

# WHITE PAPER: Boresight Aerial Target Drones



BORESIGHT PTY LTD UNIT 3, 96 WOLLONGONG STREET, FYSHWICK ACT 2609 AUSTRALIA www.boresighttargets.com FOR MORE INFORMATION CONTACT OLIVER PRICE +61 (0)421 106 827 oliver@boresighttargets.com



# BACKGROUND



Drone proliferation has meant that even unsophisticated adversaries are able to use small Unmanned Aerial Systems (sUAS, collectively "drones") for ISR and/or for weapons delivery. **This is no longer an emerging threat – it is here and now.** The nature of warfare and public safety has changed forever.

There are now numerous examples of adversaries weaponizing commercially available hobbyist drones and launching them against ground forces within the Middle East and elsewhere. A few examples are shown above.

Further, there are multiple UAS provider companies working on drone swarming capabilities, where multiple weaponised drones can be controlled by a single operator, exacerbating the potential drone threat.

There are numerous companies offering Counter-small Unmanned Aerial System (C-sUAS) capabilities, claiming to be able to detect, mitigate and in some cases defeat these drones. Detection typically occurs through identifying the radio frequency (RF) communications between a drone and its controller, via radar or optics.

Figure 1 - Weaponized DJI Phantom Drones

After detection, there are two main ways to defeat drones:

- 1. via kinetic means ie. shooting them down, or
- 2. or via RF means ie. through jamming or similar.

These systems range in size, scope and complexity from body worn or handheld, to integrated vehicle mounted and through to fixed site installations.

Both means have their own benefits and limitations and both could be viewed as "dual edged swords". Kinetic means entails shooting rounds into the sky, however what goes up must come down. Directed Energy (DE) weapons are also in development with several nations, however when does a DE weapon cease to be effective? RF jamming can affect not just the drone itself but other communications and GPS signals, including friendly force communications and GPS.

Both kinetic and RF C-sUAS methods require well trained personnel. Additionally, they require well practiced and validated procedures to ensure that their application and limitations are understood and compensated for.

# REQUIREMENT

To ensure a well-trained and ready C-sUAS force, kinetic and RF C-sUAS means require a capable aerial target solution to train and certify personnel and equipment against, as well as to validate Standard Operating Procedures (SOP's) and Rules of Engagement (RoE).

Importantly, this aerial target solution must be affordable enough so as to make it expendable, enabling enhanced and realistic training and certification to be regularly undertaken across different Defence domains. Personnel need to be able to "train as they fight" and to be able to "train against the future".

A "Crawl, Walk, Run" training regime needs to be implemented, commencing with individual proficiency against single targets through to collective proficiency on complex C-sUAS technologies. The ability to implement an increasingly complex training capability, introducing different mission profiles, platform types, attack vectors and simultaneous multiple aerial targets is required.

Until Boresight, there were no known affordable target providers aimed specifically at the C-sUAS training and testing market. Until Boresight, the only drones used for this purpose were typically repurposed, expensive drones that are often not able to be used to destruction due to their cost.

There are other drone target providers which typically provide larger platforms for target acquisition, identification and tracking of the drone threat up to the point of weapons release. However, these larger sized drone targets are costly and resource intensive to manufacture and use and are not efficient for C-sUAS training activities.

Hanging paint tins or balloons underneath expensive drones and hoping not to hit the drone does not fit the mantra of "train as you fight" and will only get a training and preparedness regime so far.

# **BORESIGHT** CAPABILITIES

Boresight was established specifically to address the current deficiencies in the market for a true C-sUAS aerial target provider for training and testing. Boresight has developed or is in the process of developing several aerial target drone platforms as well as the supporting mission planning software that will provide highly capable, affordable and expendable systems. Further detail on each capability is below.

#### **BORESIGHT QUADCOPTER AERIAL TARGET DRONE**





Figure 2 – Boresight Quadcopter Aerial Target Drone

Specifications: Range: 2.5km plus Speed: 18m per second Endurance: 20+ minutes Frequency: 433/868/902/915MHz Size: 400mm diagonal Weight: 1.3kg Camera: Nil

The Boresight Quadcopter aerial target drone has been designed to mimic the general size and performance specifications of the most popular commercially available quadcopter, a quadcopter that was widely used by ISIS in Syria for weapons delivery, ISR and propaganda missions.

The Boresight Quadcopter aerial target drone has been designed from the ground-up to allow for easy assembly which also allows for rapid production and lower production costs. To achieve this, it maximises the amount of 3D printed components and locally sourced parts whilst using a clever design philosophy of reducing the overall build complexity of the Quadcopter.

The Boresight Quadcopter aerial target drone will have the necessary expected failsafes, including procedures for loss of communications, loss of GPS, return to home, auto-land and a "land now" capability.

The Boresight Quadcopter aerial target drone is available for use now.



Figure 3 – Boresight Hexctopter Aerial Target Drone

Specifications: Range: 2.5km plus Speed: 15m per second Endurance: 20 minutes Frequency: 433/868/902/915MHz Size: 1100mm diagonal motor to motor Weight: ~5kg Camera: Nil

The Boresight Hexcopter aerial target drone has been designed to mimic the general size and performance specifications of larger quadcopters, hexcopters and smaller octocopters that are commercially available.

The Boresight Hexcopter aerial target drone has been designed from the ground-up to allow for easy assembly which also allows for rapid production and lower production costs. To achieve this, it maximises the amount of 3D printed components and locally sourced parts whilst using a clever design philosophy of reducing the overall build complexity of the Hexcopter.

The Boresight Hexcopter aerial target drone will have the necessary expected failsafes, including procedures for loss of communications, loss of GPS, return to home, auto-land and a "land now" capability.

The Boresight Hexcopter aerial target drone is available for use now.

#### **BORESIGHT VTOL GROUP 1 AERIAL TARGET DRONE**



Figure 4 – Boresight VTOL Group 1 Aerial Target Drone

Specifications: Range: 5km plus Speed: 30m per second Endurance: 25 minutes Frequency: 915MHz or 868Mhz Size: 2200mm (w) x 800mm (l) Weight: 7kg Camera: Nil

Development of the Boresight VTOL Group 1 aerial target drone has commenced. A VTOL capability was specifically chosen as it removes the requirement for a launch mechanism. Similar to a quad or Hexcopter, the VTOL capability will also enable the aerial target drone to be pre-positioned for the conduct of training serials.



The size and performance specifications of the VTOL Group 1 aerial target drone are in many cases similar to a Group 2 UAV. This means that the VTOL Group 1 aerial target drone could in some circumstances be used as a Group 2 aerial target.

The Boresight VTOL Group 1 aerial target drone will have the necessary failsafes that would be expected of it, including procedures for loss of communications, loss of GPS, return to home, auto-land and a "land now" capability.

The Boresight VTOL Group 1 aerial target drone is will be available for use from mid-2021.



Boresight is progressing with the development of its Flight Management and Mission Planning (FMMP) software. The FMMP will allow for the easy creation of mission plans, from simple single aerial target drone flight patterns through to, when used in conjunction with the Formation Flying capability outlined below, complex, multiple simultaneous aerial target drones flight patterns of different aerial target platforms.

Examples of some pre-programmed mission profiles, stepping through in complexity, are shown below.

## Basic Mission Packages





#### **Basic Mission Package Example:**

Showing a basic mission profile of a single Quadcopter aerial target drone flying east / west at the same altitude.

This is a simple mission that could be used in the initial stages of individual training for either RF or kinetic based C-sUAS capabilities, testing individual proficiency.

### Intermediate Mission Packages



Figure 6 – Intermediate Mission Package Example

#### Intermediate Mission Package Example:

Showing an intermediate mission profile of dual Quadcopter aerial target drones flying east / west at the same altitude.

This is a mission that could be used in the initial stages of collective training for either RF or kinetic based C-sUAS capabilities, testing proficiency.

Advanced Mission Packages







#### Advanced Mission Package Example:

Showing advanced mission profile of a multiple Quadcopter and Group 1 VTOL aerial target drones flying towards the C-sUAS capability in different patterns and at different altitudes.

This is a complex mission that could be used in the final stages of collective training for either RF or kinetic based C-sUAS capabilities, testing collective proficiency, SOPs and RoE.

The FMMP allows for the easy conduct of pre-planned flight scenarios for testing and trialling activities. Mission plans can be pre-programmed and pre-loaded prior to an activity, increasing actual flight time whilst on the flight range.

The FMMP software is being progressively developed in stages, enabling:

- 1. Control of a single aerial target of any of the Boresight platforms by a single pilot flying operator-controlled missions.
- 2. Control of a single aerial target of any of the Boresight platforms by a single pilot with the ability to fly preprogrammed mission profiles of varying complexity.
- 3. Control of multiple aerial targets of any of the Boresight platforms by a single pilot with the ability to fly preprogrammed mission profiles of varying complexity and attack vectors ie. Formation Flying.

Combined, the Boresight FMMP software will allow for the flight of multiple aerial targets of multiple aerial target platform combinations for a layered UAV threat for the military C-sUAS operator to train against.

#### **BORESIGHT SWARMING**



As discussed above, the FMMP will enable a Boresight aerial target drone Swarming capability. Swarming is where 2 or more aerial targets fly the same pre-programmed or manually flown flight profile, providing for multiple simultaneous targets. These multiple targets can be of the same Boresight aerial target drone platform or of different platform types flying the same mission.

Swarming will further the ability to provide complex

training scenarios for personnel and systems. It's likely easy enough to single defeat а aerial target using RF or kinetic means, however what are the "actions on" or procedures if there are multiple inbound aerial threats?

Formation Flying will further the ability to provide complex training scenarios for personnel and systems. It's likely easy enough to defeat a single aerial target using RF or kinetic means, however what are the "actions on" or procedures if there are multiple inbound aerial threats?

Additionally, the

Swarming capability will remove the need to have an individual pilot for each aerial target platform as is currently the case ie. if three commercially available drones are to be used then then three drone pilots are required. This is resource, personnel and dollar expensive. The Boresight Swarming capability removes this requirement and resource overhead.

#### **BORESIGHT C2 MIMICKING**



The frequencies used by the Boresight aerial target drones are 433/868/902/915MHz, either selectable depending on customer preference local regulations. These or frequencies were deliberately chosen as they extend the ability of the aerial target drones to be able initiate complex target scenarios. Most commercially available drones operate at 2.4GHz for the command communications and 5.8GHz for the video link. Not using the 2.4GHz / 5.8GHz frequencies means that RF based detection and mitigation effectiveness can be further tested. The reality is that adversaries will auickly pivot awav from 2.4GHz communications links if they're able to be easily defeated.

However, Boresight has commenced the R&D process of developing a drone Command and Control (C2) mimicking capability. The intent of this capability is to allow a Boresight aerial target to simulate the C2 output of common COTS drone types, for example a DJI Phantom 4 Pro using the OcuSync flight controller software.

C-sUAS systems often operate by taking advantage of the C2 link that the drone threat uses. These systems may use this RF link to detect and localise the drone threat depending on the characteristics of the C-sUAS system of the drone target itself. For further utility within the C-sUAS industry, implementing a drone C2 Mimic system will become an increasingly important development area. This system should be able to replicate a range of individual drone types' C2 signatures, including the following characteristics:

- **Frequency:** Replicate RF frequency signatures.
- Modulation: Replicate modulation patterns used to transmit data.
- **Hopping:** Replicate different channel hopping patterns.
- Power: Replicate power management systems.
- Localisation: Replicate data packets that are used to provide drone/GCS localisation.
- **Control:** Replicate data packets that are used to control drone's flight.

Having a C2 mimicking capability allows the extension of the multi-threat, multi scenario threat vectors by having different Boresight aerial target appear to be different common COTS drones simultaneously, further enhancing training realism.

The ability to mimic this C2 footprint means that the Boresight aerial target drones can be further used as targets to test, validate and certify RF based C-sUAS systems. This mimicking capability will allow customers to detect and identify Boresight target drones utilising the same RF signatures as COTS drones.

Using the more affordable Boresight drone target allows for a C-sUAS operator to utilise the drone RF signature for detection and identification of the threat without concerns about damaging expensive COTS drone equipment.

# BORESIGHT USE CASES

The use cases for Boresight aerial target drones can be roughly categorised into the following user groups:

- Defence, security, law enforcement and other government agencies,
- Kinetic based C-sUAS capability companies, and
- RF based C-sUAS capability companies.

There is cross over between each of these for specific use cases, with the main use cases being as follows.

## SUPPORT TRAINING, EXERCISES, CERTIFICATION AND VALIDATION

Boresight's aerial target drones provide the perfect, cost-effective solution for individual and collective C-sUAS training. The aerial target drones are affordable enough to be used for shooting down using kinetic methods or for bringing to the ground using RF mitigation methods.

With the ability to gradually increase target threat profiles and scenarios, from a single target on a simple flight path to numerous

simultaneous aerial targets at different velocities, attack vectors and altitudes, Boresight's aerial target drones can be used to implement a 'Crawl, Walk, Run' training regimen.

Boresight's aerial targets can be used to test and certify personnel and equipment, and to validate Rules of Engagement and Standard Operating Procedures, ensuring that personnel and equipment are trained, ready and able to meet the threats posed by drone attack.

## SUPPORT PRE-DEPLOYMENT TRAINING AND READINESS

Boresight's aerial target drones can be used to support predeployment training and readiness activities, honing skills and equipment knowledge prior to arriving in-theatre. Through use of its Mission Planning software, training can be scenario driven to meet known, expected, likely and emerging threat vectors.

Personnel can deploy secure in the knowledge that they know how to defeat the threat of drones and are proficient in the use of their equipment to do so.

## SUPPORT C-SUAS CAPABILITY DOWN-SELECTION AND RISK MITIGATION ACTIVITIES

Government agencies are purchasing increasing numbers of C-sUAS systems, either as part of a broader weapons program or via RF based detection and mitigation systems.

Boresight's aerial target drones can be used as an effective capability down selection and risk mitigation capability, assisting agencies in validating the claims of vendors during technology selection and purchasing activities. Agencies can use Boresight's aerial targets to effectively put a vendor's claims to the test.



## DEMONSTRATION AND TESTING CAPABILITY FOR INDUSTRY

Boresight's aerial target drones can be used by the C-sUAS industry to assist in the ongoing development, testing and sales demonstrations of their technology. With its ability to provide affordable, expendable target drone solutions, Boresight aerial target drones can be used throughout the development and sales cycle process in both 'dry run' and 'weapons free' formats, for "soft kill" and "hard kill".

The ability to increase mission complexity and scenarios enables realistic testing to be conducted and analysed, with results fed back into ongoing product development.

The cost-effective nature of the Boresight aerial target drones means that customer demonstrations can move beyond the normal 'canned' type of demonstrations, enabling demonstrations to destruction of targets to be conducted. This in turn increased potential customer confidence that a vendor's systems work as advertised.

# ABOUT BORESIGHT

Boresight was established by personnel with long term experience within the UAV, Defence, intelligence, and law enforcement domains, with the aim of providing highly capable but affordable and expendable drones as aerial targets.

The emerging threat posed by drones, from cheap quadcopters used for surveillance through to sophisticated 'suicide' drones is changing the nature of warfare and public safety. Government agencies and Counter-UAS companies need a high performance and cost-effective solution to train and test against.



Boresight provides that capability.





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