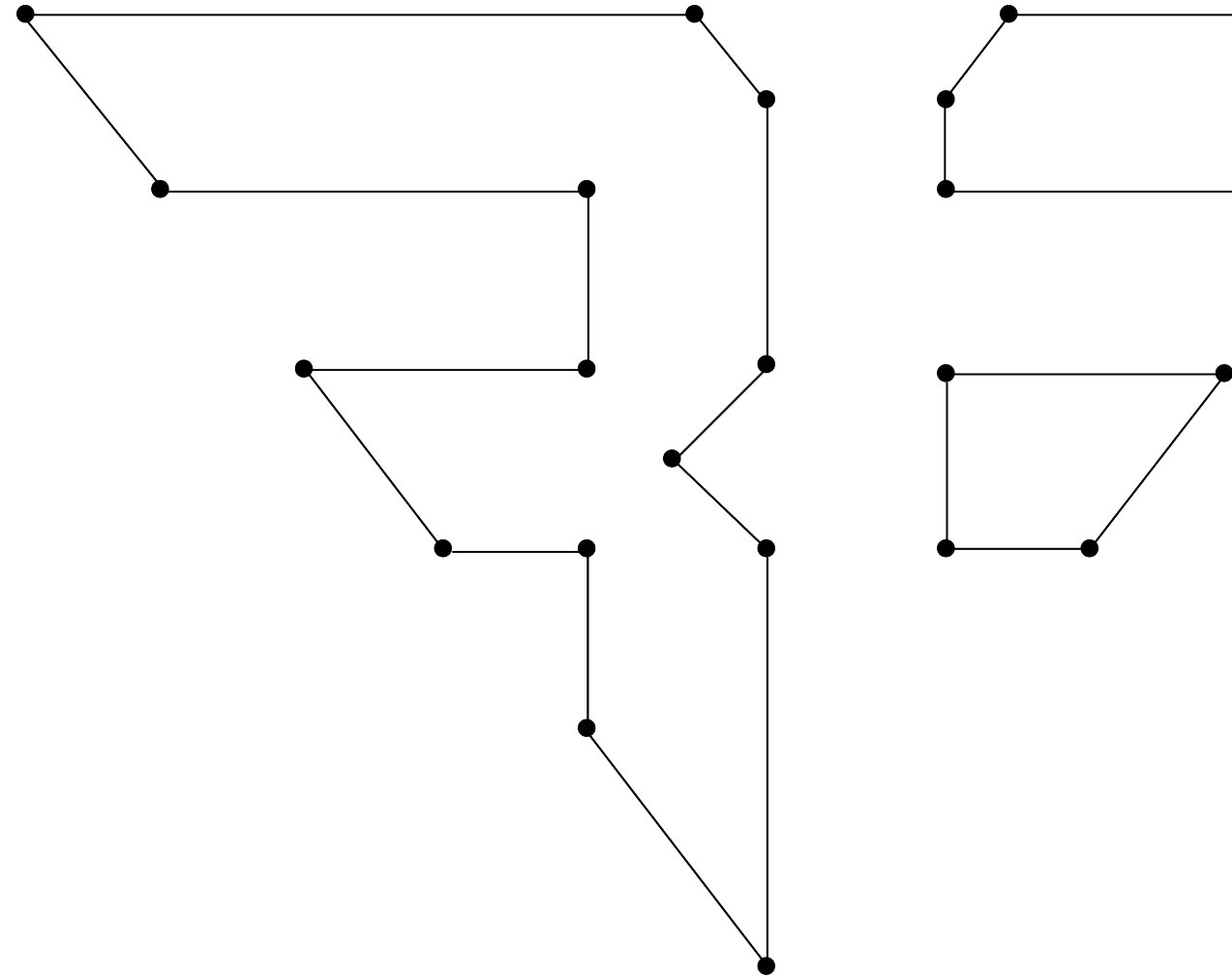
MAKE: Build a Wi-Fi Drone Disabler with a Raspberry Pi – May 2016

- <http://makezine.com/projects/build-wi-fi-drone-disabler-with-raspberry-pi/>



LASER

SHOOTING DRONES WITH FRICKIN LASER BEAMS



Drone Defenses Gone Wild

SHOOTING DRONES WITH FRICKIN LASER BEAMS

~\$11 million



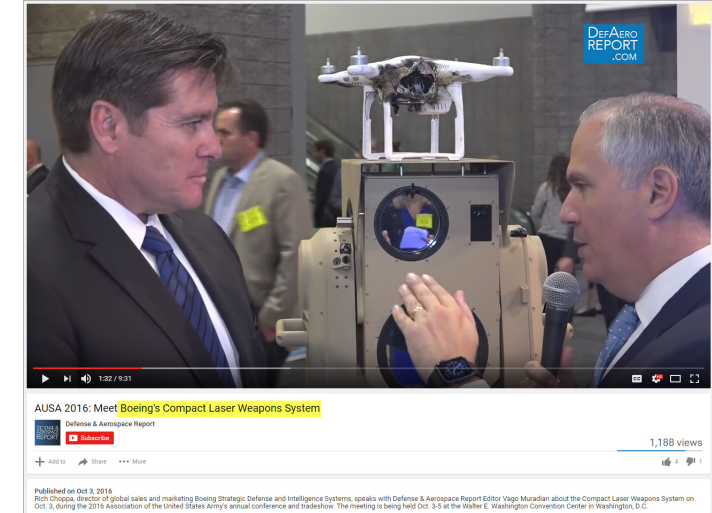
[LA Times - To keep drones out of high-risk areas, companies try hijacking them and shooting them down - 07Oct2016](#)

- “Last year, Boeing unveiled its compact laser weapons system, which ignites targeted drones. At a demonstration in California, Boeing said it took only about 15 seconds for its 2-kilowatt laser to disable the drone.”

[Wired.com - Welcome to the World, Drone-Killing Laser Cannon - 27Aug2015](#)

- “The laser can take the 220 volts of power it needs from a generator or mobile battery pack and is controlled with nothing more than a laptop and an Xbox 360 controller, and the system will take over to track and fire on a drone itself once it's in range.

[Boeing's Compact Laser Weapons System: Sets Up in Minutes, Directs Energy in Seconds - 27Aug2015 - YouTube](#)



Drone Defenses Gone Wild

SHOOTING DRONES WITH FRICKIN LASER BEAMS



POPULAR
SCIENCE

The Navy Is Going To Test A Big Laser Soon

150 kilowatts of directed energy, pointed at an unknown date on a calendar.

By Kelsey D. Atherton June 24, 2016



Laser Weapon System On The USS Ponce

US Naval Research, YouTube Screenshot

Damage done by laser weapons is a function of power and time. The longer a laser can stay on a target, like a drone or an incoming missile, the more damage it can do. The more powerful that laser is, the less time it needs to spend burning its target. The U.S. Navy already has a 30-kilowatt laser mounted on a ship. Yesterday, at a summit on directed energy weapons in Washington, D.C., the Navy announced it plans to go bigger: 150 kilowatts.



Not yet lethal ? 11 December 2014, Atlantic Ocean. Senior Chief Master-at-Arms Shannan Richardson receives training in the use of an LA-9/P laser aboard the amphibious transport dock ship USS Arlington. Seen here mounted on a rifle stock, this hand-held GLARE/LA 9/P laser from B.E. Meyers, is used by individual Sailors out to 4 km at night and 1.5 km during daylight for hail and warning across linguistic and cultural boundaries. U.S. Navy photo by Mass Communications Specialist 2nd Class Stevie Tate

U.S. Navy LaWS - AN/SEQ-3 Laser Weapon System or XN-1 LaWS

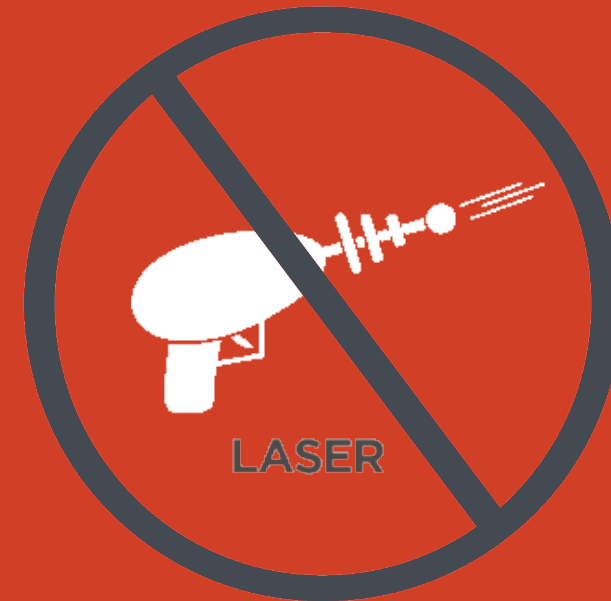
- https://en.wikipedia.org/wiki/Laser_Weapon_System

Defeating Laser Weapons

SHOOTING DRONES WITH FRICKIN LASER BEAMS



1. **Mirrors (Dielectric or Bragg)**
2. **Smoke, Dust, Obscurants**
3. **Thermal Transport Delay**
4. **Ablative Materials (heat -> gas)**
5. **Metamaterials (bend light like Predator)**
6. **Adsys Controls – Helio**
 - **Detects laser and fights back**



Popular Science - Drones Fight Back Against Laser Weapons - 04Nov2016

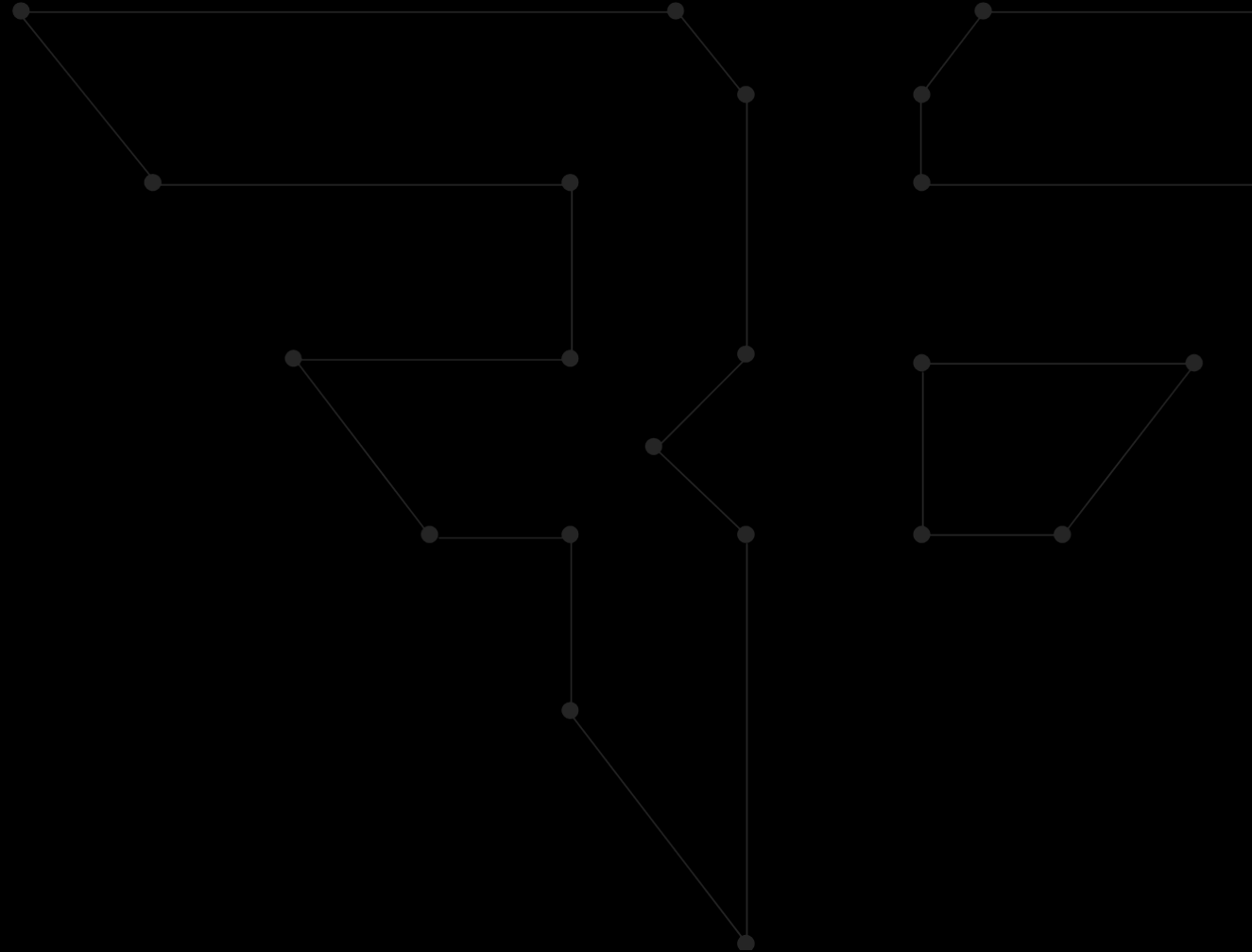
- <http://www.popsci.com/laser-guns-are-targeting-uavs-but-drones-are-fighting-back>

Counter Directed Energy Weapons - Office of Naval Research

- <https://www.onr.navy.mil/en/Media-Center/Fact-Sheets/Counter-Directed-Energy-Weapons.aspx>

LEGAL ISSUES

YOU HAVE THE RIGHT TO REMAIN FRUSTRATED



FAA Rule on Small Drones

CHANGING LEGAL LANDSCAPE

- <https://registermyuas.faa.gov/>

Effective: 29 Aug 2016

**Federal Aviation
Administration**

New Account Login

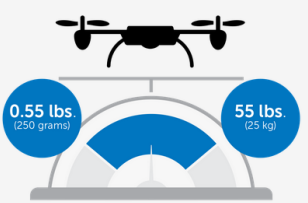
Welcome to the Small
Unmanned Aircraft System
(sUAS) Registration Service

This site will allow you to register your small UAS
with the FAA and update your registration.

REGISTERLEARN MORE

Do I need to register my Unmanned Aircraft?

You need to register your aircraft if it weighs between **0.55 lbs.**
(250 grams) and up to **55 lbs.** (25 kg)



You will be subject to civil and criminal penalties if you meet
the criteria to register an unmanned aircraft and do not register.

The rules for operating an unmanned aircraft depend on why you want to fly.

	Fly for Fun	Fly for Work
Pilot Requirements	No pilot requirements	Must have Remote Pilot Airman Certificate Must be 16 years old Must pass TSA vetting
Aircraft Requirements	Must be registered if over 0.55 lbs.	Must be less than 55 lbs. Must be registered if over 0.55 lbs. (online) Must undergo pre-flight check to ensure UAS is in condition for safe operation
Location Requirements	5 miles from airports without prior notification to airport and air traffic control	Class G airspace*
Operating Rules	Must ALWAYS yield right of way to manned aircraft Must keep the aircraft in sight (visual line-of-sight) UAS must be under 55 lbs. Must follow community-based safety guidelines Must notify airport and air traffic control tower before flying within 5 miles of an airport	Must keep the aircraft in sight (visual line-of-sight)* Must fly under 400 feet* Must fly during the day* Must fly at or below 100 mph* Must yield right of way to manned aircraft* Must NOT fly over people* Must NOT fly from a moving vehicle*
Example Applications	Educational or recreational flying only	Flying for commercial use (e.g. providing aerial surveying or photography services) Flying incidental to a business (e.g. doing roof inspections or real estate photography)
Legal or Regulatory Basis	Public Law 112-95, Section 336 – <i>Special Rule for Model Aircraft</i> FAA Interpretation of the Special Rule for Model Aircraft	Title 14 of the Code of Federal Regulation (14 CFR) Part 107

i The **NEW** Small UAS Rule (Part 107), including all pilot and operating rules, will be effective on **August 29, 2016**. For more detailed information, please see:

- [Summary of the Small UAS Rule \(PDF\)](#)
- [Small UAS Advisory Circular – How to Use the Rule \(PDF\)](#)
- [Complete Text of the Small UAS Rule](#)
- [Sample Aeronautical Knowledge Test Questions \(PDF\)](#)

Need more information? [Read about how to fly a UAS for your work or business.](#)

Taylor vs. FAA - Lawsuit Against Drone Rule

CHANGING LEGAL LANDSCAPE



19 May 2017

[RC Groups - Taylor v. FAA Update - 04Mar2017](#)

[DRONELIFE - The Lawsuit Over Drone Registration: Taylor vs. Huerta & FAA - 14Jun2016](#)

[Hackaday - Don't Like the FAA's Drone Registration? Sue Them! - 26Sept2016](#)

- “My case challenging the FAA's model aircraft registration regulation, and the application of DC-area flight zones to model aircraft is scheduled for **oral argument** in the U.S. Court of Appeals for the D.C. Circuit on **March 14, 2017.**”

How a little-known insurance lawyer became a symbol of (drone) liberty

When the Federal Aviation Administration started enforcing new rules around model aircraft pilots, John Taylor went from drone hobbyist to crusader.



John Taylor and one of the drones he custom built.

Slashdot

Stories

Firehose >

All

Popular

Polls

Deals

Submit

Americans No Longer Have To Register Non-Commercial Drones With the FAA

(recode.net)



113

Posted by msmash on Friday May 19, 2017 @03:20PM from the go-and-be-happy dept.

A federal appeals court on Friday struck down a federal rule that required owners of recreational drones and other model aircraft to register the devices with the Federal Aviation Administration. The FAA had announced the rule in 2015 in response to growing reports of drones flying near manned aircraft and airports. Drones have become increasingly popular with hobbyists and more than 550,000 unmanned aircraft were registered within the first year it was required. From a report:

The court ruled that the FAA's drone registration rules, which have been in place since 2015, were in violation of a law passed by Congress in 2012. That law, the FAA Modernization and Reform Act, prohibited the FAA from passing any rules on the operation of model aircraft -- in other words, rules that restrict how non-commercial hobbyist drone operators fly. Now, if a person buys a new drone to fly for fun, they no longer have to register that aircraft with the FAA. But if flying for commercial purposes, drone buyers still need to register. The lawsuit was won by John Taylor, a model aircraft enthusiast, who brought the case against the FAA in January 2016. Since first opening the FAA's registration system in December 2015, more than 820,000 people have registered to fly drones.

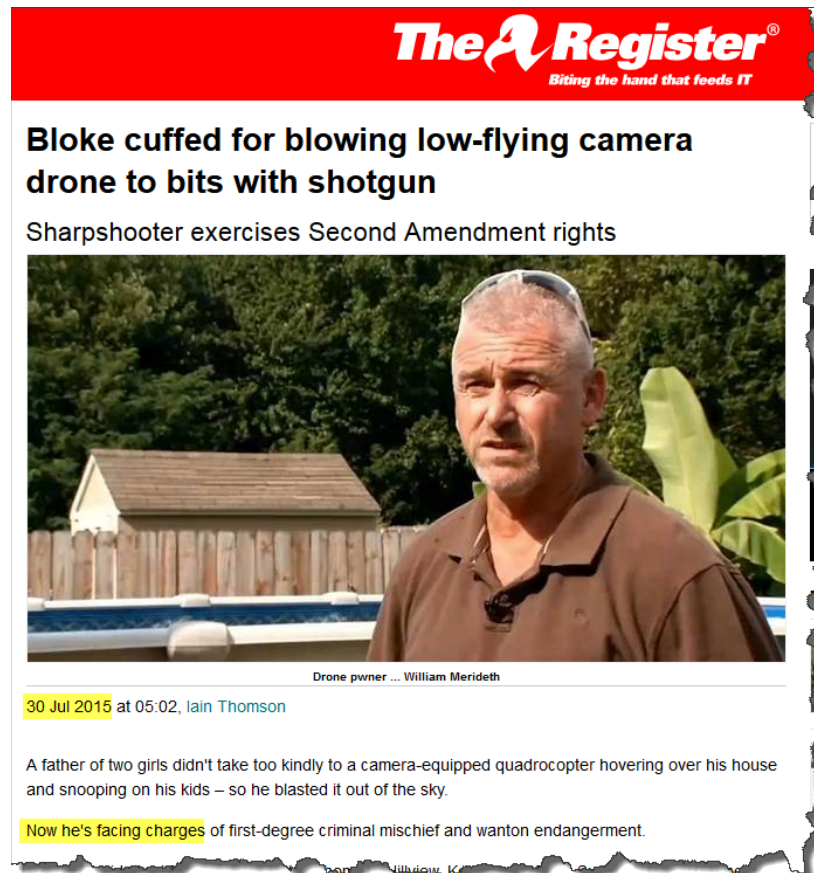
Hard to Legally Defend Against Drones

IF YOU CAN'T JAM THE SIGNAL, AND YOU CAN'T BLAST WITH A SHOTGUN... THEN WHAT?



[The Register - Bloke cuffed for blowing low-flying camera drone to bits with shotgun - 20July2015](#)

[Digital Trends - Drone Shooting is a Federal Crime - 17Apr2016](#)



*"What the h*** are we supposed to use, man, harsh language?" – Aliens (1986)*

WARNING: Shooting LiPo Batteries Is Dangerous

BASICALLY AN UNSTABLE BOMB – POKE AND IT BLOWS UP



YouTube - What happens when you puncture a LiPo battery - July2014

- <https://www.youtube.com/watch?v=wUFxlf4fXjo>

Hard to Legally Defend Against Drones

IF YOU CAN'T JAM THE SIGNAL, AND YOU CAN'T BLAST WITH A SHOTGUN... THEN WHAT?



[Digital Trends - Drone Shooting is a Federal Crime - 17Apr2016](#)

Aircraft Sabotage Law:

"Conviction for violating the FAA statute could result in a 5-year prison term."

EVEN IF YOU'RE BOTHERED BY THAT DRONE OVER YOUR HOUSE, YOU CAN'T SHOOT IT DOWN

By Bruce Brown — April 17, 2016 7:26 AM



You can't shoot drones, it's a federal crime

The FAA wants people to stop shooting drones. At least 12 drones have been shot out of the sky in five U.S. states and the Federal Aviation Authority says it's a federal crime, according to a report in [Forbes](#). Even if they're over your house. Even if they're carrying running chainsaws.

The FAA says you can't shoot them down and you can't disturb or interfere with someone flying a drone. Apparently drone pilot harassment is a bit less of an issue than, say, banging on the flight deck door on a passenger aircraft, but it's still against the law. Enforcement, however, seems sketchy — as in, no one's been arrested yet under the federal statute.

In response to a question from a Forbes reporter, the FAA cited statute 18 USC 32. The aircraft sabotage law authorizes prosecution of anyone who damages an aircraft or commits a violent act against persons operating the aircraft, or even in the aircraft, should that act endanger the safety of the aircraft. Exactly what constitutes an "act of violence" is not defined in the statute, but clearly shooting a drone or its pilot would qualify.

FUTURE IS AWESOME

1980'S SCI-FI... FINALLY HAPPENING



The Future was on TV in the Past

GADGETS – SMALLER **FLYING DEVICES** & DROPPING OFF **GROUND DEVICES**



1. Drone Swarms
2. Hybrid Approaches
3. Under-water Drone
4. Micro / Bug-sized Drones



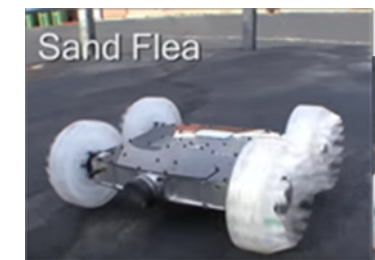
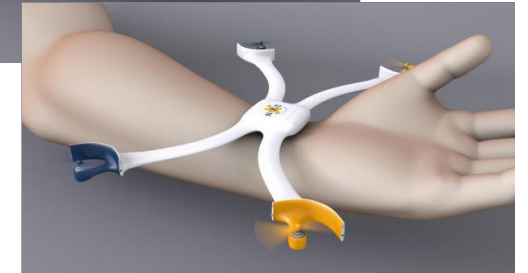
24 (TV) – Spy Bot



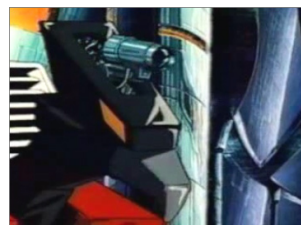
Call of Duty - RC-XD Remote Control Car (w Camera/Mic)



Wearable drones



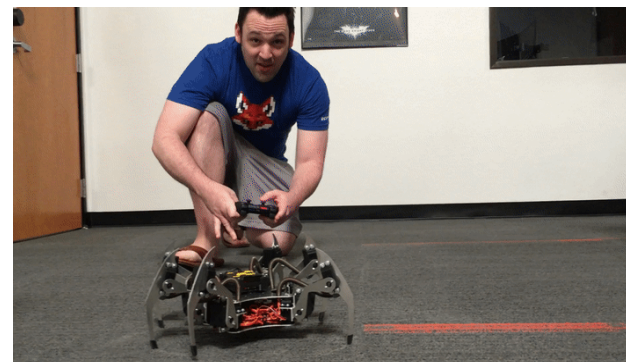
Sand Flea - Jumping Infiltrating Robot



Transformers – Laserbeak



Erle-Spider
The Linux legged drone



The Future was on TV in the Past

GADGETS – SMALLER **FLYING DEVICES** & DROPPING OFF **GROUND DEVICES**

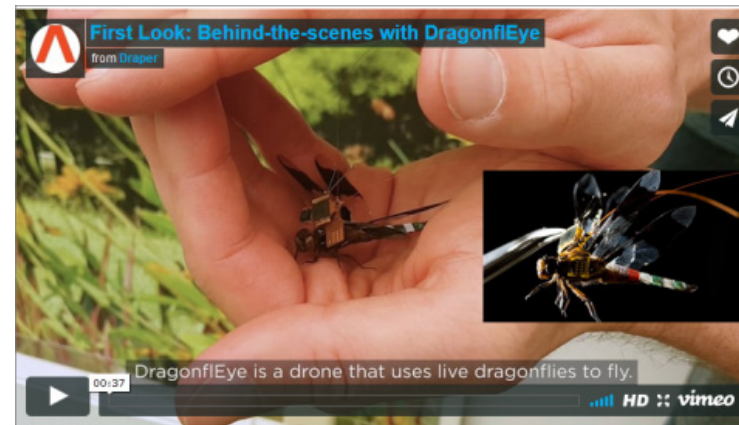
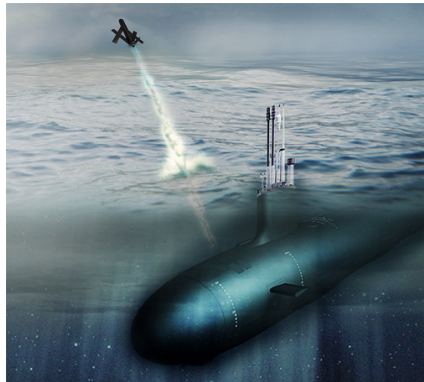


1. Drone Swarms
2. Hybrid Approaches
3. Under-water Drone
4. Micro / Bug-sized Drones



US Army – Micro Copters

This low-cost underwater drone aims to democratize the ocean for wannabe treasure hunters



DragonFly Cyborgs



The Future was on TV in the Past

GADGETS – SMALLER **FLYING DEVICES** & DROPPING OFF **GROUND DEVICES**

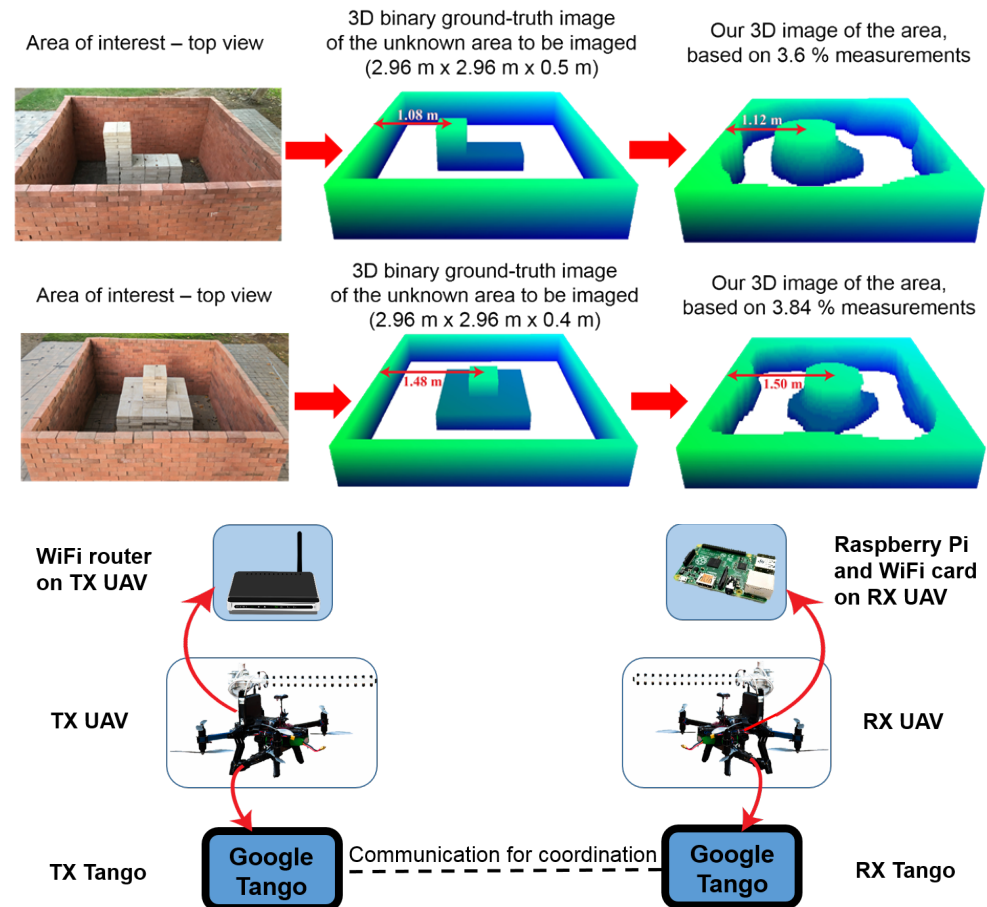


Drones can now see through walls — sort of.

Researchers at the University of California, Santa Barbara, just figured out how to use [Wi-Fi signals and drones](#) to create 3D maps of the inside of buildings. The video above demonstrates their process, which is also detailed in a [paper](#) published online.

For the experiment the team used two drones. One sent Wi-Fi signals from one side of the structure, while the other picked up what was left of the signal (the received signal strength or RSSI) on the other side of the walls. The result is a pretty decent image of what's inside the building.

Instead of Superman and X-ray vision, we have drones and Wi-Fi. But like Superman, the drones might be able to take some 3D measurements of the inside of collapsed buildings and so on before emergency rescue arrives.

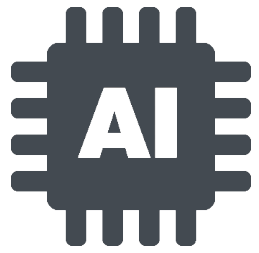


Mashable - These drones use wifi to make 3D images - 20Jun2017

• <http://mashable.com/2017/06/20/drones-3d-wifi-map/>

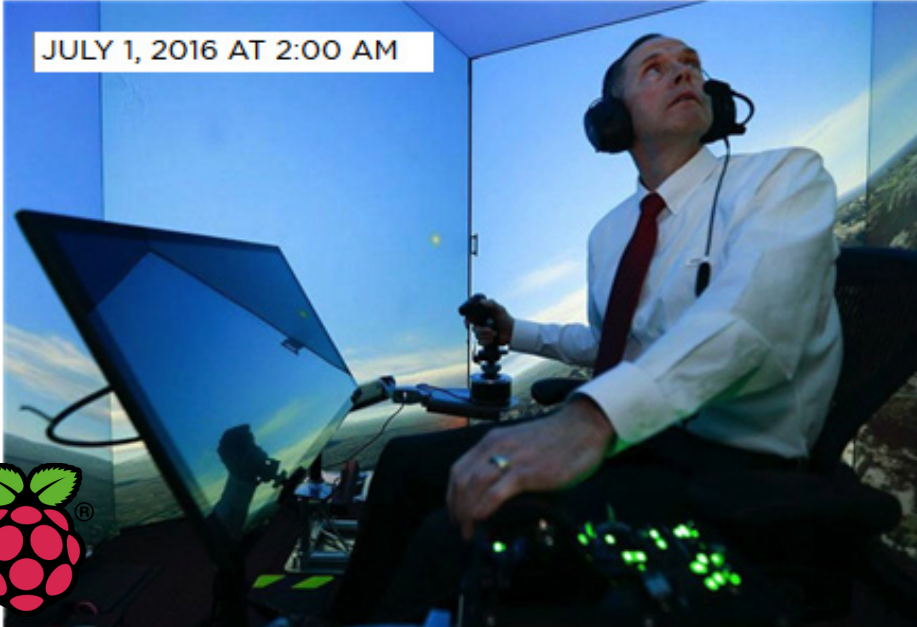
The Future was on TV in the Past

GADGETS – SMALLER **FLYING DEVICES** & DROPPING OFF **GROUND DEVICES**



Raspberry Pi-Powered AI Beats Human Pilot in Dogfight

JULY 1, 2016 AT 2:00 AM



An AI that runs on Raspberry Pi made headlines in [Newsweek](#) this past week.

When the Raspberry Pi computer was first launched in 2012 to promote the teaching of computer science, its creators probably didn't imagine the \$35 device would one day take on a professional fighter pilot in a dogfight—and win.

But that is exactly what a doctoral graduate at the University of Cincinnati set out to do when he built a Pi-powered artificial intelligence pilot. The AI, dubbed ALPHA, went up against retired United States Air Force Colonel Gene Lee in a series of simulated battles, beating Lee in every single engagement.

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Aerial Informatics and Robotics Platform

Established: February 15, 2017

Bridging the simulator-to-reality gap with **Aerial Informatics and Robotics** platform

Machine learning is becoming an **increasingly important artificial intelligence approach to building autonomous and robotic systems**. One of the key challenges with machine learning is the need for many samples — the amount of data needed to learn useful behaviors is prohibitively high. In addition, the robotic system is often non-operational during the training phase. This requires debugging to occur in real-world experiments with an unpredictable robot.

Autonomous robot security guard has a built-in drone to stop intruders





THANK YOU
THANK YOU
THANK YOU
THANK YOU
THANK YOU
THANK YOU

Have A Nice Day

Bishop Fox – Danger Drone Research:

- <http://dangerdrone.io>

Attributions (Images in Slides)

[Wi-Spy image](#)

[Adapter image](#)

[ASUS USB image](#)

[Wi-Fi Antenna image](#)

[Blue-Tooth USB adapter image](#)

[Roving Networks image](#)

[BlueSMiRF image](#)

[Arduino BlueTooth image](#)

[Raspberry Pi BlueTooth image](#)

[O'Reilly BlueTooth Book image](#)

[SENA Adapter image](#)

[Wi-Fi Pineapple image](#)

[Raspberry Pi image](#)

[BlueTooth Module Breakout image](#)

[BlueTooth Bee image](#)

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