WEIBEL
DOPPLER RADARS

Addressing the proliferated threat of drones

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Business Development

Introduction

Richard Engelholm

- Army officer (infantry and long range recce)
- Deployed to Kosovo (2002) and Helmand/Afghanistan (2006 & 2010).
- Strategic HR advisor to the Danish Chief of Defense.
- PA to the prime minister of Denmark.
- Business Development Manager with Weibel Scientific.
- Reserve officer posting: Deputy chief of staff with The Queens Royal Guards.

Weibel Scientific

- Small family owned tech company.
- X-Band Doppler Radars since 1978.
- 70% of all delivered radars are on US soil.
- End-users like NASA, US Army, US Navy, US Air Force.
- Weibel emerges from the instrumentation sector (test and qualification) where precision and accuracy are the decisive capabilities.

Hypothesizes

- The general integration of drones in modern societies leads to a diversified and complex aerial threat picture that will disrupt our usual sectoral responsibilities.
- There will be an increased push towards allowing non-law-enforcers to operate heavier mitigation measures, including both kinetic/non-kinetic weapon systems.
- There is no one technology or one system that solves the task solemnly.
- The wars in Nagorno-Karabakh and Ukraine have shown the disruptive potential of drones. We must expect these lessons identified to spread.

Drone classification

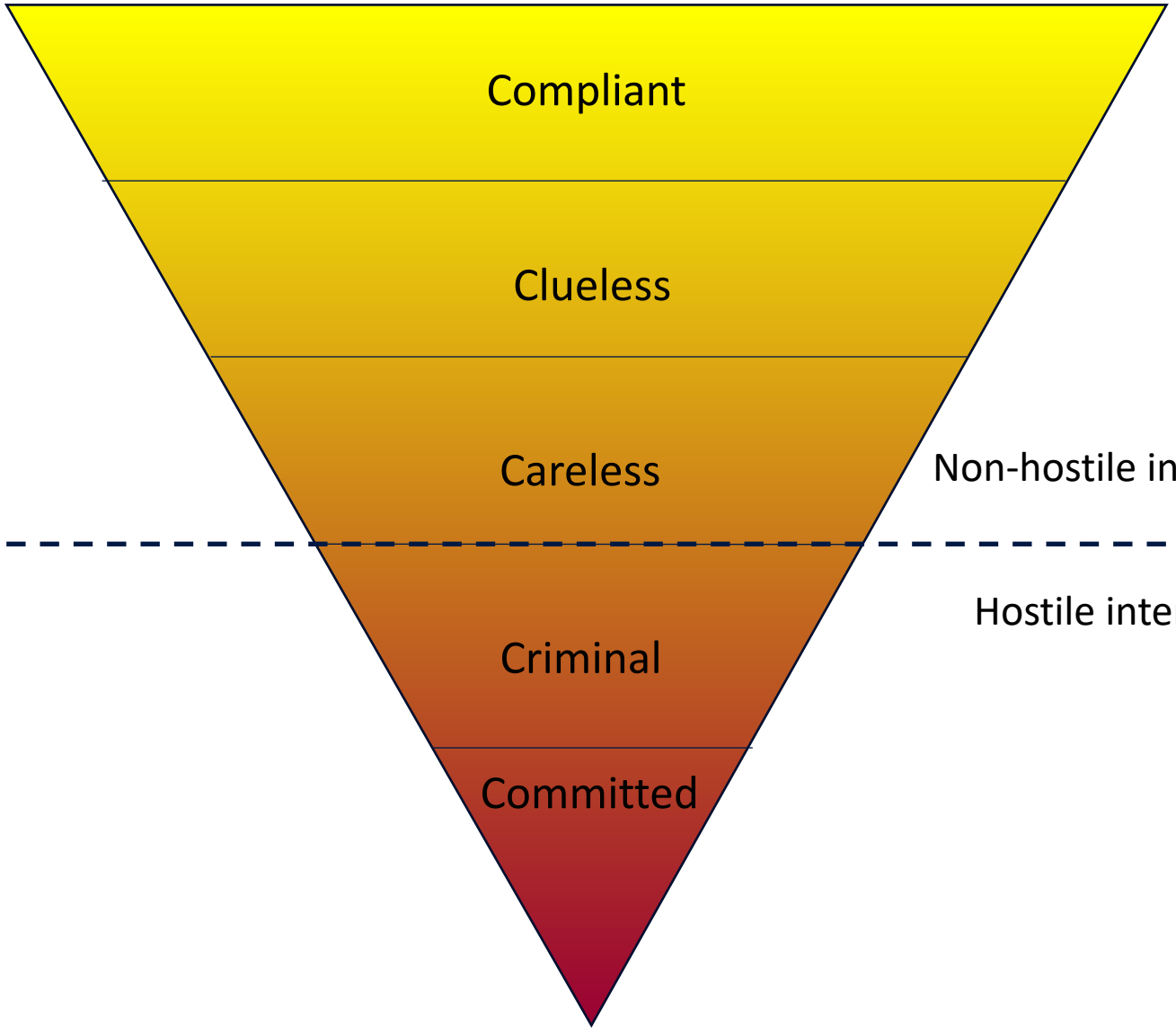
Table 1: UAVs Classification according to the US Department of Defense (DoD)

Category	Size	Maximum Gross Takeoff Weight (MGTW) (lbs)	Normal Operating Altitude (ft)	Airspeed (knots)
Group 1	Small	0-20	<1,200 AGL*	<100
Group 2	Medium	21-55	<3,500	<250
Group 3	Large	<1320	<18,000 MSL**	<250
Group 4	Larger	>1320	<18,000 MSL	Any airspeed
Group 5	Largest	>1320	>18,000	Any airspeed

*AGL = Above Ground Level
**MSL = Mean Sea Level
Note: If the UAS has even one characteristic of the next level, it is classified in that level.
Source: "Eyes of the Army" U.S. Army Roadmap for UAS 2010-2035

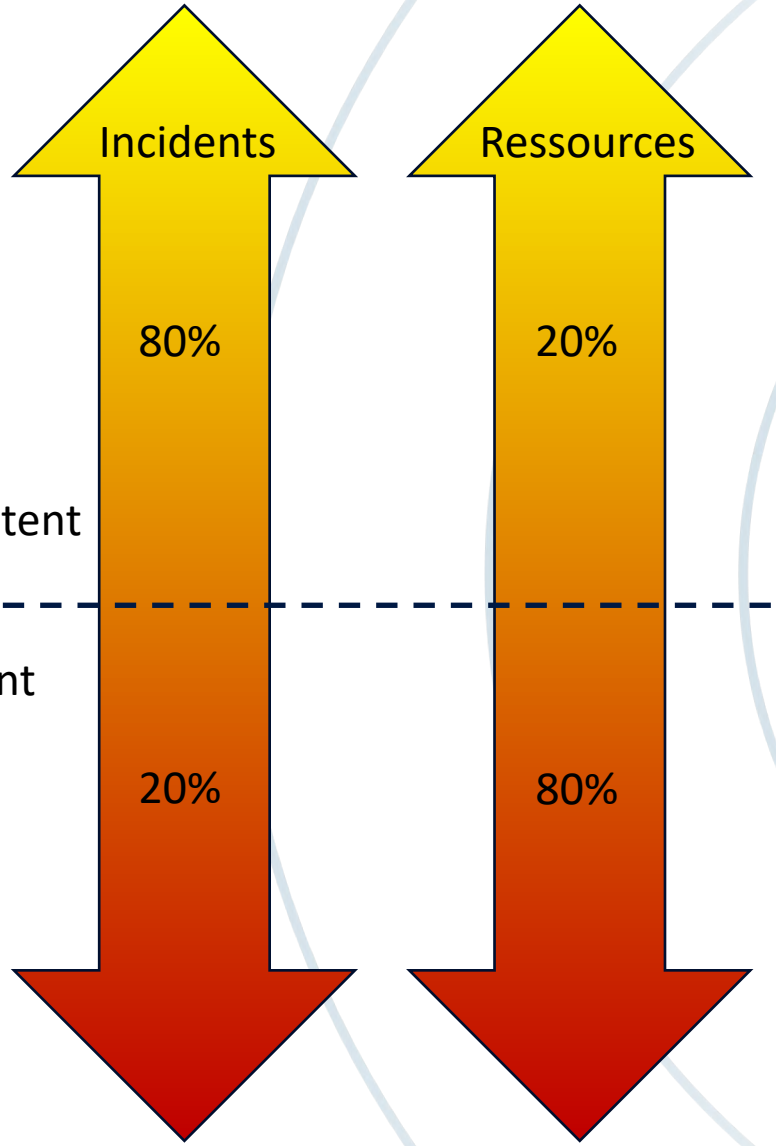
Group/class	Sub-category	Weight
1	Nano	< 250 gram
	Micro	250 gram – 2 kg
	Mini	2 kg – 10 kg

The proliferated drone threat



Non-hostile intent

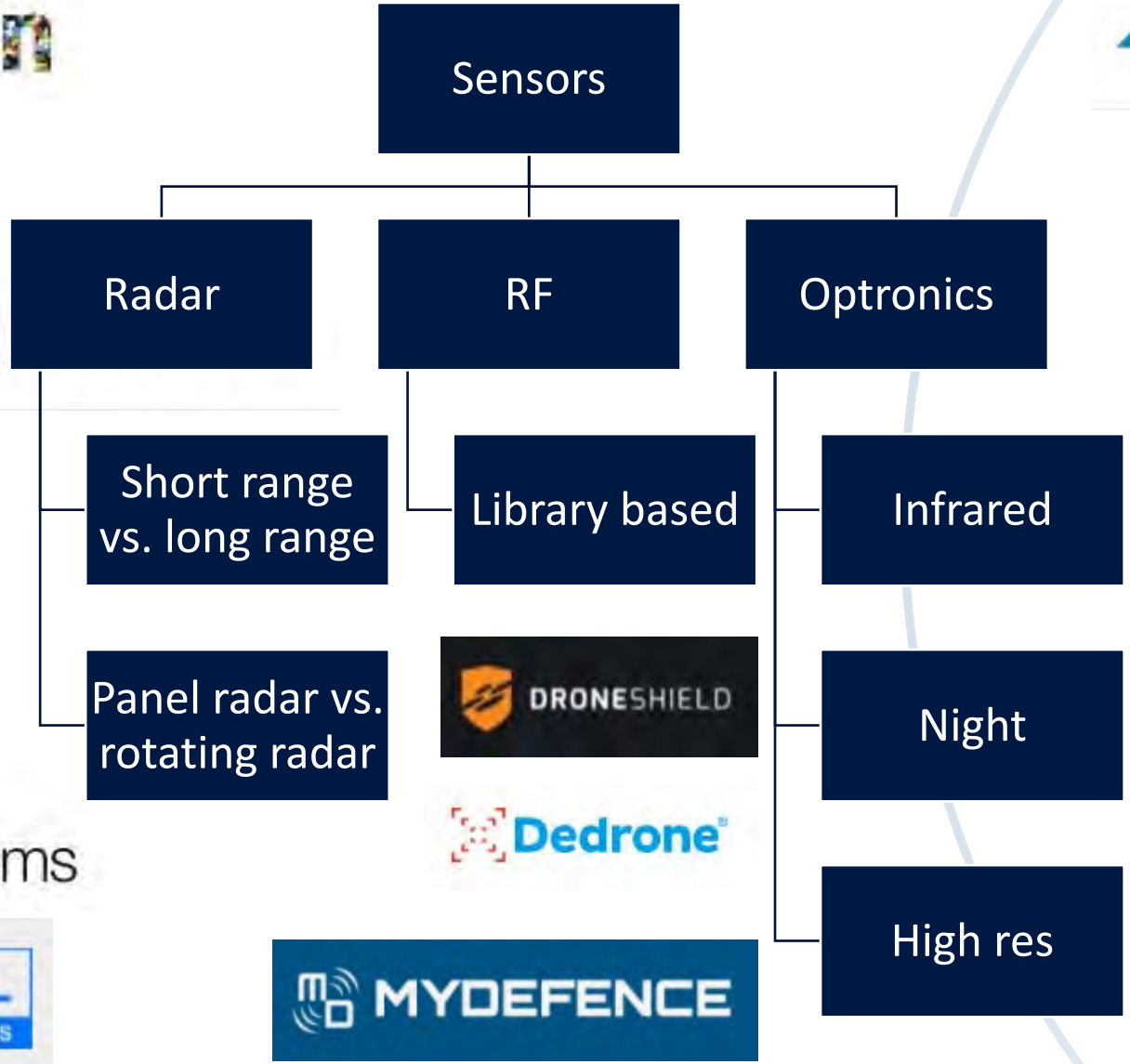
Hostile intent



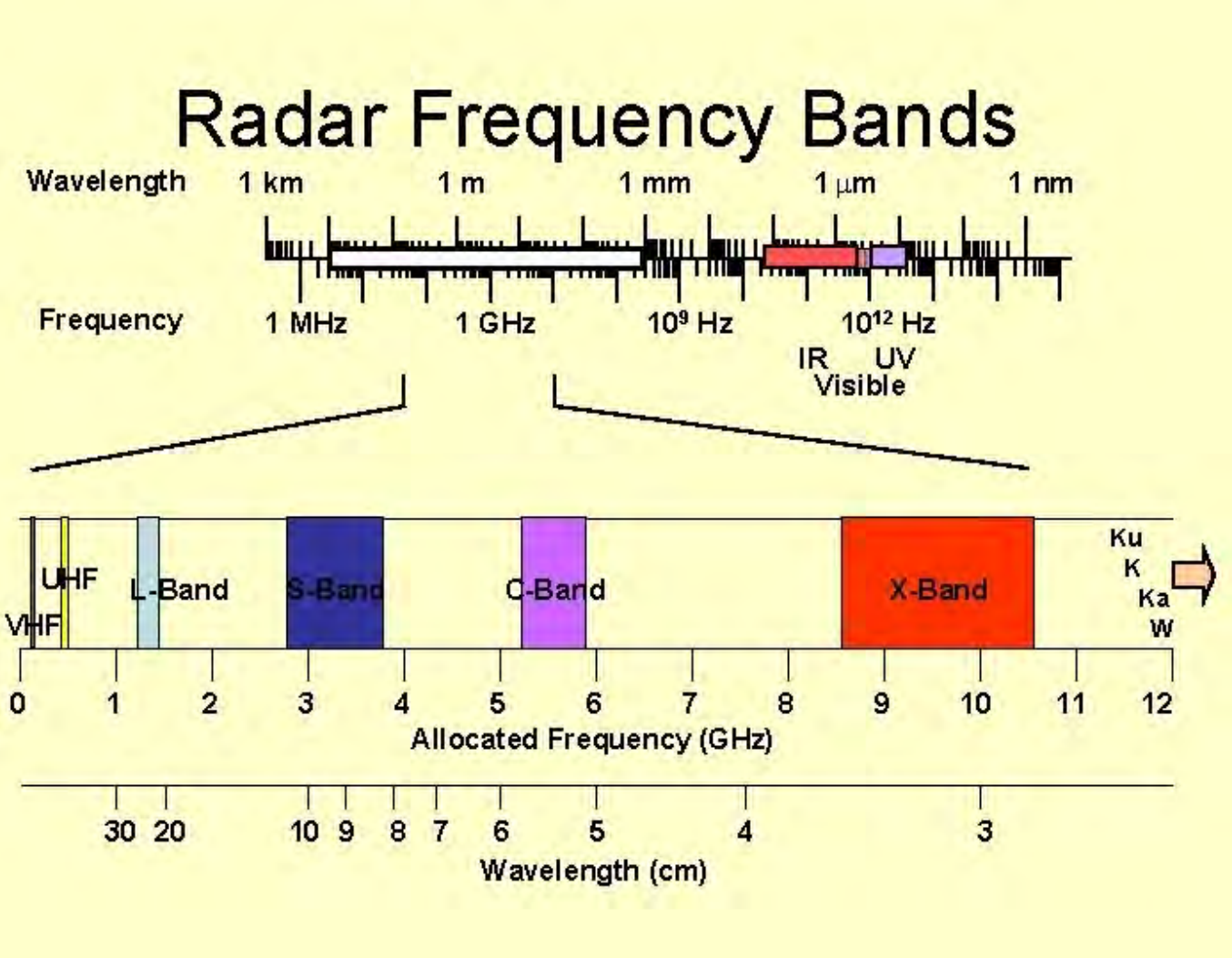
-Sheriff
-State Police
-Border Patrol
-Port Security
-Air Port Security (TSA and FAA)
-Private Security Guards

-FBI
-CIA?
-Secret Service
-Armed Forces

The diverse portfolio of sensors



Frequency bands



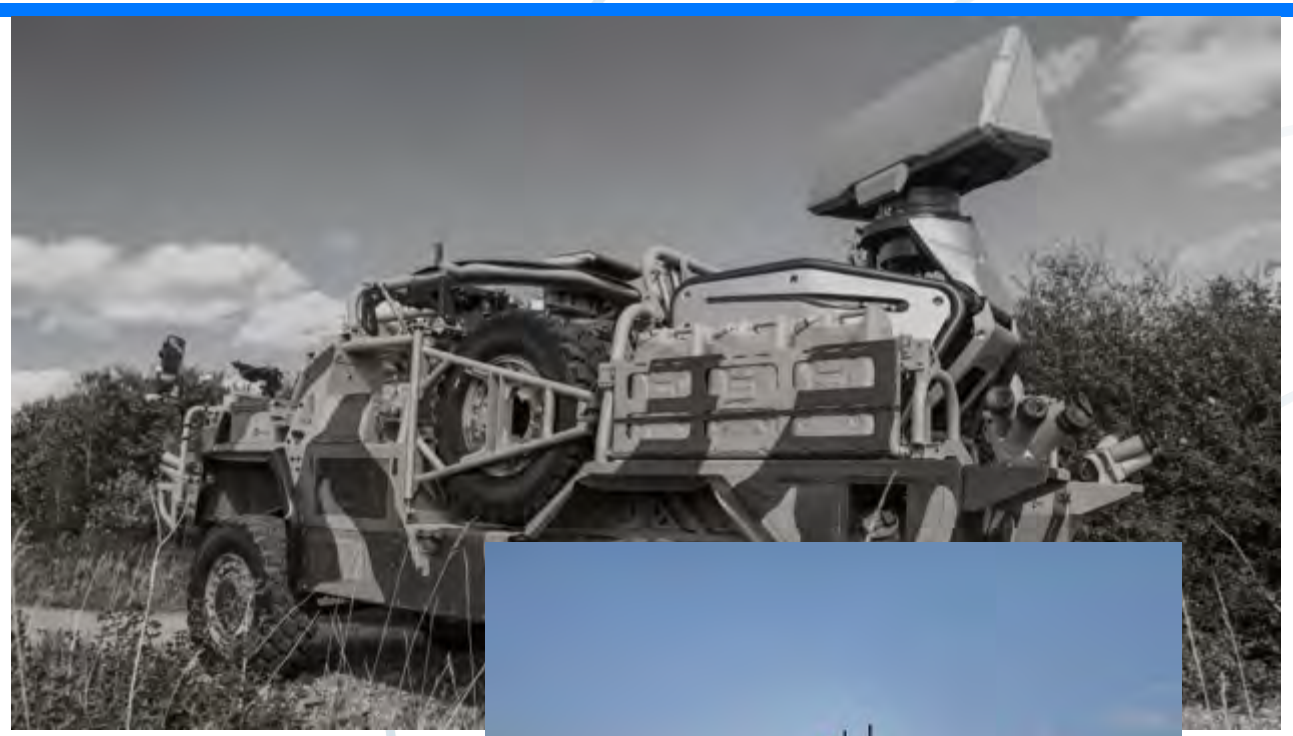
- Lower frequency/longer wave length:
  - Longer range
  - Better weather resilience
  - Lower resolution
  - Lower accuracy
- Higher frequency/shorter wave length:
  - Shorter range
  - More vulnerable to weather
  - Higher resolution
  - Greater accuracy
- Rule of thumb:
  - Link between object size and wavelength

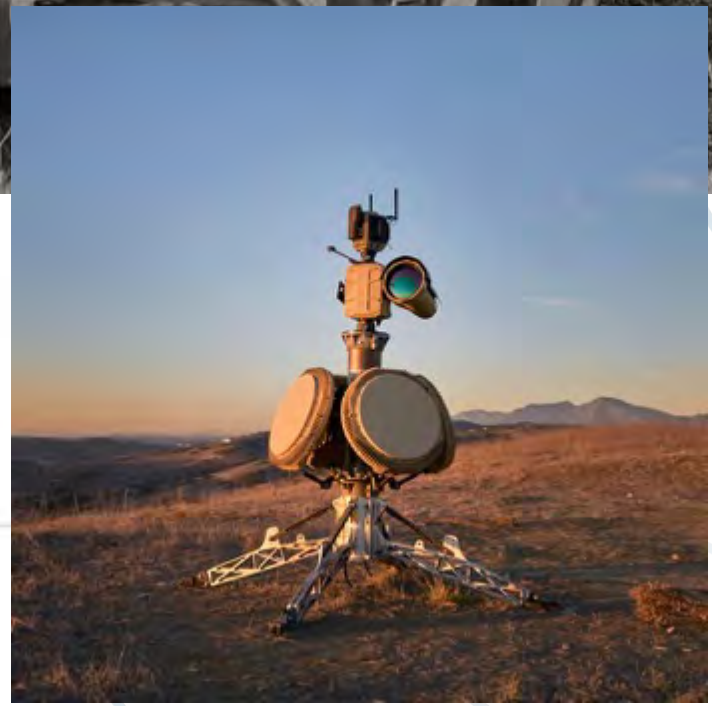
Things to consider when establishing counter drone systems

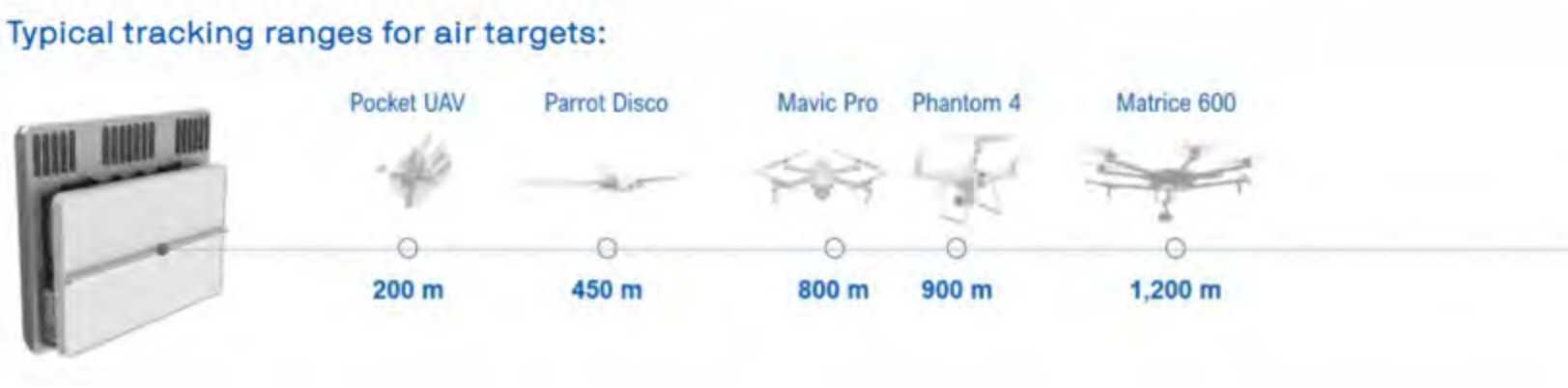
- Threat
  - Size of drone (nano, micro, mini, small)
  - Hostile/non-hostile (purpose)
- Mandate
  - Notify authorities
  - Non-kinetic mitigation measures
  - Kinetic mitigation measures
- Preferred/desired mitigation
  - Simple A2AD
  - Take out drone
  - Take out drone and capture pilot
- Decision making process
  - Rely on SOP (basic self defense)
  - Need time to consider different options
- SWaP-C
  - Preference towards discrete systems
  - Need for mobile solutions
  - RoI on the business case.
- Future requirements
  - Potential integration in UTM
  - Modularity and interoperability.

Things to consider when choosing radar(s)

Grou	eight
	0 gram
	m – 2 kg
	– 10 kg







Things to consider when choosing your components

- Weather
- Desired/needed range
- Settle with perimeter protection or “4D” capability?
- Clutter suppression
- More smaller radars or fewer larger radars
- Rely on one vendor
- Off-shore or coastal location
- Need for:
  - Detecting
  - Tracking
  - Classifying

Physical outline of your installation

- Approx. 3 x 5 miles
- Line-of-sight issues
- Question: Settle with perimeter protection or “4D” capability?
- System of systems:
  - Surveillance radar supported by
  - RF detectors iot detect the pilot &
  - Fixed panel radars at high level PoI
  - Linked to high res surveillance cameras
  - (Followed by an adjacent analysis on mitigation measures.)

Conclusion

- The drone/counter-drone arms race will sky rocket potential safety costs. It’s imperative for end-uses to insist on interoperability and modularity.
- There is no such thing as one-size-fits-all. All counter-drone solutions must be designed case to case.
- Don’t put all your eggs in one basket.
- Have people with technical insight advise you. End-users can not expect of themselves to know everything about e.g. the weather’s impact on sensors.
- Test the possible solutions in the worst case and the most likely scenarios.
- Don’t jump to conclusions – or procurement.

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