HOMELAND DEFENSE AND SECURITY
INFORMATION ANALYSIS CENTER

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COUNTERING UAS THREATS IN THE HOMELAND

Current Threats and Emerging Technology

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UAS - CLASSIFICATION

Source: Army Corps of Engineers

UAS Group	Group 1	Group 2	Group 3	Group 4	Group 5
Representative UAS	Raven (RQ-11), WASP	ScanEagle	Shadow (RQ-7B), Tier II, STUAS	Fire Scout (MQ-8B, RQ-8B), Predator (MQ-1A/B), Sky Warrior ERMP (MQ-1C)	Reaper (MQ-9A) Global Hawk (Q-4) BAMS (RQ-4N)
Maximum Weight (lbs) (MGTOW)	0–20	21–55	< 1,320	> 1,320	> 1,320
Normal Operating Altitude (ft)	< 1,200 AGL	< 3,500 AGL	< FL 180	< FL 180	> FL 180
Speed (kts)	100	< 250	< 250	Any Speed	Any Speed

THREAT TRENDS

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Global incidents show rogue drones have increased

Seurity Magazine, May 2022

"Wow, that was close." Drone incidents on the rise

Dayton Daily News, Jan 2019

D.C. Airport Incident Exposes Gaps in Counter-Drone Authorities

Bloomberg Government, Jul 2022

Your drone is interfering with Hawaii emergencies

KHON2, Jul 2022

Sex offenders using drones to target schools as criminal quadcopter use rises rapidly, police warn

EXCLUSIVE

Inews, , Jul 2022

Drones flying into NATO territory have forced the alliance to decide how to respond -- if at all -- to incidents inside its borders

CNN, Mar 2022

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LARGE UAS

Capable of long range and carrying weapons

Unlikely to be used by bad actors but incredibly dangerous

Intelligence, surveillance, & reconnaissance

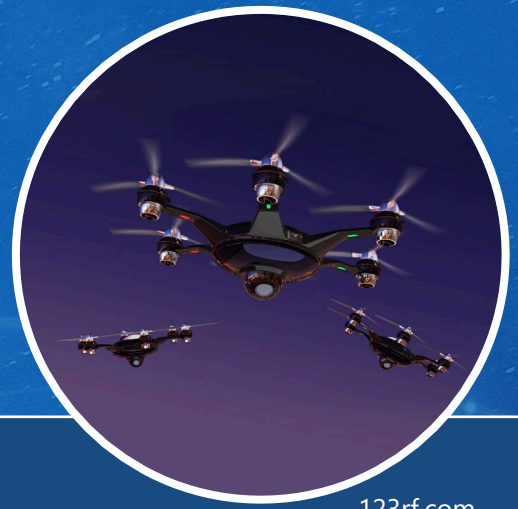
DVIDS

SMALL UAS

DJI Matrice 300 RTK (19 lb)

Flyability Elios 2 (3.2 lb), designed to fly indoors

Micro-UAS



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SWARMS

Use of artificial intelligence/machine learning to operate drones

Designed to overwhelm traditional detection and countermeasure systems

Could be controlled by one person who may not be in the area where drones are operated

123rf.com

SPRAYERS

Used for farming applications

Market research shows an increase in the agriculture drone market from $200 million in 2020 to over $2 billion in 2030

AVAILABILITY & SPEED

US Army

Many drones of varying levels of sophistication available for commercial purchase

Hobbyists can easily build drones from readily available parts

3D printing drones/ parts

Small, easy to acquire hobby jets, capable of sending drones over 200 mph

- Simple model jet engine, less than 3 in./70mm in diameter, available from $369-$459
- Larger model, 4 in./110 mm diameter, sold for $2,420.98. (Made in China)

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COMMUNICATIONS

Shutterstock

Longer range communications allowing for potentially longer flights

On-board guidance systems reduce jamming efficacy and potential for other outside interference. (e.g., a hockey-puck sized, 16 gram, inertial navigation system can be purchased online for $1,350)

4G and 5G communications

- Drones can use cell phone communications for flight control
- This provides operators a BVLOS (beyond visual line of sight) capability
- “Flying drones on cellular networks, particularly 5G networks, is a viable option for delivering low-latency and high-performing applications.” (DHS, 2021)

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Categorizing UAS-Related Cyber Threats

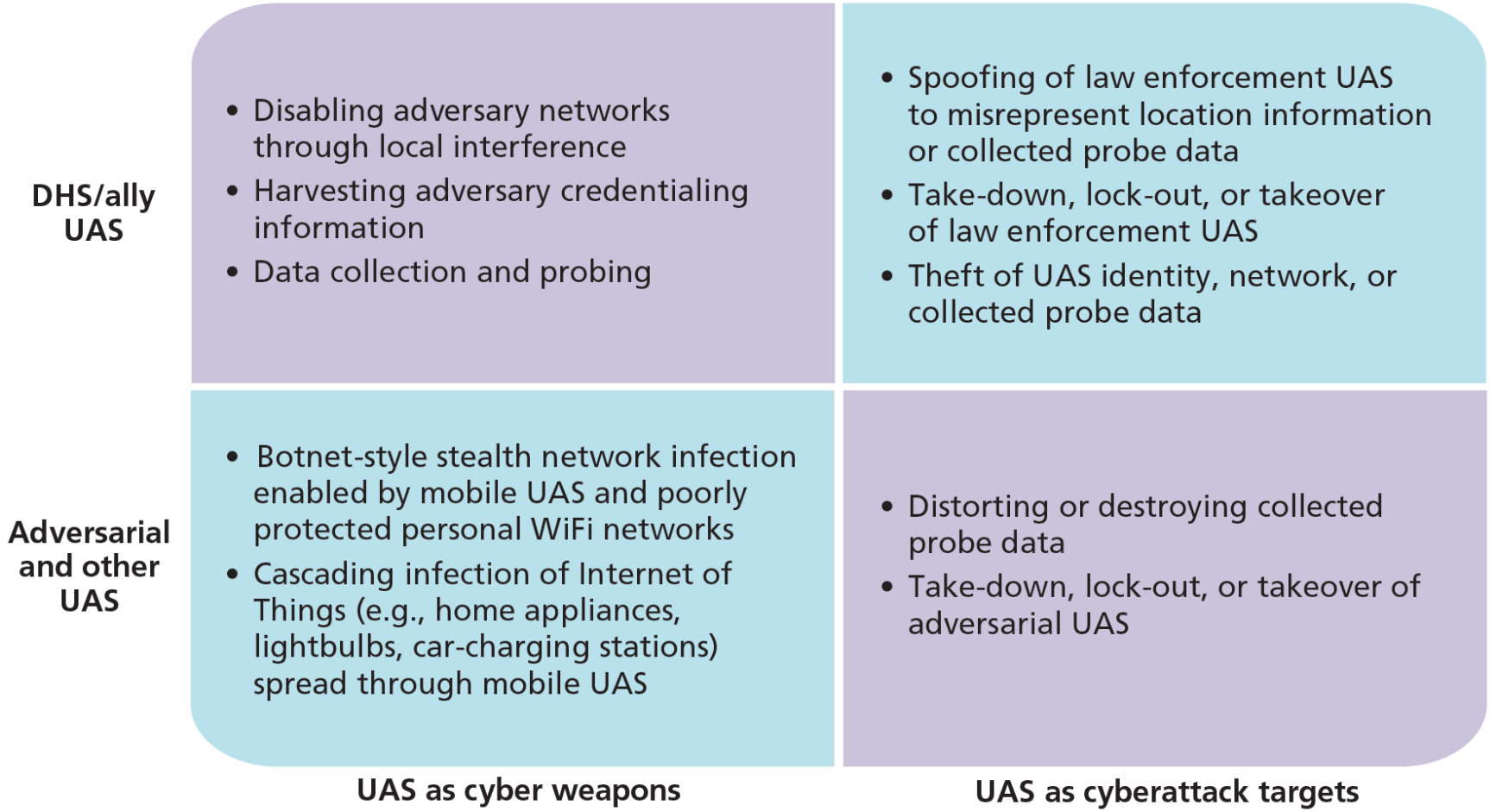

Image Credit: HSOAC

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EMERGING IMPROVEMENTS: BATTERIES

Vast research in private and public sector in battery tech.

Batteries are increasingly lighter, smaller, and store more energy.

Batteries can cause HAZMAT risks (Li-ion batteries).

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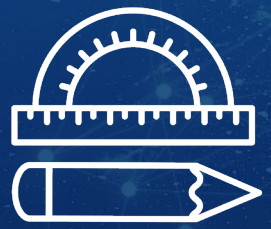
EMERGING IMPROVEMENTS:

SIZE, WEIGHT, & POWER



Constantly evolving.

Advanced manufacturing techniques are leading to lighter and sturdier products.

Size ranges from micro- to large unmanned aerial vehicles that can carry materials.

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COUNTER-UAS

METHODOLOGY

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Source: DoD Counter-sUAS Strategy

DEPARTMENT OF DEFENSE

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CISA

U.S. Air Force

DARPA

HOMELAND

- The burden of tactically detecting and identifying anomalous systems IVO US forces and facilities is responsibility of installation commander.
- Efforts ongoing to integrate small UAS into National Airspace System.
- Harmful RF, laser, microwave, etc., has the potential to affect civilians or property.

HOST NATION

- HN environments have a diverse array of statutes and regulations.
- Operations in HNs must comply with local laws, obligations, treaties, or other requirements.
- Local commanders' authority to protect U.S. interest varies by location.

CONTINGENCY

- Least restrictive, but most dangerous.
- U.S. and partners will employ UAS and manned aircraft, creating a highly congested but lesser controlled air domain.

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Source: DHS C-UAS Tech Guide

DEPARTMENT OF HOMELAND SECURITY

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DETECT

A detection is a declaration that a UAS is in the presence of a sensor. Some systems, depending on how thresholds are configured, may report any object in its view as a detection (i.e., birds, commercial planes, etc.), or they may attempt to only alert the operator of objects deemed to be considered UAS, based on system capabilities and configuration.

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LOCATE/ TRACK

A *location* is a static estimated report or display of where a ground control station (GCS) or UAV is located at a given moment. The display to the operator of the C-UAS technology can take on many forms, e.g., a heat map display, quadrant alert, or circle to indicate estimated center and location error or line of bearing (LOB).

A *track* is a compilation of location reports over a period of time. Tracks can be displayed for GCS and/or UAVs. Generally, it is displayed as a line or a sequence of dots.

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CLASSIFY/ IDENTIFY

Classification is the assignment by the C-UAS technology (either autonomously or by an operator) of a potential target UAS to a high-level category such as UAS type, group, manufacturer and/or specific communication protocol.

Identification is the assignment by the C-UAS technology (either autonomously or by an operator) of a UAS to a more specific name or category, such as physical address of its modem, or the exact make/model of the UAS.

Note that the terms, classify and identify, are often used interchangeably, but can have different meanings for different audiences.

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MITIGATE

Mitigate is often used interchangeably with negate, interdict or neutralize. It describes the methods used to remove or reduce the threat posed by a UAS. These methods include technical means, such as RF or GPS jamming, spoofing/hijacking and kinetic attack; however, these technical methods are likely not legal for any entity other than DHS, DOJ, DOD or DOE to conduct. Mitigation may also include any capability or action associated with finding the sUAS operator and having that person safely land the sUAS, which would likely be permissible if the underlying detection system can be lawfully operated with Federal surveillance laws, as well as FCC and FAA regulatory standards and requirements.

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COUNTER-UAS

LEGAL CONSIDERATIONS

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REGULATORY CONSIDERATIONS:

Federal Aviation Administration

FAA

Part 107

Commercial use, requires license.

Recreation use “carve out”

Recreational use, must register drones, optional safety test.

UAS are defined as an aircraft

The same as a commercial airline.

FAA can regulate the airspace above private property

Intrusion by air over another’s property may no longer be a trespass.

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REGULATORY CONSIDERATIONS:

Federal Communications Commission

FCC

Jammers are illegal.

Can only be used by FEDERAL law enforcement under specific authorities (2017 and 2018 National Defense Authorization Act).

Jammers may interfere with others operating on the same frequency bands.

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STATE & LOCAL LAW ENFORCEMENT

To be effective, state and local laws could focus on the operators

- Understand effective tactics to locate operators if a UAS is operating illegally
- Communicate with local community-based organizations (clubs) regarding appropriate drone use
- Means to detect, identify, and track drones are legal, provided they don't violate FCC/FAA rules

Work with local lawmakers to create effective statutes

- May limit drone operators from being in certain areas. Due to line-of-sight requirements, this limits the drones' flight area.

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DETECTION

TECHNOLOGY

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Detection Types

- Radar
- Electro-Optical (EO)
- Infrared (IR)
- EO/IR (combined)
- Radio Frequency (RF)
- Acoustic
- 5G

Photo Source: NSWC Crane

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D-Fend Solutions:

EnforceAir

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Identifies and Locates "Rogue drones"

Uses RF frequency detection

Locks onto drone signal

Takes over drone communications

This is not in line with FCC regulations for local/state law enforcement

Lands drone in predesignated safe zone

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Fortem Technologies:

TrueView® *Radar*

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Low SWaP-C

Less than 15.5 lbs / 7 kg, uses 38 Watts

360 Degree view

AI at the Edge

Sorts out drones from “other noise”

Scalability

Can be linked together for contiguous view

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Squarehead Technology:

Discovair G2

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Acoustic Sensor

128 microphone array

Automated Target Detection

Claims “nearly zero false alarms”

Pinpoint Direction Accuracy to target

Sorts out drones from “other noise”

Works alone or with C2 system through API

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QinetiQ:

Obsidian Counter Drone System

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Detect
3D radar with high accuracy position and quick refresh

Track and Identify
Combines radar with micro-doppler

AI
Minimize false alarms

Act
Continuously updated 3-D position allows for precise targeting

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Opgal:

Accuracii XRU HD and Thermal Imaging PTZ

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Long range thermal imager

Low cost w/ thermal image stabilization

Ruggedized for Harsh Environments

Laser Range Finder

Deny data extraction from unauthorized users

Low Maintenance

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Cobalt Solutions:

Urban Canyon Detection Tracking and Identification

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Sponsored by DHS SBIR
Awarded Phase II SBIR in September, 2021; in testing

Uses existing 5G base stations to detect and locate
Reduces need for costly equipment

Uses mmWave frequencies for high target resolution
Better accuracy than X-band radars

Coverage depends on 5G coverage in area
Limited in lower density areas

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Terahertz Radar (for Stealth UAS)

Terahertz radar freq. (300GHz-3,000 GHz)
Up to 450m day and 300m night

Emits Photons
Ability to penetrate nonmetals

Precise, but short range
Penetrate skin and reflect off of metallic frame, but very small range

Promising Future technology

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VHF and UHF Band Radar

Useful for stealth crafts

Can cover much of the sky

Frequency is low enough that the drone does not detect the radar waves

Imprecise location

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INTEGRATION

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DHS: C-UAS Interoperability Analysis: *Data/Object Model Layer Standards*

- Homeland Security Systems Engineering & Development Institute (HSSEDI) Report, released December 16, 2021
  - Key Findings
    - Machine-to-Machine (M2M) Standards
      - Cursor on Target (CoT)
      - Tactical Counter UAS Technologies (TCUT)
      - Universal Command and Control (UC2)
    - Radar Data Transmission
      - All Purpose Structured EUROCONTROL Surveillance Information Exchange (ASTERIX)
    - Motion Imagery Metadata
      - Motion Imagery Standards Board (MISB) suite of standards

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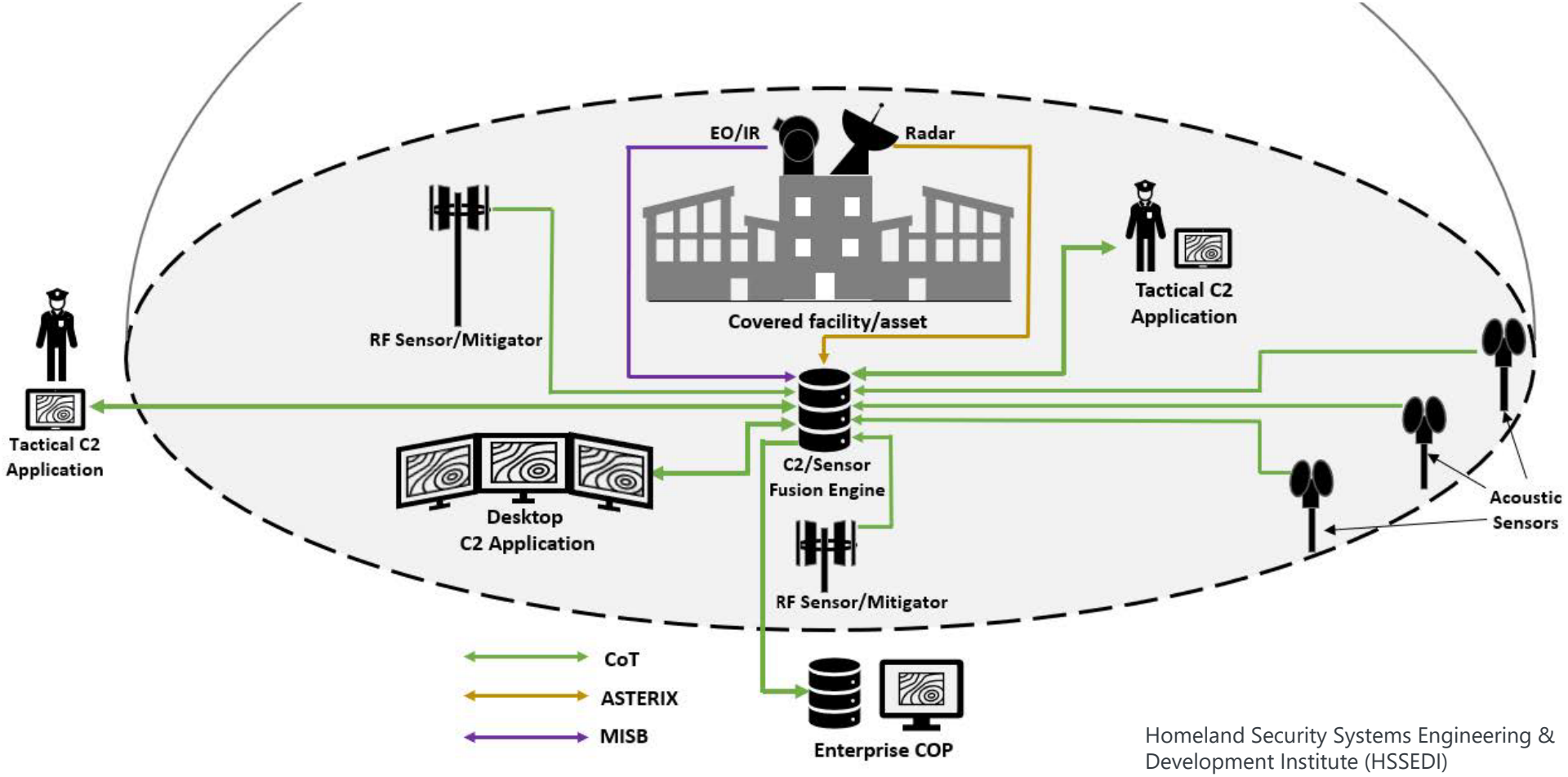
NOTIONAL SYSTEM ARCHITECTURE



Homeland Security Systems Engineering & Development Institute (HSSEDI)

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What Does this Mean?

A fully functional, well designed CUAS system will be expensive.

DHS is working on interoperability standards, but no standard has been adopted yet.

SLTT organizations need to work with Federal partners to increase CUAS funding, coverage, and interoperability.

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MITIGATION

TECHNOLOGIES

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DVIDS

JAMMING

Illegal for state and local law enforcement!

- RF jamming
- GNSS
- UAS function on the 2.4 GHz and 5 GHz spectrum
- These are common frequencies for other kinds of equipment
- GNSS jamming may impact emergency services and transportation in the areas that use the L-band

DVIDS

ELECTROMAGNETIC

- THOR
- AUDS
- Leonidas
- MAUI
- Drone Guard
- DroneDefender
- MESMER
- Silent Archer
- CORIAN

123rf.com

SPOOFING

- Take control of UAS C2.
- Illegal, even for law enforcement
- Usually results in the UAS landing

DVIDS

KINETIC EFFECTS

Illegal for state and local law enforcement!

- Cannot destroy UAS in the air; aircraft according to FAA rules
- Follow to land, usually near operator
- Danger of collateral damage

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