SpotterRF

Protection Beyond Fences™

Mitigating the Drone Threat

Counter Drone - Threat and Mitigation Rev 001

MITIGATING THE DRONE THREAT

Mitigating the Drone Threat

Most Organizations Have Mature 2-D:
-Threat Assessment
-Vulnerability Assessment
-Countermeasures Implementation
-Risk Management

3-D Threat Brings New Challenges:

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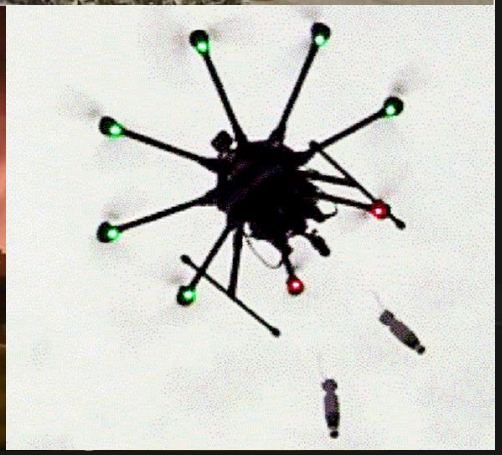
Modern Threat Reality

MULTIPLE UAV/CUAVs ARE CREDIBLE TODAY

- Cooperative **swarms** coming soon
  - *- Poor-Man's MIRV*
  - - Overwhelm response capability
- Few/no pilot skills needed
- Minimal risk to pilots
- Pilots quickly shift to other attack duties
- Payload
  - - 1-2lbs (Phantom4, Disco), 11-15lbs (S1000)
  - - Near Future: 20-40lbs (p107), 60-100lbs
- Range: 1 to 20+ miles

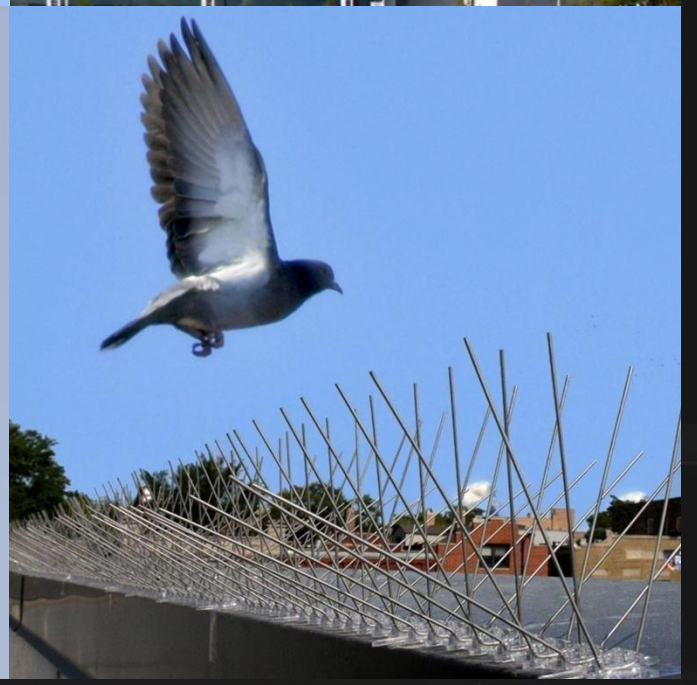


Prevention

Passive Mitigation:
A Resilient Foundation
Inform and Warn

Mitigation structures above ground-level

Response force
- Random facility egress options with cover/concealment, good camera coverage
- No Congregation
- Movement



Response Procedures

PASSIVE THREAT (Containment)
- Find the pilot

- Roles / responsibilities for intercepting the pilot and drone

- Security alerts – communication

- Possible lock down

- Possible movement of people until vulnerability nutralized

MALICIOUS THREAT (Save Lives)
- All Hands on Deck

- Roles for emergency response

- Emergency communication

- Evacuation or Shelter in place

- Lock down

- Law enforcement engagement / alerts

- Technology counter measures – if appropriate

RECOVERY
- Assess Impact

- Emergency Recovery Plans

- Disaster Recovery

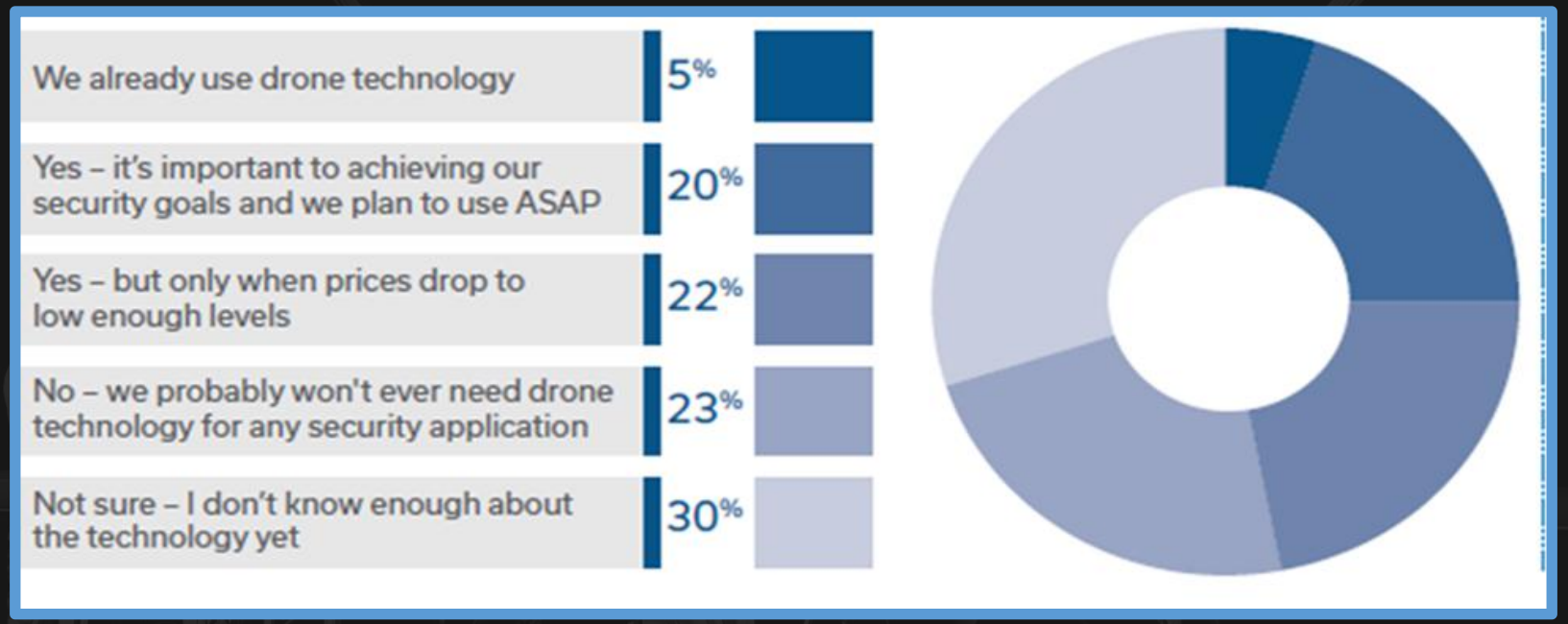
- Business Continuity

REPORT
- Witness documentation - Identification of pilot / operator
- Collect evidence (chain of custody) - Document event & Impact


COUNTER DRONE
TECHNOLOGY

Counter Drone Tech

Counter-drone Technology Survey



Counter Drone Tech

C-UAS PRODUCTS AT-A-GLANCE

Number of C-UAS products	235
Number of manufacturers	155
Systems capable of detection only	88
Systems capable of interdiction only	80
Of both detection and interdiction	67

C-UAS INTERDICTION METHODS

Jamming (RF, GNSS, or Both)	96
Net	18
Spoofing	12
Laser	12
Machine Gun	3
Electromagnetic Pulse	2
Water Projector	1
Sacrificial Collision Drone	1
Other	6

Counter Drone Tech

Radar	Detects the presence of small unmanned aircraft by their radar signature, which is generated when the aircraft encounters RF pulses emitted by the detection element.[19] These systems often employ algorithms to distinguish between drones and other small, low-flying objects, such as birds.
Radio-frequency (RF)	Identifies the presence of drones by scanning for the frequencies on which most drones are known to operate. Algorithms pick out and geo-locate RF-emitting devices in the area that are likely to be drones.
Electro-Optical (EO)	Detects drones based on their visual signature.
Infrared (IR)	Detects drones based on their heat signature.
Acoustic	Detects drones by recognizing the unique sounds produced by their motors. Acoustic systems rely on a library of sounds produced by known drones, which are then matched to sounds detected in the operating environment.
Combined Sensors	Many systems integrate a variety of different sensor types in order to provide a more robust detection capability. For example, a system might include an acoustic sensor that cues an optical camera when it detects a potential drone in the vicinity. The use of multiple detection elements may also be intended to increase the probability of a successful detection, given that no individual detection method is entirely failproof.

Counter Drone Tech

	Main Limitations
Optical	Narrow field of view and only works during the day
Acoustic	Does not provide precise location data and does not work well in noisy urban environments, constant updates of acoustic profiles required
Thermal	Narrow field of view that is limited by moisture in the air
Radio Freq	Can not detect drones that are flying autonomously with no emissions and difficult to use in urban environments with many RF transmitters. High False Alarms
Large Radar	Unable to operate in urban environments and easily overwhelmed by bird detections and requires secondary sensor for identification
Compact Radar	Works well in urban environments but requires multiple radars for a complex terrain and a secondary sensor for identification and evaluation of the threat

Counter Drone Tech

	Night & Day	Rain	Fog	Snow	Urban Clutter	Wide Area Coverage	Detect Autonomous	Precise Location
Optical	⊘	⊘	⊘	⊘	✓	⊘	✓	⊘
Acoustic	✓	⊘	✓	⊘	⊘	• 100m-1km	✓	⊘
IR	✓	⊘	⊘	⊘	✓	⊘	✓	⊘
Radio Freq (RF)	✓	✓	✓	✓	•	✓ 4km	⊘	•
Large Radar	✓	✓	✓	✓	⊘	✓ 1-3km	✓	✓
Compact Radar	✓	✓	✓	✓	✓	• 1km	✓	✓

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Counter Drone Tech

Combined Sensor Systems

Primary Sensor: Radar for consistent detection over wide areas
Secondary Sensors: RF Radios and Cameras for confirmation and evaluation

Homeland Security
Science and Technology

Market Survey Report
Sept. 2017

SpotterRF

Counter Drone Tech

Response Systems

RF Jamming	Disrupts the radio frequency link between the drone and its operator by generating large volumes of RF output. Once the RF link, which can include WiFi links, is severed, a drone will either descend to the ground or initiate a "return to home" maneuver.
GNSS Jamming	Disrupts the drone's satellite link, such as GPS or GLONASS, which is used for navigation. Drones that lose their satellite link will hover in place, land, or return to home.
Spoofing	Allows one to take control of the targeted drone by hijacking the drone's communications link. (Also known as protocol manipulation.)
Laser	Destroys vital segments of the drone's airframe using directed energy, causing it to crash to the ground.
Nets	Designed to entangle the targeted drone and/or its rotors.
Projectile	Employs regular or custom-designed ammunition to destroy incoming unmanned aircraft.
Combined Interdiction Elements	A number of C-UAS systems also employ a combination of interdiction elements—most commonly, RF and GNSS jamming systems that work in tandem.

Counter Drone Tech

CHALLENGES / LIMITATIONS of C-UAS Response Technologies

Drone on Drone: Can be dangerous, very difficult in practice and ineffective for a swarm attack

Kinetic Counter Drone: Can be dangerous, when having flight interrupted by physical means will fall to the ground at considerable speed. Considered by many as inappropriate for use over crowds.

RF Jamming Systems: work by disrupting the drone's communication; drones can be programmed to operate autonomously without an active RF link. Jamming systems could also interfere with legitimate communication.

Drone technology itself is not standing still…. Requiring constant response to advancing technology.


LEGALITY

Legality

Overview of legal barriers to counter-UAS interventions

Many countermeasures for detecting and mitigating unmanned aircraft systems (UAS)/drones are considered illegal under certain federal laws that were enacted at a time when advanced UAS technology was unforeseen. Depending on the technique, one or more of the following statutes or regulations, and potentially others, may be violated:

Access to protected computers
Computer Fraud and Abuse Act, 18 U.S.C. Section 1030

Electronic communications
- *Wiretap Act, 18 U.S.C. Section 2511*
- *Pen/Trap Statute, 18 U.S.C. 3121*
- *Communications Act of 1934, as amended, 47 U.S.C. §§ 301, 302a(b), 333.*

Interference with civil aircraft
Aircraft Sabotage Act, 18 U.S.C. Section 32

Legality

There is a growing recognition in Washington of the urgent need to address the potential threat posed by unauthorized drone operations

In 2016, Congress granted counter-UAS authorities to two federal agencies:

DOE Fact Sheet

Legality

In 2018 as part of the FAA Reauthorization Act and the Preventing Emerging Threat Act the following agency were given drone mitigation authority

DHS Counter Drone Fact Sheet

Legality

FAA Reauthorization Act

Overview

- Places limits on the interception of communications obtained in the course of lawful and appropriate Counter-UAS operations.

- Mirrors the legislative language included in FY17 and FY18 NDAAs providing counter-UAS authorities to DOD

- Limits what DOJ and DHS can protect and who can carry out these activities.

What you can do?

Contact your Representative and Senators to share your views regarding counter-UAS authorities
- Visit these sites to identify your individual congressman/congresswoman and Senators and get contact info. – house.gov; senate.gov

Consider engaging in trade association activities focused on advancing counter-UAS issues
- Talk to representatives from the Security Industry Association (SIA) or other groups to find out what they are doing in this area and how you can get involved

Participate in federal rulemaking process developing counter-UAS regulatory framework
- Visit reginfo.gov to monitor rulemaking developments and to identify opportunities to submit formal comments

APPENDIX

Appendix

Why the status quo is untenable – the careless, clueless and criminal

Proliferation of drones expected to give rise to incidents involving the "careless and clueless."

Over the next five years, the FAA projects that the hobbyist and commercial small UAS (sUAS)/drone fleets in the U.S. will increase exponentially:

Type	2016	2021	Percent change
Hobbyist	1.1 million	3.55 million	222%
Non-Hobbyist (Commercial)	42,000	420,000	900%
Total	*1.142 million*	*3.97 million*	*247%*

Source: FAA Aerospace Forecast 2017-37

Capabilities of drones make them attractive for "criminal" use.

"Terrorist organizations have an interest in using drones…..I think the expectation is that it is coming here, imminently."

- FBI Director Christopher Wray, testifying before Senate Committee on Homeland Security and Governmental Affairs (9/27/17)

Appendix

FAA Drone Incident Reporting

Document and provide the following information to FAA:

- Identity of operators and witnesses (name, contact information)
- Type of operation (hobby, commercial, public/governmental)
- Type of device(s) and registration information (number/certificate)
- Event location and incident details (date, time, place)
- Evidence collection (photos, video, device confiscation)

Contact your FAA LEAP agent or an FAA Operations Center for assistance.

FACILITY	STATES	PHONE NUMBER	EMAIL
Western ROC	AK, AZ, CA, CO, HI, ID, MT, NV, OR, UT, WA and WY	425-227-1999	9-WSA-OPSCTR@faa.gov
Central ROC	AR, IA, IL, IN, KS, LA, MI, MN, MO, ND, NE, NM, OH, OK, SD, TX and WI	817-222-5006	9-CSA-ROC@faa.gov
East ROC	AL, CT, FL, GA, KY, MA, ME, MS, NC, NH, PR, RI, SC, TN, VI and VT	404-305-5180	9-ESA-ROC@faa.gov
East ROC	DC, DE, MD, NJ, NY, PA, VA and WV	404-305-5150	9-ESA-ROC@faa.gov

Appendix

Basic Law Enforcement Response D.R.O.N.E.

Direct attention outward and upward, attempt to locate and identify individuals operating the drone. (Look at windows/balconies/roof tops).

Report incident to the FAA Regional Operations Center (ROC). Follow-up assistance can be obtained through FAA Law Enforcement Assistance Program special agents.

Observe the UAS and maintain visibility of the device, look for damage or injured individuals. **Note:** Battery life is typically 20 to 30 minutes.

Notice features: Identify the type of device (fixed-wing/multi-rotor), its size, shape, color, payload (i.e., video equipment), and activity of device.

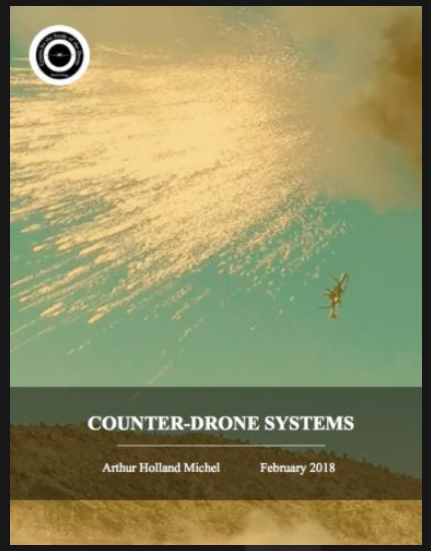
Execute appropriate police action: Maintain a safe environment for general public and first responders. Conduct a field interview and document ALL details of the event per the guidance provided by the FAA. www.faa.gov/uas/resources/law_enforcement/

Always follow agency policies *– Take appropriate action based on the facts and circumstances of the incident and site/area-specific laws and rules. The FAA's enforcement action does NOT impact ANY enforcement action/s taken by law enforcement.*

Local ordinances that may apply include, but are not limited to: *Reckless endangerment, criminal mischief, voyeurism, inciting violence.*

Appendix

Counter UAS Product Catalog



ABOUT THE CENTER FOR THE STUDY OF THE DRONE

The Center for the Study of the Drone at Bard College is an interdisciplinary research institution that examines the novel and complex opportunities and challenges presented by unmanned systems technologies in both the military and civilian sphere.

235 C-UAS Products

http://dronecenter.bard.edu/

COUNTER-UAS PRODUCTS

Manufacturer	Product Name	Country of Origin	Detection	Interdiction	Platform	Source
Aaronia AG	RF Drone	Germany	RF		Ground-based	Link
Accipter	NM1-8A Drone Radar System	Canada	Radar		Ground-based	Link
Accipter	NM1-KHSxV Security Radar System	Canada	Radar, EO, IR		Ground-based	Link
Advanced Protection Systems	ctrl+sky	Poland	Radar, Acoustic, EO, IR, RF		Ground-based	Link
Advanced Radar Technologies	Drone Sentinel	Spain	Radar, EO, IR		Ground-based	Link
Airbus DS Electronics/Hensoldt	Xpeller	Germany	Radar, E/O, Other	RF Jamming, GNSS Jamming	Ground-based	Link
Airbus Group SE	Counter UAV System	France	Radar, IR,	RF Jamming, GNSS Jamming	Ground-based	Link
Airspace Systems	Airspace	USA		Net	UAV	Link
Alion Science and Technology		USA		Spoofing	Ground-based	Link
Allen-Vanguard	ANCILE	Canada		RF Jamming	Ground-based	Link
ALX Systems	Sentinel	Belgium	EO, IR		UAV	Link
ALX Systems	Spartiath	Belgium	Radar		UAV/Ground-Based	Link
AMTEC Less Lethal Systems	Skynet	USA		Net Shotgun Shells	Handheld	Link
ApolloShield	CyberBox	Israel	RF		Ground-based	Link
ArtSYS360	RS500	Israel	RF	RF Jamming, GNSS Jamming	Ground-based	Link
Ascent Vision	CM202U	USA	EO, IR		Ground-based	Link
Aselsan Corporation	IHASAVAR	Turkey		RF Jamming, GNSS Jamming	Handheld	Link
Aselsan Corporation	IHTAR	Turkey	Radar, RF	RF Jamming, GNSS Jamming	Ground-based	Link
Aveillant	Gamekeeper 16U	United Kingdom	Radar		Ground-based	Link
Babcock	LDEW-CD	USA	Radar, EO, IR	Laser, Gatling Gun	Ground-based	Link
BATS	Drone Guard	Belgium	Radar, EO, IR	RF Jamming, GNSS Jamming	Ground-based	Link
Battelle	Drone Defender	USA		RF Jamming, GNSS	Handheld	Link

Counter UAS Directory

http://www.unmannedairspace.info/wp-content/uploads/2017/10/Counter-UAS-directory-October-2017.v2.pdf

The counter UAS directory by *Unmannedairspace.info*

The following directory is a listing of available counter-UAS systems, networks and components and is supplied free of charge to unmannedairspace.info website visitors for information purposes only. The directory is under constant review and will be updated and enlarged. Information is supplied directly by suppliers, with data edited to remove unverifiable claims. The publisher accepts no responsibility for the information supplied. Website sources for the data plus further contact information are given alongside product and services descriptions.

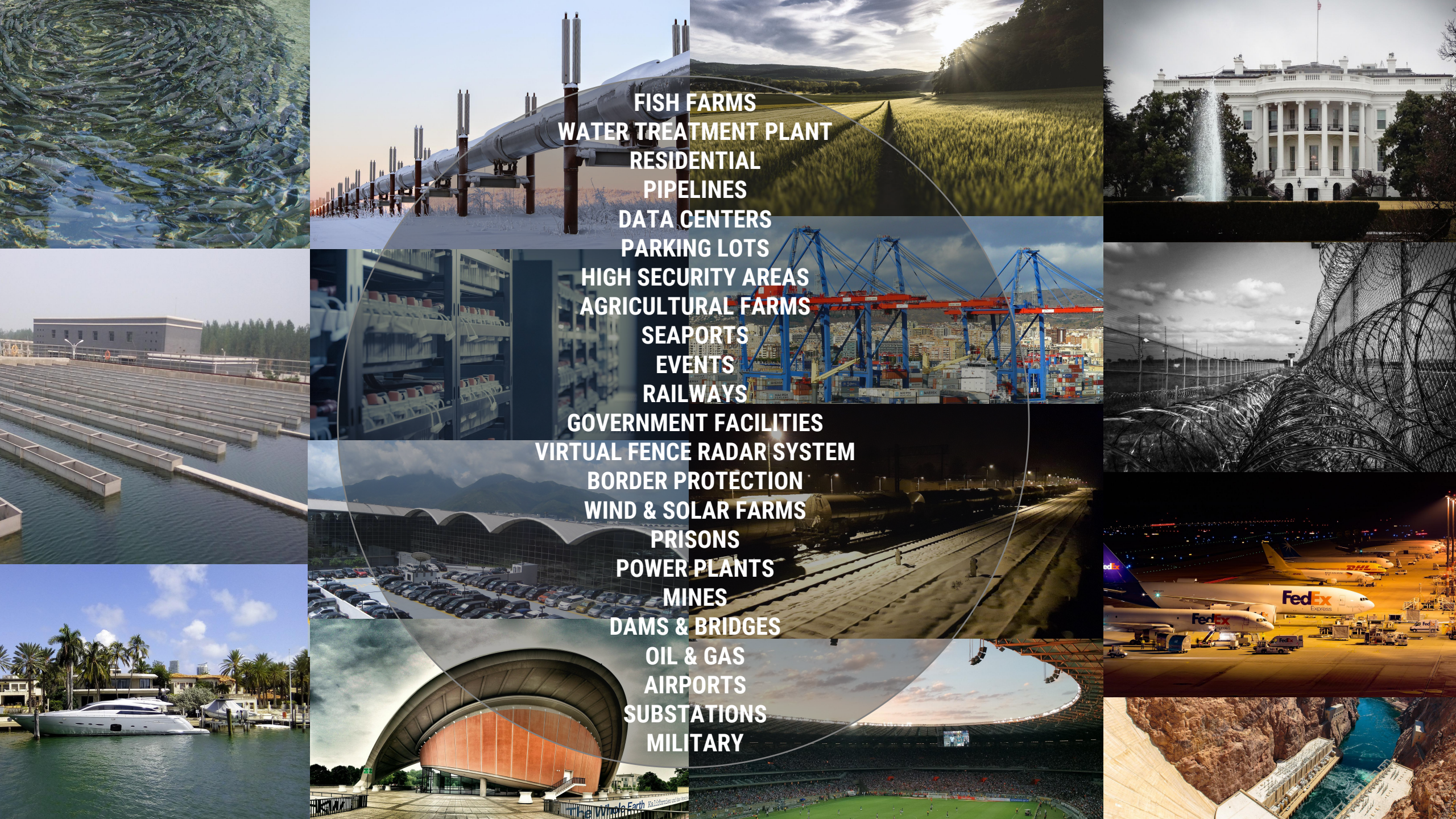
Company	Product	Description	Website
Blighter	AUDS	AUDS is a smart-sensor and effector package capable of remotely detecting small UAVs and then tracking and classifying them before providing the option to disrupt their activity. The system may be used in remote or urban areas to prevent UAVs being used for terrorist attacks, espionage or other malicious activities against sites with critical infrastructure. The AUDS Team brings together three leading British companies, each with the unique capabilities required to create an effective counter UAV system. Blighter's A400 series air security radars are able to DETECT small UAVs in all weather conditions, 24 hours a day flying in urban areas or near to the horizon. The Chess Dynamics Hawkeye Deployable System (DS) and EO Video Tracker, featuring both a long range colour camera and a high sensitivity Thermal Imager (TI), along with state-of-the-art video tracking technology, is able to TRACK the UAV and, combined with radar target information, classify the target. The operator is then able to make a timely and informed decision to use the Enterprise Control Systems (ECS'), smart RF inhibitor to selectively interfere with the C2 channels on the UAV allowing the system to DISRUPT the UAV's mission. The smart RF inhibitor uses directional antennas to achieve maximum range of operation with minimum collateral effect.	http://www.blighter.com/products/auds-anti-uav-defence-system.html
Boeing	Counter-electronics High Power Microwave Advanced Missile Project (CHAMP)	In October 2012 Boeing and the U.S. Air Force Research Laboratory (AFRL) Directed Energy Directorate, Kirtland Air Force Base, N.M., successfully tested the Counter-electronics High-powered Microwave Advanced Missile Project (CHAMP) during a flight over the Utah Test and Training Range. CHAMP, which renders electronic targets useless, is a non-kinetic alternative to traditional explosive weapons that use the energy of motion to defeat a target. During the test, the CHAMP missile navigated a pre-programmed flight plan and emitted bursts of high-powered energy, effectively knocking out the target's data and electronic subsystems. CHAMP allows for selective high-frequency radio wave strikes against numerous targets during a single mission.	http://www.boeing.com/features/2012/10/bds-champ-10-22-12.page
BSS Holland	DroneBlocker	DroneBlocker is a full-stack counter-WiFi-UAV solution, from detection to neutralization. For Wi-Fi drones (Parrot Bebop, AirDrone, 3DR Solo) and hybrid Radiofrequency/Wi-Fi drones (some DJI Phantom, Yuneec Typhon, Blade Q350). DroneBlocker offers capabilities from detection, localization, identification to neutralization – connection breaking and in some cases remote control over the drone.	http://www.bssholland.com/product/counter-wifi-uav-solution-drone-blocker/
CACI	CORIAN	CORIAN is a configuration of CACI's SkyTracker TM UAS tracking solution tailored to meet the U.S. Army's evolving OCONUS mission needs. This system detects, identifies, tracks, and mitigates UAS by exploiting their radio signals. The system not only exploits UAS but also locates their ground operators. CORIAN is configured for the Army to host multiple EW capabilities to non-kinetically defeat UAS at long range. This	http://www.caci.com/wwt/16-05/cober_electronic_warfare_sensor_suite.pdf

COUNTER UAS DIRECTORY – OCTOBER 2017

Citadel Defense Company	DFU 3000 Drone Defense System	The DFU 3000 Drone Defense System can detect drones at 1.2km and engage at 800 metres. Citadel has filed a series of patent applications covering the proprietary technologies that have created the integrated DFU 3000 system. Available in static, manpack or mobile configurations, the system offers both passive monitoring and one-button operation, according to the company, and the systems gives 360° coverage, a capability to defeat multiple drones – up to five at a time – and a small form factor and footprint (the unit weighs just 5.9kg). The DFU 3000 Drone Defense System is aimed at a broad range of user applications, from surveillance and counter-narcotics missions to infrastructure and crowd protection.	https://www.citadelthreatmanagement.com
Dedrone	Drone Tracker	Dedrone provides an automatic, integrated, and self-contained platform that delivers drone classification and countermeasures to secure against drone threats and their operators 24/7. The company says DroneTracker is the only modular system on the market that can be customized to address site-specific threats, adapted for easy integration to an existing security program, and accommodates building structures, landscapes, and other exterior conditions." Dedrone's DroneTracker platform provides a complete airspace monitoring and management solution through a convenient browser-based interface. DroneTracker allows users to readily configure multiple sensors, active and passive countermeasures, and alerts for automatic, 24/7 operation. The software continuously displays real-time airspace information and classifies drones using Dedrone's DroneDNA advanced analysis and pattern recognition capabilities. Defensive measures against hostile drones can be activated automatically, with security service providers notified as appropriate. Dedrone automatically classifies, issues alerts, and records evidence to identify and assess potential threats, and can automatically trigger offensive or defensive countermeasures if needed.	https://www.dedrone.com/en/dronetracker/drone-protection-software
Delft Dynamics	DroneCatcher	Project DroneCatcher started in 2015 when Dutch Police, Military Police and others called for solutions for the protection against unmanned mobile systems. DroneCatcher is a compact mechanically-operated net system designed and integrated in small unmanned helicopter. From the flying platform a net is fired on a hostile drone. The net can be equipped with a parachute to avoid endangering people on the ground. The demonstrator is now operational and the project is on-going as a defence customer has awarded a budget for further development.	http://www.delftdynamics.nl/index.php/en/
	System and EO		http://www.chess-dynamics.com/hawkeye-deployable-systems/
Chenega International	dronesafeguard	dronesafeguard is a mix of layered C-UAV solutions that seek to interdict intruder drones as far out as possible from the facility, asset or person being protected. This is "protection in depth" and it relies on progressively interleaved C-UAV systems and sub systems to: detect, track, respond and then defeat the drone risk threat before physical, asset, cyber or reputational damage is inflicted. Developed with synergia.	https://chenegainternational.com/media/1195/counteruav_ops.pdf

	DroneShield, DroneSentry, Drone Sentinel, DroneCannon	DroneGun provides a safe countermeasure against a wide range of drone models. It allows for a controlled management of drone payload such as explosives, with no damage to common drones models or surrounding environment due to the drones generally responding via a vertical controlled landing on the spot, or returning back to the starting point (assisting to track the operator). The DroneGun MkII drone countermeasure product is a second generation version and is a rifle-style handheld jammer device, effective at the standard frequencies of consumer and commercial drones globally. An optional GPS-jamming capability is also available to customers where lawful. The product offers a number of improvements over the first generation of DroneGun, including a substantially ruggedised design, lighter weight, and improved jamming algorithms. DroneSentinel provides the fully integrated sensor suite of DroneSentry without the DroneCannon RF countermeasure capability. With integrated data from all available sensors, users can rapidly detect and assess potential threats. An intuitive user interface provides live and historical data from all sensors, and broadcasts configurable alerts based on user-defined criteria. DroneSentry integrates DroneShield's suite of sensors and countermeasures in a unified platform deployable in permanent or temporary installations. Incorporating	https://www.dronesheld.com/

AUDS	The AUDS Technology Team brings together three leading British companies each with the unique capabilities required to create AUDS. The Blighter Surveillance Systems Blighter A400 series Air Security radar is able to DETECT small UAVs in all weather conditions 24 hours a day. The Chess Dynamics EO/IR camera system, with state-of-the-art video tracking technology, is able to TRACK the UAV and, combined with radar target information, classify the target. The AUDS system utilises state-of-the-art radar, precision thermal and daylight cameras, advanced video tracking, and non-kinetic defeat capabilities. AUDS is a TRL-9 level system, and is in full production. The next generation of the system is well underway and was due to begin testing and qualifications in August 2017.	http://fileve.com/counter-uas.html
Icarus	Built from internal investments, the ICARUS™ system can identify and intercept commercially available drones. Its multi-spectral sensor system detects and characterizes incoming drones within seconds, before using cyber electromagnetic activity to disable it or allowing the operator to take control of the drone and move it to a safe area.	http://lockheedmartin.com/us/innovations/061416-webt-laser-swarms-drones.html
Indago	Lockheed Martin/Sikorsky's Indago quadrotor will be paired with the MyDefence Communication KNOX counter-unmanned aerial system (C-UAS) system under a new development agreement between the companies. Collaborative development will take place at MyDefence in Denmark. The project is part of an industrial cooperation programme in Denmark with Sikorsky, a Lockheed Martin company. Project goals include pairing the Indago with the KNOX system to achieve rapid response aerial surveillance capabilities. This solution will allow users to quickly and effectively detect adversaries and record evidence that could be used for prosecution. The pairing of the KNOX and Indago systems would be especially useful to secure areas such as critical infrastructure, prisons and private property.	http://www.lockheedmartin.com/us/products/procerus/indago-uas.html
Lockheed Martin	ATHENA	ATHENA is a transportable, ground-based system that serves as a low-cost test bed for demonstrating technologies required for military use of laser weapon systems. Lockheed Martin funded ATHENA's development with research and development investments. It uses the company's 30-kilowatt Accelerated Laser Demonstration Initiative (ALADIN) that provides great efficiency and lethality in a design that scales to higher power levels. ATHENA is powered by a compact Rolls-Royce turbo generator.	http://news.lockheedmartin.com/2017-09-10-Upgraded-Lockheed-Martin-Laser-Outguns-Threat-in-Half-the-Time


FISH FARMS
WATER TREATMENT PLANT
RESIDENTIAL
PIPELINES
DATA CENTERS
PARKING LOTS
HIGH SECURITY AREAS
AGRICULTURAL FARMS
SEAPORTS
EVENTS
RAILWAYS
GOVERNMENT FACILITIES
VIRTUAL FENCE RADAR SYSTEM
BORDER PROTECTION
WIND & SOLAR FARMS
PRISONS
POWER PLANTS
MINES
DAMS & BRIDGES
OIL & GAS
AIRPORTS
SUBSTATIONS
MILITARY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