EMERGENCY SERVICES FOUNDATION

2016

Establishing a Remote Piloted Aircraft & Systems (RPAS) Unit for Police and Emergency Services

ESF Scholarship: **Inspector Craig SHEPHERD**

Position: **Unit Commander – Police Air Wing**

Organisation: **Victoria Police**

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1 Part 1 - Introduction

1.1 Acknowledgements

I acknowledge the support and contributions of the following organisations and persons who have either supported this scholarship and or supported me whilst undertaking this study tour.

Organisations:

- **Emergency Services Foundation** Victoria (stakeholders and their representative management teams)
- Victoria Police Force
- Victoria Police Air Wing
- New South Wales Police
- Australian Federal Police
- Babcock International Group
- Leonardo's Helicopters

- National Police Chiefs Council (UK)
- QinetiQ UK
- Unmanned Air Systems Capability Development Centre (UASCDC) via the Home Office UK
- Centre for Applied Science & Technology (CAST), Home Office UK
- London Fire Brigade and BlueLight Project
- UK National Counter Terrorism Policing HQ (NCTPHQ)
- North East Counter Terrorism Unit, West Yorkshire Police
- National Offenders Management Service (NOMS)
- 2016 Commercial UAV Show UK (Terrapin Events Company)
- Royal National Lifeboat Institute, UK *(provided via Skybound Rescuer)*
- European Emergency Number Association (EENA)
- Mid and West Wales Fire and Rescue Service (UK)
- Donegal Mountain Rescue (Ireland)
- Greater Copenhagen Fire Department (Denmark)
- Reykjavik SAR Team (Iceland)
- Devon & Cornwall and Dorset Police
- Northamptonshire Police and Northamptonshire Fire & Rescue Service
- Police Scotland Air Support Unit and UAV Unit
- National Police Air Service (NPAS) for England and Wales (Wakefield, England)
- NPAS – Lippitts Hill NPAS Base

I would specifically like to acknowledge the following people for their support both in Australian and whilst on the study tour:

- Inspector Randy Anderson, Victoria Police Force
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- Ms Lauren Adams, Director of Aviation Onshore, Babcock (Aviation Company)
- Jeff Salvestro-Martin, Leonardo Helicopters

- Inspector Mark Callaghan, Operations Commander, Surrey and Sussex Police and support officer to Assistant Chief Constable Steve Barry UK (NPCC)
- Assistant Chief Constable (ACC) Steve Barry, Surrey and Sussex Police
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- Carl Davies from the UASCDC
- Detective Chief Inspector Colin Smith, Centre for Applied Science & Technology (CAST), Home Office UK
- Alan Brooke from the Home Office's Centre for Applied Science & Technology
- David Rowlett (non police) CAST Chief Remote Pilot, UAV Capability
- Steven Adams, Strategy and Inclusion, London Fire Brigade
- Inspector Trebess, National Counter Terrorism Policing HQ (NCTPHQ)
- David Owen, North East Counter Terrorism, West Yorkshire
- Joanna Parish, C-UAS Lead for National Offenders Management Service (NOMS)
- Gemma Alcock (Skybound Rescuer) representing the RNLI, UK
- EENA and JI Project Team
- Inspector Andrew Hamilton, Devon & Cornwall and Dorset Police, UK
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- Kevin Hardwick, Joint Operations Team, Northamptonshire Police & Fire and Rescue Service
- PC Stuart Neilson, Police Scotland UAV Unit (Air Support Unit)
- Inspector Nickolas Whyte, Air Support Unit, Police Scotland
- Mr Russell Woolford, NPAS, Assistant Operations Director UK
- Police Sergeant Andrew Hutchinson, Lippitts Hill NPAS Air Base Manager


EMERGENCY
SERVICES
FOUNDATION


THE COMMERCIAL
UAV SHOW


LFB
LONDON FIRE BRIGADE


SKYGUARD
RESCUER


POLICE
SCOTLAND


Home Office


babcock


POLICE


NPAS


POLICE
Surrey & Sussex
Working Together


QinetiQ


LEONARDO


NaCTSO
National Counter Terrorism Security Office


NPCC
National Police Chiefs' Council


COUNTER
TERRORISM
POLICING
NORTH EAST


Working together


Lifeboats


NPCC
National Police Chiefs' Council
National Counter Terrorism Policing
Headquarters


Home Office


SEARCH AND RESCUE
NORTHAMPTONSHIRE


National Offender
Management Service


UAS CDC


112
SOS
european emergency number association


DONEGAL MOUNTAIN RESCUE TEAM
D.M.R.T.
MEMBER


HJÁLPARSVEIT SKÁTA
REYKJAVÍK


GWASANAETH TÂN AC ACHUB
Canolbarth a Gorllewin Cymru
Mid and West Wales
FIRE AND RESCUE SERVICE


GREATER COPENHAGEN
FIRE DEPARTMENT

1.2 Purpose of the Scholarship

To travel to England and Scotland to gain specialist knowledge and identify best practice in establishing a Remote Piloted Aircraft & Systems (RPAS) Unit for police and emergency services in Australia.

1.3 Executive Summary

Remote Piloted Aircraft and Systems (RPAS), commonly known as drones, Unmanned Aerial Vehicles (UAVs) and Unmanned Aerial Systems (UAS), are now commonly available and are being used worldwide.

Over the last decade, the rise in use and proliferation of RPAS has been steadily, if not rapidly increasing. The type, size, use and technology of RPAS has been changing, expanding and growing significantly to the point that they are fast becoming a regular sight in technology, emergency services and emergency management related avenues world wide.

Drones, which is the legacy name for unmanned aerial systems (UAS) (as it is known in the UK), has historically been viewed as military equipment that delivers weapons in support of military conflicts. However, the terminology in the civil aspect has changed from drones to UAS, UAV and RPAS in other areas of the world such as Australia.

RPAS is defined by the International Civil Aviation Organisation, as a form of unmanned aerial system, which is non-autonomous in its capacities and with the aircraft being subject to direct pilot control at all stages of flight despite operating 'remote' from that pilot. The Australian Civil Aviation Safety Authority (CASA) use the term RPAS as its primary day-to-day terminology instead of UAS, whilst the UKs Civil Aviation Authority (CAA) refer to them as UAVs.

RPAS technology is evolving at pace. Flight duration, ease of flight, weight and capability of payloads (cameras, payloads etc.), ability to operate in confined areas (buildings and caves etc.) and challenging environments (wind, temperature, low light etc.) continues to improve. Costs are plummeting and high functioning machines are already within the grasp of those prepared to spend as little as $8,000. The hobbyist and modelling community continue to innovate with many 'amateur' machines out performing their commercial counterparts. Drone racing as even become a legitimate sport for many enthusiasts.

RPAS is increasingly easy to operate; a skilled 'pilot' is no longer a requirement. Many systems are flown via a tablet computer (or similar device) and flight control is largely intuitive; very little instruction is needed. Remote operation allows effective control at distance and is a skill that can be developed in isolation. There is no requirement or need to be part of a club or organisation, a degree of expertise can be achieved using the internet (forums, blogs etc.) for example.

For police and emergency services, RPAS effectively provides entirely new levels of technical support to the user through the provision of a flying camera or payload. RPAS

technology represents a significant enhancement to numerous police and emergency services tasks and missions as it is capable of flying into places that piloted aircraft cannot go and can perform operations that, given their "dull, dirty and dangerous[1]" nature, would normally pose significant risk to life and property. In short, RPAS has its place and a particular role in law enforcement and emergency management insofar as it significantly enhances response capabilities across a wide range of general and specialist tasks.

Victoria Police, like so many agencies in Australia (law enforcement and emergency management agencies) are now looking to RPAS as a supplementary capability that can be harnessed to increase their service delivery to our communities.

Thanks to the Victorian Emergency Services Foundation (ESF), the lessons that are being learnt by our colleges within the law enforcement and emergency services in England and Scotland can be explored with a view of bringing those lessons back to Australia for use by all.

1.4 Australian Context – RPAS Capabilities Law Enforcement Agencies

Currently, as of December 2016, most police forces in Australia are either employing RPAS in support of their role and functions or they are exploring, researching and assessing the use and application for their agencies.

To mention only a few, Queensland Police, New South Wales Police (NSWP) and the Australian Federal Police (AFP) are well ahead of all other police services in Australia as they have already commenced operations and are currently building their knowledge, experience and capabilities with RPAS.

In regards to emergency services across Australia, some agencies are also developing their RPAS capabilities, such as, but not limited to:

- Life Saving - Victoria and NSW
- Victorian Metropolitan Fire Brigade, and
- Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR), to mention only a few.

The steady increase in agencies starting to look to RPAS as a support tool, will continue as will the immense growth in the RPAS industry as more and more companies work towards providing specialised emergency management related RPAS equipment to sell to police and emergency services globally. The emergency services sector is seen as a major growth opportunity for the PRAS industry with both hardware and software companies are banding together to develop these new RPAS equipment. Traditional aviation companies like Babcock, Airbus and Boeing are also examples of companies that are expanding into the UAV - RPAS – drones world also.

[1] Superintendent John Todor, Victoria Police.

1.5 Victorian Context – RPAS Capabilities in Victoria

Over the past several years, Victoria Police has at times been directly assisted by the Metropolitan Fire Brigades (MFB) RPAS capability at critical incidents due to their current RPAS teams that are deploying to emergency situations.

Victoria Police is now implementing a 12 month research project (April 2016 to March 2017) to identify the needs of Victoria Police, develop a concept of operations (operating model) and eventually establish a RPAS unit. This unit will not only support the Victorian community via the police response but will also support all emergency services across many key areas.

The UK is currently a leader in the field of UAV research for application within police and emergency services and coupled with their similarities in the judicial systems (as part of the Commonwealth) they represent the most appropriate location to attend and gain first hand knowledge and experience.

The RPAS project is now a responsibility allocated to my role as Inspector (Unit Commander) of the Victoria Police Air Wing. The project funding specifically provides for a 12 month fixed-term project officer to support my role. The project will include a full state wide needs analysis for all law enforcement requirements of Victoria Police. This will include a nationwide comparative analysis of agencies that currently employ UAVs along with government agencies.

Project Focus Areas

The project primarily focuses on 14 key services that PRAS can provided to police and emergency services:

1. Counter Terrorisms and bomb response including post blast analysis
2. General policing and law enforcement including public demonstrations and events
3. Forensics / crime scene / disaster victim identification and Hazmat
4. Search and Rescue (land / marine / caves and tunnels / urban)
5. Emergency Management support (disaster and emergency management response)
6. Chemical, Biological and Radiological multi agency response
7. Road collision incidents response, road policing and fatal collision investigation
8. Photographic and video support
9. High risk, critical incident management and active shooter response including paramedic response and triage
10. Thermal imaging for night time and low light-no light situations
11. Victim location and identification in remote areas and or high risk environments
12. Maritime emergency management and law enforcement
13. Tactical response operations
14. Exercise management.

The Victoria Police RPAS capability is now supported via the ESF through the provision of funding to travel to England and Scotland to continue this research on behalf of police and emergency services.

A key advantage in attending England and Scotland is identifying and understanding their development programs and lessons that they learnt along the way, both good and bad.

2 Part 2 – Study Tour Overview

This section of the report provides a running commentary (summary version) of the initial research that was conducted to identify the relevant agencies and areas within England and Scotland that would be attended during the study tour. As can be seen below, each contact and subsequent liaison assisted in identifying other agencies that could also be contacted. It is through this process that the agencies that I actually visited and persons I met with were identified and coordinated.

This process has been documented because it is often assumed that an application for scholarship is submitted with a full and final version of the proposed itinerary. This however is not the case. The proposed itinerary is exactly that, "proposed". It is not until the application is approved that the itinerary is finalised through meeting requests and further liaison with the overseas agencies. When the initial contacts in England and Scotland are notified that you are in fact approved for the travel, it is then that they start working with you to determine actual dates and meetings with key contacts, which then leads on to more contacts becoming available as they know you are going to be attending as apposed to "might be attending". This process is in fact a journey and as such I have articulated the journey as it highlights the linkages between contacts and agencies that are discovered along the way.

Note: This report will continually make reference to RPAS, drones, UAV and or UAS. This is due to the fact that some areas and persons within England and Scotland refer to remote piloted aircraft as either drones, UAS, UAV or RPAS. For this reason I have not altered their terminology and as such the reader should note that for the purposes of this paper, all four terms relate to exactly the same thing and are interchanged as needed.

Summary of Study Tour

In 2016, Inspector Craig Shepherd commenced researching international police and emergency Service agencies that were working with the RPAS environment in order to determine what lessons could be learnt from those agencies. By learning from the opportunities and challenges from other agencies, we could capitalise on the identified lessons and opportunities whilst learning about the challenges and how they were managed.

During this process, the United States of America (USA) appeared to be quite complicated with its current RPAS capabilities due to multiple layers of legislative challenges and a vastly differing approach from may agencies within the USA, whilst the United Kingdom (UK), to which our judicial, police and emergency services are so closely linked, seemed to be more appropriate. It was identified that both England and Scotland were progressing rapidly with their RPAS capabilities at both local and national levels.

Contact was made with several agencies in England, which then allowed me to identify further valuable contacts throughout England and into Scotland.

It was through these contacts and enquiries that I validated that I should focus my attention on the UK as apposed to the USA.

In early 2016, I applied for and was granted an Emergency Services Foundation Scholarship to travel to the England and Scotland to conduct my study tour to complete the necessary research into RPAS, UAS, drones and *flying things*.

The following information provides a summary of the progress I made during the planning and attendance stages of the scholarship and the links that were made from contact to contact.

Part 3 of this report will then summarise the outcomes of each of the meetings and visits that were carried out during October 2016.

National Police Air Service

The first contact point was the National Police Air Service (NPAS) as they are the equivalent of the Vitoria Police Air Wing, and they provide aviation services to the 43 police forces across the UK. It is noted that Police Scotland are not part of NPAS and maintain their own Air Support Unit in Glasgow, Scotland. It was initially assumed that the NPAS were the driving force behind RPAS in the UK, however, due to their move from local police forces having their own aviation assets to a national service in 2012, they had not been engaged in the RPAS environment at that stage. However, it was noted that they soon would be. During the study tour I did visit the NPAS national operations centre in Yorkshire and the notes are provided at section 3.16 of this report.

Through speaking with the NPAS Assistant Operations Director Mr Russell Woolford[2], I learnt that NPAS was not yet working with RPAS but the National Police Chief Council (NPCC[3]) was leading the national UAV portfolio, (*which brings police forces in the UK together to help police coordinate operations, reform, improve and provide value for money*[4]), and had appointed one of the Nations 43 Police Chiefs as the holder for the National UAV Portfolio.

Lippitts Hill NPAS Base - London

Additional to the NPAS facility in Yorkshire, the NPAS afforded me the opportunity to attend the London based NPAS Air Base at Lippitts Hill, where I was able to discuss the drones/manned aircraft strategies with the Base Manager Sergeant Andrew Hutchinson. This meeting related specifically to the implications and strategies for employing UAVs and aircraft in the same geographical areas (air space around London) and at times as part of the same tasks. Refer to section 3.17 of this report.

2 Mr. Russell Woolford (NPAS Assistant Operations Director) – russell.woolford@npas.pnn.police.uk
3 NPCC - http://www.npcc.police.uk/Home.aspx

4 http://www.npcc.police.uk/

National Police Chief Council

Russel Woolford from NPAS then put me in contact with the NPCC. This National UAV Portfolio, like many national projects, was allocated to Assistant Chief Constable (ACC) Steve Barry of Surrey and Sussex Police. Working directly for ACC Barry was Inspector Mark Callaghan who is the Operations Commander of the Surrey and Sussex Police and was appointed as the support officer to ACC Barry. A summary of the NPCC Drone Portfolio is provided at section 3.1 of this report along with a summary of the testing and training that they are conducting with drones in the Surrey and Sussex Police areas. This UAV project was due to be completed in 2016 and I was informed that I would receive a copy of their projects final report. It should be noted that obtaining this report was only possible through the visit to the UK and the relationship that was built throughout the entire process.

It was through Inspector Callaghan that I learnt that whilst they were managing the national UAV portfolio they were also working with the Metropolitan Police, Aviation Policing Learning & Development Unit (APLD) at Heathrow.

Aviation Policing Learning & Development Unit

The APLD is the learning and development centre where UAV operators are trained and deployed within the Heathrow area, which sits within the Surrey and Sussex Police area of responsibility.

This unit has already moved from the needs analysis project phase through to become the training facility for UAV operators. Interestingly, in the submission for the ESF Scholarship, it was intended that I would meet with this team, however, I then learnt that they were the training providers, whereas I was focused on capability development and deployment phases of these PRAS projects. As such, I continued to liaise with personnel from the APLD but did not attend their office during the study tour nor is any information from their work unit included in this report as it was out of scope.

Benefits Register

Through further conversations with Inspector Callagan at (NPCC) and Acting Sergeant David Christy (VicPol) it was identified that there was a need for a RPAS Benefits Register to map and record all of the benefits that PRAS can provide to police and emergency services. The need for a Benefits Register is listed as a learning. The benefits register that has been developed for the Victoria Police report can be reviewed upon request.

That Benefits Register provides a list of those benefits that may be of assistance to police and emergency services in Australia. Upon return from this trip, this register is being used to continue the work being performed for Victoria Police.

The register shows the benefits of employing PRAS to the relevant service categories and notes the type of benefit being provided, being: Substitute, Support or Enhance the currently used equipment, capabilities, technologies etc.

Essentially, the benefits of RPAS can be grouped into one or more of the following:

- Substitutes, Supports and or Enhances existing capabilities
- Offers entirely new police and emergency services response capabilities
- Maximises efficiencies in some focus areas
- Delivers cost effective technology alternatives
- Accords with current global policing trends
- Existing regulatory frameworks make implementing a new aviation capability achievable
- Reduces workplace harm and increases safety by assisting with the dull, dirty and dangerous work.

Devon, Cornwall and Dorset Police

Further discussions with Inspector Callaghan identified that Inspector Andrew Hamilton of the Devon & Cornwall and Dorset Police was in the process of developing a Drone Unit. This Drone Unit has been progressively explored and developed since 2015 and it is intended to be operational in 2017. Enquiries with managers of that unit were undertaken with a view of visiting that location during the study tour, however, it was not possible to attend their area as there was insufficient time and funds to travel from London to Dorset. However, in order to ensure that the opportunity was taken to meet Inspector Hamilton, I met with him in London during the 2016 Commercial UAV show. A summary of their program and the meeting with Inspector Hamilton is provided at section 3.13.

Leonardo's Aviation

Prior to leaving Australia, I was working with the Leonardo's aviation liaison office and was provided with contacts in the UK that related to the drones projects within the Leonardo's organisation. I visited the Yeovil site in the UK and was given the opportunity to explore some of the UKs high altitude drones technology. However, due to the security levels required to access that facility, no information from that visit can be included in this report. Those persons seeking to access this information who have an appropriate security clearance should contact me directly.

Babcock International Group (Aviation Company)

Whilst still in Australia, I met with Ms Lauren Adams, Director of Babcock Aviation Onshore, who at the time noted that she was the head of the drones (RPAS) project for Babcock and as such, through her contacts I was connected with the drones project within Police Scotland.

Police Scotland, Air Support Unit

I then made contact with Police Constable (PC) Stuart Neilson who was managing the project from within the Police Scotland Air Support Unit based in Glasgow and whom I visited during the study tour. A summary of their program is provided at section 3.15 in this report.

Northamptonshire Police and Fire Rescue

Whilst coordinating the visit to the Police Scotland Air Support Unit, PC Neilson informed me that the Northamptonshire Police and Fire & Rescue agency in England were already operating drones within their agency and that it was linked to their new command vehicle (truck). I then contacted Phillip Pells and Kevin Hardwick from the Joint Operations Team of the Northamptonshire Police and Fire & Rescue Service. I then coordinated a visit to their headquarters to assess their drone's capability. A summary of their program is provided at section 3.14 in this report.

Commercial UAV Show UK 2016

In assessing other drones and RPAS related activities in the UK, I identified that the Excel Exhibition Centre in London would be hosting the 2016 Commercial UAV Show on the 19th and 20th of October. I subsequently coordinated with the organisers to present at the show within the conference section. In doing so I was granted access to the speakers group and as such would gain access to a greater number of drones related units and capabilities. A summary of their program is provided at section 3.10 in this report with the information regarding key contacts that were made during the conference.

Royal National Lifeboat Institute (RNLI) UK Via Skybound Rescuer Company

At the UAV Show I took the opportunity to meet with Gemma Alcock from the private company Skybound Rescuer, who were working with the Royal National Lifeboat Institute in England (RNLI). This afforded me the opportunity to assess the national approach to drones in the marine search and rescue environment within RNLI along with the opportunity to hear about the work that Skybound Rescuers company were doing with agencies like RNLI and police. A summary of their program is provided at section 3.11 in this report.

EENA and DJI Project

At the UAV Show I also took the opportunity to meet with the project team behind the European Emergency Number Association (EENA) and DJI working group (EENA Project) that have been working on a 1 year drones project with four key agencies across Europe. The project team spoke at the conference about their project and have since put out their White Paper that provides an overview of their drones project. This was extremely valuable and relevant to this scholarship and an overview of the project is provided at section 3.12, with the White Paper referenced for those who wish to access it.

QinetiQ UK

Through contacts in Victoria Police I spoke with a company named QinetiQ UK. QinetiQ is global company that includes a significant drones project based in the UK at Boscombe Down and in Malvern, England. Through these contacts I was provided with an opportunity to visit their drones testing facilities and science laboratories. A summary of the Boscombe Downs visit it provided at section 3.2 and the Malvern site is provided at section 3.3.

Centre for Applied Science & Technology (CAST)

During our meeting at Boscombe Down, Carl Davies organised a meeting between Detective Chief Inspector Colin Smith from the Centre for Applied Science & Technology (CAST), Home Office and I (summary at section 3.5). CAST is the UK agency that conducts testing on equipment and technology such as drones on behalf of the collective 43 police forces across the UK. This visit was a significant opportunity during this study tour.

UASCDC - National Cross-Government Working Group for Counter-UAS (C-UAS) – Home Office London

Whilst at the Boscombe Down facility with QinetiQ, I met with Mr Carl Davies from the Unmanned Air Systems Capability Development Centre (UASCDC). At the conclusion of that day, Carl Davies informed me about the national Cross-Government Working Group for Counter-UAS (C-UAS). I was then afforded the opportunity to attend the Working Group, which was meeting on the 18th of October at the Ministry of Defence in Whitehall Street, Westminster, London.

At that meeting, the national project was discussed. A summary of this meeting is provided at section 3.4.

This opportunity enabled me to meet with the following personnel who all agreed to meet with me individually after the meeting (over the coming days) to discuss their individual drone portfolios. The list below provides the sequence of meetings that occurred in London.

- Steven Adams, Strategy and Inclusion, London Fire Brigade (refer to section 3.6)
- Inspector Trebess, National Counter Terrorism Policing HQ (NCTPHQ) (refer to section 7)
- David Owen, North East Counter Terrorism, West Yorkshire (refer to section 3.8)
- Joanna Parish, C-UAS Lead for National Offenders Management Service (NOMS) (refer to section 3.9)

3 Part 3 – Study Tour Outcomes

This section provides a summary of each meeting and visit along with the lessons identified from each of them. The sequence of the summaries in this section is provided in the order to which they physically occurred whilst on the study tour.

Lessons Identified

At the end of each summary a list of lessons learnt have been provided. Some of the lessons learnt come from the discussions we had at the time and from the questions that were asked. However, most of the learning's are provided by the person I met with and or from the drone projects they have been working on.

3.1 National Police Chiefs Council (NPCC) Drones Portfolio via Surrey and Sussex Police

Contacts

Inspector Mark Callaghan, Operations Commander, Surrey and Sussex Police and support officer to Assistant Chief Constable Steve Barry UK for the National Drones Portfolio via the NPCC.

Overview of the Organisation

As noted in this report, the NPCC is the national committee to which all 43 Police Chiefs are a member. This committee is simular to the Australian & New Zealand Police Commissioners Forum (ANZPCF) and the Australian and New Zealand Police Commissioners Board (ANZPAA's Board).

Following a successful bid to the Home Office Innovation fund, Surrey and Sussex Police secured a grant agreement for £249,150 in 2015 and commenced a trial to quantify the opportunities and threats of UAS technology in policing.

The project commenced on the 1st June 2015 and concluded on the 30th June 2016. The purpose of the project was to use an evidence based approach to establish; how the use of drones can realise quantitative efficiencies and safety benefits for the police service and to prepare an accurate National Threat and Risk assessment posed by drones, thus allowing work to be undertaken to develop effective mitigation measures.

In 2014/15 the NPCC identified the need to allocate the growing drones issue to one of the NPCC members as the national portfolio holder. The national portfolio holder would then undertake research of a drone capability to progress the research through to the establishment of an actual drones unit. This is aimed to be achieved through establishing an actual capability and providing the ongoing results to the national police forces via the NPCC. This process then avoids the mass duplication that was occurring where different police forces are; undertaking the same research, spending money on the same or simular technology, making the same mistakes, not learning from others and producing varying results.

When establishing the portfolio, Inspector Callaghan identified the following key benefits and then used them during the research and development phase:

- Potential to fly drones during poor weather conditions that might normally prevent traditional helicopter support (low cloud, poor visibility)
- Provide a forward-looking reconnaissance service that can cover open tracks of land quickly and effectively without long search lines across areas that include woodlands.
- Avoid issues associated with rotor downwash and therefor increase the number of times a flying camera can be employed into more confined, dusty or low level locations where the use of helicopters can be difficult

- Release helicopters from dull and routine work for use on more pressing and urgent tasks
- Reduce pilot fatigue during large scale missions by providing additional capacity for drones to cover some areas of the geographical footprint whilst helicopters cover other areas
- Noise Abatement over built up areas as drones have a nearly non existent noise signature compared with manned rotary operations
- Local police can frequently access a flying camera for situational awareness from above via their locally based drone assets
- Increased safety through increased situational awareness at tasks and incidents
- Provide greater support to other agencies such as fire and ambulance
- Increase training and exercising effectiveness through filming and observing training programs from a broad range of angles and heights, to mention only a few.

Inspector Callaghan stated that using drones would provide police with greater options and that each of the police forces across the country would be able to decide when and where they would and could employ drones to support there operations. The key is to establish a best practice for police forces to use as an example and or as a guide.

Following the development program sponsored by the NPCC, Sussex and Surrey police (as the drones portfolio holders) received the £250,000 and purchased five SkyRanger drones from Aeryon Labs in Canada (refer to photo below). Each drone was approximately £50,000 and whilst they are expensive for many police forces, they offer the opportunity to test and assess highly capable drones for policing operations.

As of October 2016, a number of learning's had been identified via the project and it is through those learning's that the portfolio will make its way from research and development into deployment into real time incidents for the good of the public.

The project is ongoing and feedback is constantly provided to the NPCC.

The NPCC have provided a number of documents for police forces to use as a guide and or as an approach to drones related issues and are summarised below. The information provided in these summaries are taken directly from the documents, which could be done because those documents were provided to me during my meetings with them.

NPCC – Guidance to Officers on DRONES, Legislation and dealing with misuse (Summary)

This guidance supports individual Force Policies for the prosecution and recording of incidents involving drones.

The ownership and use of drones are not of themselves unlawful but in certain circumstances, their use may contravene air safety legislation or other statutes, commonly used to manage other types of offending. The intention of this guidance is to address the negligent, reckless or malicious use of this technology.

NPCC – Overt Police use of DRONES, Interim Guidance to Forces

This interim guidance is intended to convey the NPCCs position on police use of drones and to assist Forces considering purchasing and operating drones to support operational policing.

A number of Forces are now trialling drones and many more are looking into how drones can be used. It is essential that Forces adopt a standardised approach to police use of drones and move forward as one. The implications of not doing so could put back the use of drones in policing by many years.

Forces should fully consider the cost implications prior to embarking on purchase of drones. Whilst the initial purchase price of entry level drones is attractive, consideration must be given to the cost of operator training and insurance. Weather capability should also be considered. Low cost drones will not be able to operate in rain or windy conditions. How would this impact on the ability of the drone to deliver what you expect it to?

There is a debate to be had around purchasing drones as opposed to buying a service in. If as a Force you only require drones to support police level incidents (single agency) it may be cheaper to commission a company to provide the service rather than purchase drones.

Drones come in a variety of specifications and prices. It is essential that a fully considered user requirement are drawn up in order to make an informed choice. One size does not fit all.

NPCC & NPAS – Standard for Deconfliction Between Police Drones and NPAS Assets

Many forces now use drones to support the delivery of local policing services. Chief Constables are ultimately responsible for their use of drones under Schedule 10 of the Sec. 22 Collaboration Agreement between forces and NPAS. The result of this means that it is likely that both NPAS and a drone will be operating at the same task or in close proximity and as such this deconfliction standard between drones and NPAS should be applied.

Final Project Report (ACC Steve Barry, Sussex and Surrey Operations (December 2016).


Official

Final Project Report

Quantifying the opportunities and threats of Unmanned Aerial Vehicle (UAV) technology in Policing

Home Office Innovation Fund Grant agreement 2015 - 004

ACC Steve Barry
Sussex and Surrey Operations

December 2016

In December 2016, the NPCC Drones - Final Project Report was finalised by ACC Barry and submitted to the NPCC for review. The document is sensitive and a copy of the report was provided to me from the NPCC and it was gratefully accepted. A copy of this report can be viewed upon request, but at this point in time no permission has been given to distribute this copy. For those wanting to view the document, please contact me.

The report contained seven key sections (Executive Summary, Background, Aims, Methodology, Outcomes, Conclusion and Recommendation's). The following paragraphs are directly copied from the report for reference.

> The project enabled a small operational training and working group to look at a training package for the police use of drones. A written proposal was submitted to the National Police Air Service (NPAS). This is now being considered as part of the Blue Light Air Service Innovation funded project led by Chief Constable Simon Byrne the NPCC Aviation lead.
>
> The project has enabled the NPCC lead for drones to work with the Department for Transport (DfT), Ministry of Defence and Home Office Centre for Applied Science and Technology (CAST) to develop a Strategic Threat and Risk Assessment. Led by the DfT this has been completed and further work is ongoing with CAST to research counter measures.
>
> The project has been able to demonstrate the potential benefits that drones could offer. The result of the consultation and operators feedback shows that officers and staff believe that drones can be used to support them in delivering a policing service. They also believe that drones can make their job safer and help the service maximise the safety of the public.
>
> 21 Forces have reported that they have purchased drones, 2 are operational and 12 others are in the development stages.
>
> Seven Fire and Rescue Services are currently operating drones with more looking to purchase drones and others using commercial providers. The drone of choice for the Fire and Rescue services are normally the Aeryon SkyRanger, the DJI Inspire and sometimes DJI Phantoms.

Lessons Identified

Topic	Lesson Identified – National Police Chiefs Council (NPCC) and Surrey & Sussex Police	No.
Funding	The use of mid to low cost, sub 20kg drones provides a financially viable opportunity to enter the drone's space by avoiding high-end costs.	1
Equipment (Drones)	Most police forces will only need the commercially available off the shelf $5,000 drones as their budgets are low, but the capability requirements can still be met with those types of drones.	2
Training	Training remote pilots should be done with the low cost DJI products as crashing and bumping into objects can have high cost impacts on the more expensive and capable aircraft.	3
Research	Mapping out the drone research and development process via defined project plans is critical to the success of the project.	4
Research	Establishing a research project in the first instance ensures that measured and methodical processes are applied as apposed to acquiring drones and then working out what to do with them.	5
Considerations	Ensure that all of the OHS, legal, privacy, data security and public opinions are known from the begging and that they are managed continually.	6
Considerations	Management of the Civil Aviation Authorities (CAA) legal and regulatory requirements requires continual attention and as such dedicated resources are required to build and maintain those relationships.	7
Equipment (Drones)	Knowing the true and realistic capabilities of each drone is critical as the specifications and capabilities listed by the manufacturer are not always correct and are not necessarily written for the type of work that police will employ them for.	8
Resources	Having to purchase multiple drone types requires increased training and resourcing needs. Limiting the number of drone models/types is critical.	9
Resources	Drones are a new capability and as such they need dedicated staff to grow and mature with the capability, human resources need to be either permanently attached to the drone unit or spend a significant amount of their time working with the capability.	10
Funding	In comparison to other methods for policing that are currently employed, drones are cheap to purchase and extremely cheap to run.	11

Outcomes	Situational awareness is dramatically increased through the use of drones and the provision of the vision can be downlinked to multiple users.	12
Considerations	Media and public focused communications can streamline the implementation of a drones unit as the public will be aware of their future application, and as such, when implementation occurs it is no surprise to the public and is readily accepted.	13
Project time lines	Due to time constraints following an extended procurement process, the timeframe planned for the NPCC project was not sufficient to allow for an effective and robust evaluation of the benefits of employing drone technology. The project commenced in June 2015, 3 months after the Innovation Fund grant. The full procurement process resulted in a contract for the supply of drones not being awarded until January 2016 with the drones only just being delivered by the end of March 2016. This resulted in the operational trial, which was initially planned to span 6 months being cut to 3 months.	14
Equipment requirements & space	The invitation to tender document outlined 3 levels / classifications; a high-end system, mid-range system and tethered drones. The outcome of the procurement process was that the suppliers of the mid-range and tethered systems were unsuccessful. The systems purchased were not ideal for placing in Armed Response Vehicles. The amount of equipment carried means that finding room for a drone pelican case and batteries was difficult. This means that the process was floored due to the complex procurement process.	15
Training	Operator training took place immediately before the operational trial; this meant that operators lacked confidence in their ability and that of the equipment, which may have impacted on the outcome of the evaluation. In hindsight a more realistic timeframe for the project would have been 2 years. 1 year for planning and purchasing and one year for an operational trial.	16
Analysis of data for evaluation	The methodology employed relied on the accuracy and capability of Command and Control systems to allow comparison between like incidents over comparable areas. They are neither accurate nor capable of pulling out comparative data. The systems are not designed with analysis in mind. To pull out any data each incident requires reading through individually and manually recording findings. Project resourcing meant that this was not possible. The project was also surprised to find that there is no national or Force level recording of resourcing data in respect of search or other large scale incidents. This made it impossible to quantitatively assess the impact of a drone.	17
Data collection	Submission of evaluation forms and recording of deployments by operators was patchy. Even though the forms were on line and reminders were sent out regularly, the project is not confident that all deployments have been captured.	18
Equipment (Space to carry	Surrey and Sussex Tactical Firearms Unit are standalone Firearms officers and do not form part of Roads Policing or proactive teams. During the trial a drone did not deploy from an Armed Response Vehicle and feedback was that the equipment was too big and should	19

equipment)	be deployed by unarmed support and not the Firearms Officers themselves	
Set up and ongoing costs	The project found that the operation of drones should not be considered a cheap option. Unmanned is a misnomer, one operator and one observer are required as a minimum to operate a drone. In hazardous environments more observers may be required. The purchase of a weather capable system with thermal image camera and 20 minutes plus battery life runs into the tens of thousands of pounds.	20
Set up and ongoing costs	Operators are required to undergo CAA accredited training which currently can only be provided by private companies. Costs vary form £600 - £1400 per person depending on company and how many operators are being trained.	21
Insurance	Insurance is required. Depending on Force and system operated this can be up to £5,000 per system per year. However some Forces are operating under crown indemnity and others have been advised to obtain specific insurance.	22
Cost of spares	Most systems are maintenance free requiring little more than regular airframe and blade checks and cleaning. It is recommended that the cost of spares are taken into account when writing business cases.	23
Interoperability with other agencies	The purchase and operation of drones by all emergency services brings with it the need to consider the interoperability of drones at incident scenes. This would include the development of downlinks that could be streamed to all services and protocols for joint service use of drones.	24
Issues with inclement weather	Most Forces are trialling cheaper drones that are not designed for operating in inclement weather. The most popular DJI systems are designed for capture of aerial imagery and not for 24 x 7 use by emergency services. Although they have now made a thermal camera available, a number of Forces commenced their trials without one and are unable to operate at night. Whilst useful for proof of concept study and good weather aerial imagery, they cannot be relied upon to provide all weather 24x7 support to Forces.	25
Drones supplement manned aircraft, they don't replace	Small rotary drones can and should be considered as an air support option complementary to fixed wing and helicopters. Collision investigation, aerial imagery, hydroponics search and directed patrol can all be carried out by drone. Other areas of support such as firearms, public order, missing person and suspect search can be carried out by both. Vehicle and suspect pursuits in built up areas can only be carried out by helicopter or fixed wing.	26
Cost	Cost of purchase - Systems that have the potential to effectively support 24 x 7 policing operations are currently very expensive. Depending on the structure of a Force a number of these systems will need to be purchased and Forces are unlikely to find the funds	27

	from existing budgets.	
Public Perception	Public perception – Feedback from the recent Government Public Dialogue events on the use of drones by the police was positive and lead the project to conclude that this is more of a perceived than an actual barrier. It is important that Forces engage with communities on the subject of drones and are open and transparent around their use. A good example was provided by Devon and Cornwall working with Dorset who opened their project for independent audit of their compliance with the Surveillance Camera Code of Practice and have received a Certificate of Compliance.	28
Detect and avoid technology	Detect and avoid/collision avoidance technology – This is still in its infancy and until widely available on systems at reasonable cost will limit operations to small rotary drones within line of sight.	29
Deconfliction	It is likely that both NPAS and a drone will be operating at the same task or in close proximity and as such this deconfliction standard between drones and NPAS should be applied.	29

3.2 QinetiQ UK – Boscombe Downs

Contacts

- Emma Hodgetts - Engineering Manager, Chief Air Engineer Group BCE, Farnborough
- Alex Cruttwell – QinetiQ UK, Boscombe Down, Airborne Surveillance, QinetiQ
- Carl Davies from UASCDC was also present



I attended the QinetiQ facility at Boscombe Down, West of London to meet with the QinetiQ team and discuss their high altitude and long endurance UAS programs.

This conversation was based around the high end of the market (Watchkeeper, Pseudo Satellite technologies) and as such the questions and answers provided in this report do not relate to the smaller end of the market where the majority of end users are focusing their attention. Interestingly, whilst most agencies only focus on the low end, the higher end is now being realised through a number of UAS programs that are moving out of the shadows of the Defence and intelligence agencies into the light (police, emergency services and industries like Water, Energy, Agriculture etc.). This section of the study tour was designed to look at what exists in the higher end of the market and what that means for the State of Victoria and its agencies. Given that QinetiQ are one of the leading UAS development experts in the world, the opportunity to meet with them in the UK was a great opportunity.

Note: Some aspects of the discussions with QinetiQ have been withheld for privacy and I.P related reasons, however, a vast amount of information from QinetiQ is available for the general public.

Overview of the Organisation

QinetiQ is a British multinational defence technology company headquartered in Farnborough, Hampshire. It is the world's 52nd-largest defence contractor measured by 2011 defence revenues, and the sixth largest based in the UK. It is the part of the former UK government agency, Defence Evaluation and Research Agency (DERA), which was privatised in June 2001. The remainder of DERA was renamed as QinetiQ. It has major sites at Farnborough, Hampshire, Ministry of Defence (MoD) Boscombe Down, Wiltshire, and Malvern, Worcestershire, former DERA sites. It has made numerous acquisitions, primarily of United States-based companies.

MoD Boscombe Down is the home of a military aircraft testing site, located near the town of Amesbury in Wiltshire, England. The site is currently run, managed and operated by QinetiQ. The site was originally conceived, constructed, and operated as Royal Air Force Station Boscombe Down, more commonly known as RAF Boscombe Down, and since 1939, has evaluated aircraft for use by the British Armed Forces.

Within the United Kingdom, QinetiQ UK provides a UAS centre that provides an environment for testing, development, demonstration and training with UASs. Supported by local air traffic services, they are at the forefront of UK UAS operations and procedural development. Primarily based in Wales with management teams in Boscombe Down, QinetiQ offers a complete infrastructure for UAS operations teams who work with companies like BAE and governments like the UK governments MoD.

The UAS systems being discussed are primarily high end long endurance UAS with military and or high end civilian technology based capabilities as apposed to the lower end of the market such as UAVs below 10 kg and off the shelf products.

Essentially, QinetiQ does the science and technology for a range of companies that include, but are not limited to: Babcock, BAE, Airbus and hundreds of other companies. They support and develop systems, but don't build their own fleet of UAS as they support organisations that do. If an agency or company sought support from QinetiQ, that support would include:

- Evaluating the most cost-effective UAV platform / solution, which can evolve to suit the needs of the client
- Integrating the UAS service into the environment progress the aircraft from the development stages to the flying stages quickly
- Providing sophisticated and integrated technologies and evaluation and processes to develop I.T platforms and communications systems for UAS developers
- Providing testing facilities and multi-integration technologies to thoroughly test and assess UAS in all aspects of design, development, production and flight.

As well as helping customers choose the right unmanned system, they support existing or planned activities – handling everything from site survey to operation and maintenance, as well as training on system management, imagery and use of information.

Outcomes of the Discussions with QinetiQ at Boscombe Down

Through attending the facility, the following focus areas were discussed:

a) What would be a 'complete package for UAS', from assets through to operational deployment?
b) What is the division of UAS and various 'classes' – i.e. size and weight?
c) What are the existing constraints facing UAS and their use. For example, life cycle, hours of deployment, software, training, etc.?

a) What would be a 'complete package for UAS' from assets through to operational deployment?

Watchkeeper

One solution is the UK built Watchkeeper UAS. This system is currently employed by the MoD in the UK and has been deployed in Afghanistan as surveillance platform.

This Thales and QinetiQ AS3 communications intelligence (COMINT) system is ready to fly as a payload on Thales's Watchkeeper unmanned aerial vehicle (UAV). The Watchkeeper can fly to 16,000 ft., travel up to 140 miles from its base station, travel at 95 miles per hour and remain aloft for up to 17 hours. The aircraft is designed as a high tech surveillance platform with world-leading intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) solutions.

The Watchkeeper project could be employed as a state based asset and includes high tech systems to provide persistent support to the Victoria Agencies. The system could operate in support of policing operations, emergency management and any incident that requires a high altitude long endurance persistent surveillance capability.

The complete package would include the:

- Hardware - UAS (aircraft) and its base station (flying station and equipment)
- Software – All of the mission systems and software programs
- Communications – All ground and air based communications systems downlink
- Full CASA compliance and testing support / liaison
- Full training packages for positions holders
- Management support for deployment and mission profiles
- Provision of initial and or ongoing human resources

- Full operational deployment imagery interrogation and intelligence gathering, management and storage
- Ongoing IT support

The full package can be an end-to-end service, or what is referred to as in the aviation industry is a turn key solution. Other options include the client providing their own flight and ground staff, however, for this level of UAS it is highly recommended that a turn key solution or a solution that is close to turn key be used due to the highly technical and sophisticated programs that the UAS includes.

The benefits from this type of system include, but are not limited to:

- A flying camera system that can remain aloft and provide up to 17 hours of continuous persistent aerial imagery (following targets, pursuits and or conduct searches for extended periods of time)
- Provide highly efficient live and downlinked imagery of targets
- Provide FLIR systems for low-light or no-light situations
- Operate over a radios of 140 mile from the operating base station (landing area)
- Provide a highly manoeuvrable and nimble UAS
- Ability to quickly move from location to location with a speed of 95 mile per hour, to mention a few.

Zephyr (Pseudo Satellites)

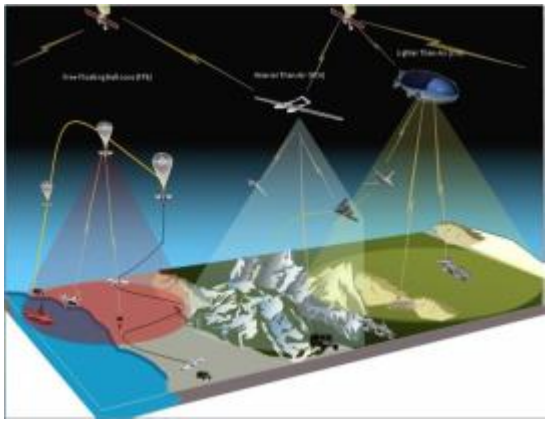
Another system that could be of use are the Zephyr (Pseudo Satellites) made by Airbus, that can operate at 70,000 ft. and can be airborne for weeks at a time. These systems fly above commercial aircraft and above the weather. They can provide a constant 24/7 stream of imagery.

Zephyr delivers a truly unique, real-time pseudo satellite capability to provide wide area persistent presence at low through-life cost. Running exclusively on solar power, Zephyr flies at about 65,000 ft., above the weather and other air traffic. It flies autonomously for months, filling a capability gap between satellites and Unmanned Aerial Systems (UAS) by providing an affordable, adaptable and persistent solution. Airbus has a unique, demonstrated lead in the design, build and operation of HAPS allowing low risk access to a world class development and the ability to continuously evolve with advances in payload technology.

The first unmanned aircraft of its kind to fly in the stratosphere, Zephyr harnesses the sun's rays, running exclusively on solar power, above the weather and conventional air traffic. It is HAPS: a High Altitude Pseudo Satellite, able to fly for months at a time, combining the persistence of a satellite with the flexibility of a UAS.

Uniquely designed for both military and commercial purposes, Zephyr can deliver numerous payload capabilities across two platforms. Zephyr S with its ability to carry payloads, offering voice, data communications both line of sight and beyond the line of sight, and line of sight high resolution optical imagery. Zephyr T carrying larger payloads offers the ability to bring more active payloads to the fore; for example, widespread, persistent internet coverage to remote areas of the globe, and active RADAR. Together they enable real-time mapping, internet and a number of surveillance opportunities to meet a broad range of requirements.

The first picture below provides a simply viewpoint showing the area of coverage provided by the camera systems inside the different aerial platforms the communications linkages. The second is an example of the imagery being provided.



The pictures shown above provide an overview of the type of aerial imagery that this type of system provides. The UAS in flight provides imagery of a geographical area that can be zoomed into or out of. The location of the aircraft and the cameras it carries are like beams of light in the dark with respect to its area vision. To gain imagery of an area outside the beam (field of view) the aircraft is moved and the beam of vision follows it. The Zephyr can travel 2,000 km in a 24 hour period so it could be moved from one end of the state to the other in a short period of time. Its speed and manoeuvrability is different to the Watchkeeper and as such any decision between the two types of high end UAS would be based on the needs of the client and the operating model that best fits that client.

Key Features

- Autonomous, high reliability platform
- Exclusively solar powered – no fuel limitation on flight endurance
- Operating at altitudes above the weather and conventional air traffic
- Low vibration and structural loads to allow high efficiency, lightweight payloads
- Operable globally as a “Constellation” – markedly reducing operating costs
- World’s most advanced and only flight proven HAPS

- Over 14 continuous days of flight – longer than any other High Altitude UAV
- Not constrained by the flying hours limitation of manned flying vehicles
- Designed and tested to allow routine flight clearance by military and civil authorities.

Simular to the Watchkeeper, there are packaged options for systems of this nature. The turn key solution is available whilst a more limited package could also be employed, albeit that the State would need to employee and specifically train personnel for this type of role.

b) What is the division of UAVs and various 'classes' – i.e. size and weight?

The UK CAA, EASA proposals, various European countries' views and NATO approaches to UAS classification.

The issue of classification is an interesting dilemma for authorities and the variance between some are provided below.

UK CAA guidance (CAP 722)

Proposes three categories (Small Unmanned Aircraft, Light UAS and UAS):

Mass Category	Mass (kg)	Responsible Regulatory Body
SUA	0-20	National Aviation Authority
Light UAS	> 20 to 150	National Aviation Authority
UAS	> 150	EASA[5]

Table 1 - Mass Categories Relating to UAS

MAA

Considered for the Defence Air Environment, as issued by the Military Aviation Authority, shown below aligned to NATO classification thus:

Common Taxonomy	MTOW	Starting MAA Category	NATO Class
NANO	< 200g	Class I(a)	Class 1 *< 150 kg*
MICRO *<2kg*	200g to 2kg	Class I(b)	
MINI *2-20 kg*	2kg-20kg	Class I(c)	
SMALL *>20 kg*	20kg-150kg	Class I(d)	
TACTICAL *<150 kg*	> 150kg	Class II	Class II *150 - 600kg*
MALE / HALE / Strike / Combat	> 600kg	Class III	Class III *> 600kg*

Table 1 – MAA/NATO Class and Common Taxonomy

EASA

Classifications: Open, Specific, Certified. Within the Open category - 3 sub categories:

- A0 - toys and mini drones under 1kg
- A1 - Very small drones under 4kg
- A2 - small drones under 25kg

Denmark

National (aeromodelling) rules for the time being, based upon the split into the following weight limits:

- 0-7 kg no special certification apply
- 7-25 kg and jet powered aircrafts are only allowed flight by model airfields and third party liability assurance
- 25-150 kg need special approval/certification and third party liability assurance
- 150- kg regulated by EASA and need approval/certification

For the three first categories, only flying below 100 m GND, 150 m distance to buildings, roads and persons.

If the operations are in urban areas the operator have to be a professional and apply for an operations permission.

This is done by writing and have approved an operations manual, approved pilots and assurance.

Then the categories are:

- Category 1A: Between 0 and 1,5 kg or less than 150 Joule energy, VLOS Category 1B: Between 1,5 and 7 kg < 1000 Joule energy, VLOS
- Category 2: Between 2 and 7 kg, VLOS
- Category 3: BVLOS (only in segregated air space)

Germany

There are currently two weight limits: 5 kg and 25 kg.

Based on Amendment No. 14 of the Aviation Act (LuftVG) dated 08 May 2012 unmanned aircraft systems (UAS) and their control stations are defined as aircraft in Germany. According to previous regulations UAS missions are restricted to the line of sight of the controller and a take-off weight of 25 kg (§ 15a, para. 3, Aviation Regulations, LuftVO). By way of exception, the responsible aviation authority can permit the operation of UAS with a take-off mass of more than 25 kg and/or beyond the line of sight of the controller in specific airspaces in accordance with § 15a, para. 3, LuftVO. For the operation of UAS, ascent permits issued by the federal states are required, the standardization of which is proving difficult to achieve.

The broad range of UAS and their missions as mentioned above make regulation a challenge. While larger systems are based on manned flights, the origins of systems up to 25 kg are frequently found in model making. Very small systems under 5 kg which are

operated within the line of sight are already used extensively in Germany based on general ascent permits (see NFL 161/12 and NFL 1-437/15).

Individual permits are required for line-of-sight systems weighing 5 kg to 25 kg or operated in specific missions. This mean for example that a permit is needed for commercial purposes such as aerial photography, even if the UAS is <5 kg. However, there is no need for a permit under the limit of 5 kg for recreational purposes (hobby). The hazards do not depend only on the physical properties of the UAS but also on their operational range and type of mission.

French

Regulation has defined four scenarios: two VLOS scenarios and 2 BVLOS

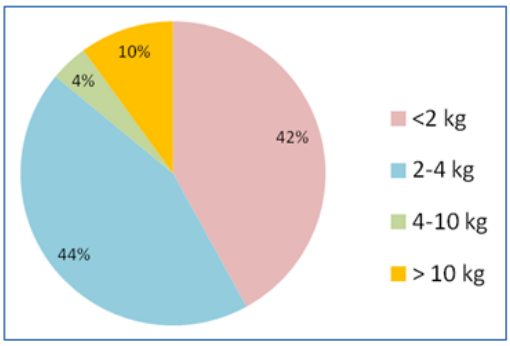
VLOS

- SCENARIO 1: Non-populated area, Height < 150 m, Mass < 25 kg
- SCENARIO 3: Populated area, Height < 50 m, Mass < 4 kg
- An administrative authorization and a safety perimeter are required
- In the next version of the regulation, the mass limit is upgraded to 8 kg
- BVLOS
- SCENARIO 2: Non-populated area, D < 1 km, Height < 50 m, Mass < 25 kg
- In the next version of the regulation, if mass < 2kg, height < 150m.
- SCENARIO 4: No distance limit, Non-populated area, Mass < 2 kg

There are also technical requirements defined for the UAVs, for each scenario.

This regulation has influenced the market:

- This diagram represents the mass of professional RPAS in France.



Derogating scenarios can be allowed according to the risk analysis. If the risk is high, a partial (or a total) certification will be required.

Professional operators have to declare their activity to DGAC, and document:

- The UAVS (what kind of UAV, how many of each kind)
- The remote pilots: their certificate, their theoretical training, their practical training
- The operational procedures
- The maintenance procedures
- The tasks description

- They are supposed to report every incident having an impact on safety.

Each year, they are supposed to send to DGAC an annual report (focusing mainly on activities and incidents); insurance is mandatory for professional operators and for manufacturers.

c) What are the existing constraints facing UAVs and their use. For example, life cycle, hours of deployment, software, training, etc.?

Given that the discussion that took place in Boscombe Down related to high end UAS, the answers only relate to those high end UAS.

The high end equipment can be used to provide persistent surveillance of metropolitan areas at high altitudes and can cover long distance vehicle incidents such as pursuits and surveillance tasks as the UAS can be airborne for 17 hours and has highly technical and capable camera, FLIR and communications equipment.

Life Cycle

The life cycle of high end UAS is extremely efficient because they replicate real aircraft as apposed to small end UAS that are easily damaged, outdated and become unusable after several years of use. High end UAS are simular to manned aircraft because the air frame can be maintained for decades with the internal and relevant external parts, engines and consumables being replaced on an as needs basis through maintenance programs. Therefore, the life cycle of the airframe will outlast its use where the smaller internal parts are continually managed under maintenance schedules.

Hours of deployment

The higher end UAS provide the opportunity for 17 hours to 4 weeks of continual flight and as such, provide an entirely different capability than the lower end UAS.

Endurance

With endurance relating to speed, operating distance and efficiency in travel, the higher end UAS will always include long distances and potentially high speeds and great distances that do not include visual line of sight and high altitudes. The discussion around endurance for high and low end UAS is a completely different concept and as such the Watchkeeper and Zephyr are different systems yet both provide excellent endurance, as they do not rely on conventional fuel loads.

Software

The benefit of most UAS in todays environment is that the software systems can be frequently updated, upgraded and or replaced. These systems are essentially a flying camera that is operated by a flying computer and therefor the software requirement is critical, sophisticated and replicable.

Training

Training for the higher end UAS is a completely different story when comparing to the lower end UAS. The remote pilots for these higher end systems often require fully trained pilots and the training is extensive and expensive. This is one of the reasons that the turn key solution for employing this type of UAS is sometimes the best solution as the provider provides the UAS, pilots and ground crews that are specially trained to mage the UAS.

Funding

Again, the funding requirement is significant and as such, the multi-agency stakeholder approach is in most cases the only funding stream that can be applied as individual agencies cannot afford the higher end UAS.

Lessons Identified

Topic	Lesson Identified - QinetiQ UK – Boscombe Downs	No.
Employment of High end UAS	It was identified that these high end UAS are highly suited to todays policing and emergency management environment and can play a significant role in response to many incidents.	30
Cost	The high end UAS are expensive and require ongoing commitment to the use and application of UAS due to the high funding requirements.	31
Cost	It was identified that these high end UAS should be approached at the State multi-agency level and not just single agencies due the high cost and the high usability and application across multiple stakeholders.	32
Glide Paths and system failures	The high end UAS can operate over large metropolitan areas due to its long glide path, should the system fail and require landing. The altitude to which it operates provides a long distance glide path and as such it does not suffer from the issues faced by light aircraft over metropolitan areas where they fly at lower altitudes and therefor have shorter glide paths.	33
Application for Emergency Services	It was identified that the emergency service agencies could be a frequent user of the Watchkeeper type of UAS as it is able to fly above commercial aircraft and also fly down to 2000 ft. when required. This type of UAS can fly across large tracks of land and sea and as such has the ability to support large scale flood, fire and weather events. Search and rescue, counter terrorism and day to day policing are also a frequent user due to its ability to remain aloft for long periods of time without the need to refuel frequently.	34
Working with CASA	It was identified that CASA (CAA in the UK) must be engaged in the discussions and planning from outset as the regulations surrounding high altitude UAS systems will need support from CASA and not just approvals. It was also identified that agencies like CASA may very well become one of the end users of the system due to their role and functions in airspace.	35
Resourcing	It was identified that this high end capability must be fully supported by a fully resourced and capable command centre or operations centre 24/7 to constantly mange the downlink imagery and ensure that missions are constantly planned, assessed and tasked accordingly.	36
Joint partnership	It was identified that governments and police agencies could consider a joint program with Defence so as to manage the very high costs associated with such technology and systems.	37

with Defence		
Needs Analysis	The most important step in evaluating expensive and highly capable technologies is to conduct full and thorough needs analysis of each agency that may request to engage in a UAS program of this nature. This will ensure that all potential financial contributing stakeholders are identified from the outset. This step is backed by a full needs analysis to ensure that the potential participating agencies have a need that matches the capabilities that these highly capable systems can provide.	38
Insourcing or outsourcing operations teams	The decision around the UAS operating teams needs to be determined from the outset. This means that the State can have its own personnel trained and equipped to operate the systems independently of other supplies, or, that the State could also outsource the operators of the equipment to the equipment provider who are experts in that UAS, who will provide that skills set. (I.e. Who will fly and manage the UAS on behalf of the State, given the high level of technical requirements of systems such as the Watchkeeper and Pseudo Satellites. It was recommended that the management of the UAS should be outsourced whilst the decision makers remains at the State level.	39
Decision making - High end UAS vs. low end UAS	It was identified that the decision around employing this high end UAS capability should always be decided in isolation from the small end UAS to which many agencies are now employing. Whilst the end result (aerial imagery) is the goal, the two ends of the spectrum are vastly different in every aspect. The smaller end of this spectrum should be progressed separately from the high end.	40
Management Teams	The management and coordination of these high end UAS can be managed at a State level and there is no need to be linked with the management teams of the small end capabilities as they do not correlate and do not link together, even though they are both UAS.	41

3.3 QinetiQ UK – Malvern

Contacts

- Chris Harrison – QinetiQ UK, Farnborough, Airborne Surveillance, QinetiQ
- Ian Fuller – QinetiQ UK, Malvern Technology Centre, Lead for Airborne Surveillance in QinetiQ
- Alex Cruttwell from Boscombe Down was also present at the Malvern site

Overview of the Organisation

Refer to Section 3.2 – Boscombe Downs for the Organisational overview of QinetiQ.

Malvern, UK

The visit to the QinetiQ site included two main focus areas, the first was technical mobile phone searching technology that can be employed in both manned and UAS aircraft and the second conversation was based on QinetiQ's counter UAS technologies.

Note: The technical mobile phone searching technology information is not included in this report due to the high level of security.

Counter UAV Capabilities

Across the globe, a large number of companies are working on counter UAS technologies, however, no single solution has yet been identified. The following information relates the technologies that can be accessed via the larger companies such as QinetiQ.

QinetiQ believes that low-cost 3D radar is the only long-term solution for countering UAS. Radio Frequency (RF) techniques are already being overcome by pre-programmed flight plans; acoustic sensors may not provide sufficient range or may experience audio interference, and cameras need to be cued on to a target. The single most reliable signatures that a small UAV possesses are its physical presence and the rotors, which are used for flight, which are exploitable by radar systems.

The QinetiQ OBSIDIAN radar has been designed specifically for counter drone operations, providing a 180° Azimuth by 85° Elevation staring antenna array. This overcomes the limitations of competing systems, which typically have less than half this coverage and use mechanical or electrical scanning; which may result in missed targets and loss tracks. OBSIDIAN also uses novel techniques to recognise drone features to avoid mis-classification of wildlife.

OBSIDIAN has been developed from the highly capable Military ALARM radar, used by the British Army to provide warning of short range aerial target attacks with >99% percent Probability of Detection and less than 1 False Alarm per week.

Intuitive Threat Warning Interface

The QinetiQ Palisade® Surveillance Management System is a fielded multi-sensor software system providing an intuitive Graphical User Interface (GUI) which requires little training. Palisade provides a cost-effective control-room solution requiring minimal manning due to its automated threat alarm and supporting integration with existing security systems to provide seamless and coherent operation.

Palisade® assesses threat tracks from the OBSIDIAN radar in real-time, classifies drones when detected, and automatically cross-cues the camera in 3D to accurately zoom onto the target of interest. Video clips are automatically tagged to tracks on the Palisade GUI and alerts are automatically generated. This functionality is designed to be easily integrated into an existing security system.

Palisade® employs advanced, patented tracking and fusion algorithms which turn raw sensor outputs into robust tracks and alerts. Intuitive, uncluttered displays enable operators to react to alerts with minimal effort.

Fielded military protection

OBSIDIAN is specifically designed to detect, identify and track small/micro UAVs. It provides rapid, high-confidence alerting of drone activity with minimal false alarms. OBSIDIAN is purpose built to provide high performance against drones and avoid mis-classification of birds, wildlife, and vehicles as shown above. OBSIDIAN's high performance is delivered from its staring antenna array, which provides instantaneous 180° Azimuth and 85° Elevation coverage per radar (a back to back pair providing full 360° coverage). Detections and track formation are made near-instantaneously without the delay caused by antenna scanning. Hovering and slow-moving targets are classified due to detection of rotor blades. These features also provide high-confidence recognition of drones and effective contiguous tracking of agile targets, which avoids mis-classification of birds and other flying objects.

Application of QinetiQ's Countering UAS Technologies into Australia

Counter UAS technologies at present, are evolving rapidly and there are multiple companies wanting to operate in this environment. QinetiQ's solutions are at the higher end of the scale and are stated above, are closely aligned to the military. The findings from this visit will be provided to VicPol as a future possibility and will be assessed alongside other capabilities that are available now and into the future.

As noted in this report, several peace's of information are being withheld from general publication, but can be accessed upon individual request.

Lessons Identified

Topic	Lesson Identified – QinetiQ at Malvern	No.
Military Grade Counter UAS	It was identified that the most comprehensive and complete package for counter UAS is a high end military grade capably. The issues however include the ability to operate that type of equipment in multiple locations at any one time. This issue may not be relevant to the military, as they would employ one counter UAS unit to protect one military base. This would not work for civilian agencies as the number of locations requiring counter UAS is extensive and the need for employing the capability would change daily.	42
Civilian Context	It was identified that other counter UAS solutions are still required for the civilian context.	43
Advances in technology	The need for UAS operators to remain up to date with emerging UAS technologies is critical to ensure that any new advanced in technology are known and where relevant enquired into.	44

3.4 UAS Capability Development Centre & National Cross-Government Working Group for Counter-UAS

Contacts

Carl Davies, Account Director / Service Delivery Manager, UAS Capability Development Centre, MOD Boscombe Down.

Overview of the CDC

At the meeting with QinetiQ on the 12th of October at MOD Boscombe Down, Carl Davies had been present and was providing information regarding the high end UAS systems along with the national level Cross-Government Working Group for counter-UAS (C-UAS). The C-UAS group includes representatives from the key UK agencies and their role is to drive the C-UAS capability for the UK.

The groups membership includes, but is not limited to:

- Fire Services
- Police – Counter Terrorism
- NPCC
- National Offenders Management Service (Prisons and Corrections)
- Search and Rescue
- Department of Transport - Maritime Coastguard Agency
- CAST
- Bluelight Air Support Project
- Department of Transport
- Ministry of Defence

The group meets on a monthly basis and they work through a defined list of issues and opportunities.

One of the topics that the C-UAS group are working on, is the UAS classification system for the purposes of considering threats and developing the National Risk Register. This is an amalgamation after discussion, of the UK CAA, EASA proposals, various European countries' views and NATO approaches to UAS classification. This section was noted in section 3.2.

Other topics include:

- C-UAS at Prisons (prevention of UAS being used to smuggle drugs, weapons, communications)
- Employing C-UAS at major sporting events
- Employing C-UAS at major emergency management operations and policing operations, to mention a few
- Contributing to the National Risk Register
- And other topics of national significance with response to UAS and C-UAS.

The groups monthly meeting for October was set for Friday the 14th at the MoD Main Building, Horse Guards Avenue, Whitehall, London.

I was invited to attend this meeting and as such I was provided with an opportunity to meet with most of the members of the UASCDC at the MoD. Most of the outcomes of that meeting cannot be included in this report, however, some aspects have been incorporated where possible.

The meeting was not only a great opportunity to assess the C-UAS programs being managed at the UK national level, but it also provided introductions to several personnel who I would not have known about nor been able to be introduced to. The following persons were present at the meeting and agreed to meet with me after the meeting, over the coming week whilst I was still in London.

- Detective Inspector Colin Smith – CAST
- Steven Adams - London Fire Brigade and Bluelight Air Support Project
- Inspector George Trebess, NPCC and Counter Terrorism
- David Owen, North East Counter Terrorism Unit, UAS
- Joanne Parish, National lead for the National Offenders Management Service (NOMS)

Again, as noted above, I would not have had the opportunity to meet with these persons if not for the invitation to attend the UASCDC meeting, which was organised by Carl Davies. This very opportunity only stems from the opportunity to travel to the UK in the first place.

The national UASCDC group sits at the same level of the Australian Attorney Generals Department (Federal) and as such is the highest possible national working group for UAS in the UK.

Additional Information – RPAS Classifications

As was noted in the visit to Boscombe Down, I was provided with copies of data relating to drones and their specifications. Carl Davies who had been present at that meeting had provided that information. On the day of the UASCDC meeting, Carl provided me with the table below that lists the RPAS classifications.

All other information pertaining to the UASCDC meeting is not provided in this report.

RPAS classification

UK/NATO Classification	Name	Weight	Wingspan	Endurance	Speed Knots	Op Alt ft	Standard or typical Payload	Responsible regularity Authority
Type 1 (<7kgs)								
Class 1 (a) Nano		<0.20kg						
Class 1 (b) Micro	Black Widow	0.85kg	0.15m	0.5hrs	NK	<800	Colour video and downlink	CAA
Class 1 (b) Micro	DJI Phantom2 Vision+	1.24kg	0.35m	0.5hrs est	<68	<500 est	HD video and downlink. With modification up to 1.5kg payload.	CAA
Class 1 (b) Micro	Raven	1.9kg	1.4m	1.5hrs	17-44	<500	Dual forward and side look EO and IR cameras with live downlink	CAA
Type 2 (7 – 150 kgs)								
Class 1 (c) Mini	Orbiter 2	9.5kg	3.0m	4hrs	30-70	<18,000	EO and IR cameras with live downlink, Laser pointer/Designator	CAA
Class 1 (d) Small	Hermes 90	115kg	5.0m	15hrs	NK	<15,000	EO and FLIR cameras, Laser Designator, thermal imager, SAR/GMTI. COMINT/DF, ELINT, LOS data link	CAA

UK/NATO Classification	Name	Weight	Wingspan	Endurance	Speed Knots	Op Alt ft	Standard or typical Payload	Responsible regularity Authority
Type 3 (>150 – 600 Kgs)								
Class 2 Light UAS (150 – 600Kg)	Hermes 450	550kg	10.5m	17hrs	NK	<18,000	EO and FLIR cameras, Laser Designator, thermal imager, SAR/GMTI & MPR and AIS. COMINT (GSM), ELINT, EW, COMM JAM, Wide Area Surveillance, LOS data link	EASA
Type 4 (>600kgs)								
Class 3 UAS (>600kg)	Hermes 900	1180kg	15.0m	36hrs	NK	<30,000	EO and FLIR cameras, Laser Designator, thermal imager, SAR/GMTI & MPR and AIS. COMINT (GSM), ELINT, EW, COMM JAM, Wide Area Surveillance, multiple weapon hard points, sitcom, LOS data link	EASA

Lessons Identified

Topic	Lesson Identified - UAS Capability Development Centre and Cross-Government Working Group for counter-UAS (C-UAS)	No.
National Approach	It was identified that a national working group must be established to ensure that the national stakeholders are connected through a defined working group approach.	45
State Approach	Australia is geographically different from the UK and as such there exists an opportunity for each jurisdictional (State or Territory) to also adopt a jurisdictional level working group both for employing UAS and Counter UAS. This would ensure a more calculated and collective approach was adopted that can include: needs analysis, equipment type, technology inclusions, joint training and joint media strategies.	46
RPAS Classifications	Using a validated RPAS classifications table is beneficial for the planning stages as it provides descriptors around the specifications of RPAS.	47

3.5 Home Office's Centre for Applied Science & Technology

Contacts

- Detective Chief Inspector (DCI) Colin Smith from the Home Office's Centre for Applied Science & Technology
- Alan Brooke from the Home Office's Centre for Applied Science & Technology
- David Rowlett (non police) CAST Chief Remote Pilot, UAV Capability.

Overview of the Organisation

The CAST facility is located at St Albans, which occupies a decommissioned Air Force Base and provides a large parcel of land with numerous building so that the personnel are free to conduct a range of tests and evaluation of equipment in a secure, confined location.

This facility also provides the perfect proving grounds for testing drones and enables drones to be flown on the base with uninterrupted access to airspace.

The meeting at CAST included DCI Colin Smith along with Mr Alan Brooke (non police) who is the scientist and Mr David Rowlett (non police) who is their chief Remote Pilot of their drone capability. Note: they only hold a Remote Operating Certificate and have a Chief Remote Pilot to conduct UAS testing and to use UAS for their internal tasks, but do not deploy onto operational tasks.

On behalf of the Home Office, which sits above all of the police forces, CAST conducts all of the scientific research and evaluation of police equipment and communications equipment for the police forces. They are the police equivalent of the DSTL (formally know as Defence Science and Technology Organisation (DSTO) in Australia).

Examples of their work include, the research and evaluation of materials to be used in ballistic vests. In this example they research and set standards on the durability requirements, materials to be used, layers of materials to be provided in the vests and all of the specifications and requirements, but they don't decide which providers will make and sell the products, they only identify and evaluate the requirements, specifications for that equipment. Police forces then use that information as the standard and arrange for manufactures to build what they require, which is based on the CAST specifications.

<u>Research into drones</u>

In regards to drones, CAST has taken on a major research project on behalf of the Home Office and for the 43 police forces. Their drone research is twofold.

Firstly, they are researching drones and their use by police forces.

Secondly, they are conducting in-depth research into countering drone technologies so that they can provide advice to police forces on countering drones equipment, which they would then use in the field. As noted in at section 3.1, CAST is linked through the NPCC to the NPAS and the drones project being managed by Surrey and Sussex police.

Police forces in the UK are not technical experts on drones and as such they would assess the capabilities and specifications of a drone, via the manufacturers specifications list and assume that those stated capabilities (flight speed, performance, camera quality etc.) would be correct. Those police officers then identify what mission profiles might suit which type of drone. However, this a floored approach as police are generally not technical experts and as such CAST has taken over the research component on behalf of the police forces.

In 2016, CAST invested approximately £100,000 and purchased 1 of each drone type that was commercially available on the market that costs between £70 and £20,000 in cost. This meant that they had 1 of each of the most commonly purchased drones on the market. This included about 15 to 20 drones in total.

Evaluation of UAV capabilities

After receiving the drones, the task was to take them out of their packaging, note down the listed capabilities of each drone, then fly drones to assess if the specified capabilities were in fact true. I.e. Battery time in defined weather conditions, speed in defined wind conditions, I.T links, performance, agility, camera quality, colour, night vision etc.

This meant that they could catalogue the drones and validate or correctly record the capabilities of each drone for police forces to access. This research in the early stages identified that some of the specified capabilities were either accurate, false or not quite as capable as is printed on the box. With a clear, validated list of capabilities for each drone, the next task was to identify which drones were suited to mission types.

For example: CAST identified that the most appropriate drone for vehicle collision investigation and 3D / 4D imagery was 1 particular drone as apposed to other drones that might serve the same purpose and provide simular cameras. The operating conditions and requirements for vehicle crash investigation identified a best-fit drone to match the task, which was validated through focused and systematic evaluation. Other tasks such as low-light or no-light capabilities were tested and the best drone with the most appropriate thermal camera system was also identified in this process. This way, if a police force needed a night vision capability, they could use the list to choose the best-fit drone to match that need, thanks to CAST.

As of October 2016, the process of working through all of the user cases / mission profiles was underway with some drone testing being conducted to complete the full list of drones, capabilities, user types and mission profiles. At the end that process, CAST will be able to provide the full list for use by police officers in the near future as a validated go to list.

The next research project was to identify the most appropriate counter UAV technology that police could acquire and use to: detect, classify, track and mitigate UAVs.

Counter UAV research

The primary issue with countering UAV technologies is that this area is still largely unresolved. There are hundreds of different drones that can be purchased (off the shelf) and then there are countless others, that hobbyists and criminals alike could build. Each drone uses different radio frequencies and other means to link the drone with the controller. Each drone has single or multiple feeds that are sent from the drone (footage, information, communications) to the controller and as such there are a countless number of differences between drones.

One method is to conduct testing, assessments and evaluation of counter UAV measures and systems that are currently available in the market place.

Each year CAST invites the companies who are working on or apparently have countering UAV technology to attend their site so they participate in police and industry drone and countering drone trials.

Essentially, these companies attend, set up their equipment as per the determined locations, then, the CAST team fly different drones on specified missions towards a target or building, whilst the companies attempt to detect and or detect and defeat that drone. This allows the companies to test this wears by attempting to counter the CAST UAVs. Through this process they are able to gain a true picture of the capabilities that each company has and how useful they may be for police related countering UAV operations.

So each year they conduct 3-4 days of trials to assess the new and emerging technologies. To date, there is no single counter UAV technology that is the answer. Each available system is doing something different. Some systems can detect a DJI but no others.

The only possible solution that the CAST team can see to be an option in the future is to have a multi system approach that provides 4 to 5 different technologies into one main unit. There is currently no-one stop shop for countering UAVs and even the technology that some companies are touting is either misleading or are only successful on a limited number of drone types.

Radar can see things in the air but cant see things below the roof tops because it cant separate the signals and as such radar is only one part of the overall solution for countering drones. Sonar is also another type of detection equipment but not useful for drones. Acoustic short-range technology can pick up some of the drones but cant pick others out of the background noise. So the solution starts to head down the lines of radar, acoustic, radio frequency identification and the list goes on (multi-sensor systems).

There is a long way to go in this field, but the CAST team are not attempting to build counter UAV technologies as it is not their role, but they are working with manufacturers to identify potential solutions by providing a proving ground and UAV missions/sorties to test the systems that they are interested in looking at.

Agencies in the UK Evaluating UAVs

Apart from CAST, the Centre for the Protection of National Infrastructure (CPNI), NOMS (for prisons and corrections) and DSTL for Defence are the four key agencies in the UK who are undertaking the countering UAV evaluation.

Supporting other agencies

CAST also use the UAVs by attaching different types of packages (payloads) and conduct tests to see how well each UAV will manage a payload of varying size and weight. Some UAVs struggle with different payload shapes whilst other struggle with weight. These profiles are structured so that each UAV is testing for the same tasks so that the results can be compared. Testing UAVs for carrying payloads into prisons (drugs or weapons) is a problem for corrections officers, so, CAST use their UAVs to undertake tests to work out the likelihood of each UAV being used for that criminal activity, and as such, it assists NOMS in determining the UAV that is most likely to be used for this tasks and how it might be used.

Additional information from the manufactures includes upgrades that people make to their UAVs such as blades (rotors) payload, equipment, but the difference in aircraft performance would not be known. Again, this is where CAST conducts the evaluation to provide to police across the country, which prevents them from having to do it.

Lessons Identified

Topic	Lesson Identified - Home Office's Centre for Applied Science & Technology	No.
Evaluation of drones capabilities	Conducting in-depth and defined evaluation of a broad range of drones is critical in determining and mapping the actual capacities of the drones that are currently available in the market place (low end low cost).	48
Counter UAV	Taking the opportunity to work with C-UAV companies also provides opportunities for agencies to assess the actual capabilities of C-UAV technologies that are currently being offered.	49
No Single Solution	It was identified and validated that there is currently no single solution for C-UAV capabilities and that research needs to continue.	50
Market Share	It was identified that approximately 80% of drones in the market place are known products that can be evaluated to gain their true capabilities and as such can be assessed.	51
DJI Market Share	It was identified that of the drones that are commonly available in the market place, DJI currently account for between 60% to 80% of the market due to the significant numbers of DJI products being purchased globally. This means that acquiring counter UAS technology that defeats DJI equipment would be the single most effective tool against current drones.	52
Research Centre	It was identified that a single research facility should be tasked to conduct simular research in the Australian context on behalf of Australian agencies. A national approach is the best approach.	53

3.6 Steven Adams - London Fire Brigade

Contacts

Steven Adams, London Fire Brigade (Bluelight Air Support Project)

steven.adams@london-fire.gov.uk

Overview of the Program

Steven Adams is a high level strategic manager in the London Fire Brigade (LFB) and reports to the Commissioner of the LFB. Steven is now currently working on a strategic Home Officer project named the Bluelight Air Support Project.

The Bluelight project has two key components. The first component is helicopter related, which requires Steven to research and assess the future air support requirements of the Home Office (police forces into the future). Currently across England and Wales the NPAS provides air support to the nation via 17 air bases that collectively maintain approximately 30 helicopters. These helicopters are deployed to tasks across the England and Wales on request by the 43 police forces.

However, availability of air support does not match the actual need. Additionally, now that the police forces have to “pay as you go”, using the fee for service model, some police forces are not requesting air support for many tasks as the cost is too high and the availability is not 100%. As such the future will see a streamlined program put in place that will, if necessary, rebalance the locations of helicopter bases. Additionally, rather than only maintaining a fleet of mid size aircraft that have limited lift, carry and deploy capabilities, the new fleet may see several heavy class aircraft being included into the NPAS operation. For example, the AW139 that can be used for tactical operations, counter terrorism and other fire services operations that require larger aircraft to match that increase need, which is a capability to lift and shift, which they don’t yet have.

The second component of the Bluelight project is to develop a national drones program that incorporates a tiered approach. These tiers will collectively deliver drone capabilities to support police and fire services. The police and fire services will then support other agencies as required with the drones project.

The first tier relates to locally used, sub 20kg drones that can be employed around the major cities / populous places to support police and emergency services. These units do not require beyond visual line of sight and as such are suitable for working above our heavily populous places because at this point and time and for another few yeas to come, no one can operate beyond line of sight drones over or near populous places. It will take a number of years of evidence based research and user case evidence with the relevant technology to prove to the CAA that those drones are safe to operate over the cities.

The second tier is using medium altitude longer endurance, beyond line of sight drones (more than likely fixed wing drones) that are capable of patrolling over low populous places (away from major cities) that can provide a higher level of aerial support to police and fire services that does not require requests for expensive helicopters to do work that simply relates to have a flying camera (eye in the sky).

This second tier includes using mid range drones with 6 to 8 hours endurance with a range capability of 50 miles and operate below 30,000 ft. that can be operated beyond line of sight. These mid range units cannot currently be operated over populous places because of their size and that fact that they are beyond line of sight drones. This means that they would be remotely located in the rural areas to support rural operations with remotely located pilots to manage them. These aircraft could carry up to 10 kg in payload (camera systems) that would ultimately cost between £500,000 and £1,000,000 each.

They can be GPS programmed to fly specific flight paths over designated areas to which the CAA might eventually approve because their locations will always be know, and or as time goes by, they may have developed an evidence base to prove to the CAA that these type of aircraft are safe over populous areas as they will employ autonomous collision avoidance technologies to avoid other aircraft.

The third tier is not within the remit at this point in time, but relates to much higher end capabilities such as the Thales built “Watchkeeper” and or the Phalanx Global Armour built “Trogan Hawk” that are Medium Altitude Long Endurance (M,A,L,E) aircraft, which are operated by the Military and Border Protection agencies. Additionally, there are technologies such as the Airbus built “Zephyr – Pseudo-satellite” drone that can operate for weeks at time at 70,000 plus feet, which is above the weather and all manned aircraft. Whilst this is currently out of scope, the opportunities they provide are significant.

The steps involved in the project are to: develop the user requirements, conduct assessments, engage with the agencies and validate their needs. The next step is to move into business case development and if successful move to implementation.

In summary, this project is being developed for the future and integrates a balanced mix of light and medium helicopter airframes that are supported by a multi layered drones project to supplement the aviation support needs of our police and fire services. This project plugs into the national working group for drones as all agencies are now aligned and are working towards a multi faceted approach.

It is anticipated in the future, the NPAS will more than likely be the national lead for management of drone capabilities. This way, all aviation assets will be centrally coordinated. This approach is also simular to the Victoria Police approach whereby the Police Air Wing is the drones (RPAS) owner.

Lessons Identified

Topic	Lesson Identified - London Fire Brigade (BlueLight Air Support Project)	No.
Research	Establishing a research project in the first instance ensures a measured and methodical process as apposed to acquiring drones and then working out what to do with them.	54
Scoping Decisions	When planning begins for a drones capability, the tiers of capability need to be understood and articulated so that the user cases can match the levels of capability that currently exist. I.e. Identifying user requirements for local operations below 400 ft., vs. user requirements for beyond line of sight offshore user requirements.	55
Central Management	A critical factor in the management of a drones unit is to ensure that the central coordination and management unit is centralised with one management team. All operational work units then deploy locally under the umbrella of a central coordination unit (such as NPAS in the UK).	56
Planning Approach	The UK model begins with the user requirements as apposed to the technical requirements. Technical requirements come second as they are the solution to the user requirements. The third stage is the business case, which is centred on the technical requirements.	57
Off the Shelf Products	In most cases, planning for drone capabilities should focus towards commercially available products rather then engagement in long term high cost purpose built drones that require your input and funding. There are more than enough companies who are investing in research and development that prevents government agencies from doing the same.	58
Expectations	A true challenge in the development of state or national programs is ensuring that the expectations of stakeholders and government sponsors are managed and constantly addressed. The aviation industry is complex and heavily regulated and progress takes time.	59
CAA (Aviation Authorities)	In many cases, the regulations surrounding drones are at the early stages and it must be noted that the aviation authorities around the world are also playing catch up and trying to keep pace with rapidly advancing drone technologies. As such, it is important to build relationships with the CAA to help them progress with your team as apposed to blocking your progress.	60

3.7 National Counter Terrorism Policing HQ (NCTPHQ)

Contacts

Inspector George Trebess, NCTPHQ

Email and contact details withheld.

Overview of the Organisation

The National Counter Terrorism Policing Network (NCTPN) (also known as the Police Counter-Terrorism Network) is the national collaboration of police forces in the UK working to prevent, deter and investigate terrorism. The Network is governed by the National Police Collaboration Agreement Relating to Counter Terrorism Activities Made Under Section 22A of the Police Act 1996.

The Network is accountable to the UK Government and the National Police Chiefs' Council Counter Terrorism Coordination Committee which is chaired by the Metropolitan Police Service Assistant Commissioner of Specialist Operations (ACSO) who also acts as the National Lead for Counter Terrorism Policing. The Network is also functionally coordinated by the Senior National Coordinator for Counter Terrorism who is usually a Metropolitan Police Service Deputy Assistant Commissioner co-located within the Counter Terrorism Command.

The Network stretches across the UK and sees specialist officers and staff working with the Home Office, MI5 and other intelligence, security and criminal justice agencies around the world. It is made up of dedicated Regional Counter Terrorism Units and national police units and is responsible for the delivery of the policing contribution to the CONTEST strategy.

The National Counter Terrorism Policing Headquarters (NCTPHQ) is responsible for developing policy and strategy and providing a single national counter terrorism policing voice on behalf of the National Counter Terrorism Policing Network. The NCTPHQ also coordinates national projects and programmes, provides administrative and support services to the national network, advises the government on budgets and resourcing for counter terrorism policing in England and Wales[5].

A UAV work unit under the NCTPHQ was established in 2014 and their role was to understand the application, implications and response to UAVs within the realm and context of counter terrorism and employ UAVs as needed. This group links into the UASCDC.

[5] NCTPHQ

Current RPAS Operations and Research

During the visit to the NCTPHQ, Inspector Trebess provided a briefing on the current UAV operations and the additional research into the use of UAVs in counter terrorism operations.

***Note**: The majority of this information is withheld and can only be accessed on an as needs basis from Craig Shepherd. Whilst Inspector Trebess provided no classified information, the information that was provided is still only available to the agencies and personnel that would qualify for such information.*

The NCTPHQ has conducted a number of assessments of UAVs with regard to the threats posed by UAVs, the current and evolving technologies used in UAVs, police use of UAVs and the countering of UAVs. This research is simular to the research being conducted by every police force in the world and is consistent with the outcomes reached by other countries.

Two documents that were internally published by the NCTPHQ are, and which were provided to Inspector Craig Shepherd include:

- NCTPHQ - Assessment – Managing Threats by UAV, and
- NCTPHQ – Critical Assessment – UAV Technology

Both documents are held by Inspector Shepherd at Air Wing and can be viewed on appointment.

<u>NCTPHQ and Partner Agencies</u>

The meeting with Inspector Trebess included an overview of the Association of Chief Police Officers (ACPO) and the work that they undertake with the NCTPHQ. ACPO, working with the National Counter Terrorism Security Office (NaCTSO) and the Centre for the Protection of National Infrastructure (CPNI) are collectively researching the UAV issues with respect to National Infrastructure, counter terrorism and the threats that they pose.

The CPNI is assessing the capabilities and availability of UAVs as they are developing quickly and now present both challenges and opportunities for the Critical National Infrastructure and other businesses. The CPNI states that the threats posed by UAVs are underpinned by a broad range of factors. Some examples are:

- Nuisance and/or reckless use
- Protest
- Reconnaissance
- Espionage
- Physical attack

CPNI aims to assist the National Infrastructure and other sensitive sites in determining the risks posed to their sites from UAVs and in ascertaining proportionate measures to mitigate these threats. Guidance relating to the use of UAVs and the risks they pose has

been published and is available to the public[6]. The CPNI has released a number of papers that relate to risks from UAVs and a copy of one particular paper was made available to Inspector Craig Shepherd, which is held for viewing by appointment only.

Whilst the NCTPHQ and national partners focus on a broad range of topics relating to UAVs, the NCTPHQ is also working towards employing UAVs in an operational capacity, again, like many other CT agencies across the globe.

The NCTPHQ has a responsibility for developing the counter UAV capabilities to support CT response teams. To achieve this, a robust process was implemented to conduct the assessment of which UAVs would be employed and what they would be used for.

The process included the following Capability Assessment Steps:

a) Identifying user cases. What is the likely user cases for the work unit, what do they want the UAV to do?

   (i.e. Response to sieges, following targets, following tactical teams, following vehicles, aerial observation, surveillance, persistent aerial downlink, building entry and room clearance etc.).

b) Identifying the required capabilities. What exact capabilities are needed to deliver on those user cases?

   (i.e. Toughness of UAV and crash and survive, to be night and day capable, weather proof, easy and quick to put together (assemble) and shut down, easy to fly, direct downlink capability, long or short distance camera systems, payload, and aerial only or marine and ground based applications only?)

c) Which UAVs fit the user cases and capability requirements? What mid range, durable and efficient UAVs fit that requirement, which are also commercially available off the shelf, to ensure easy replacement and availability of parts?)

d) What UAVs that fits the requirements also fits the budget and available resources? Does the UAV type actually fit the budget and if it does, can the UAV be effectively operated with the existing human resources?

Only after satisfying these requirements can the process continue through to development and implementation.

An interesting note for the NCTPHQ was, normally an agency or organisation would first assess if the UAV capability were a proven and validated method for future operations (i.e. develop a proof of concept).

However, according to Inspector Trebess, this has already been done by countless agencies across the world (including the UK), so why would they waste time and resources doing the same thing when we already know that UAVs have countless applications in general terms and their capabilities are in desperate need, in general terms. This approach enabled NCTPHQ to move straight to the Capability Assessment Steps listed above.

Note: Their documents will not state which UAVs the NCTPHQ will be or should be operating, as that information will only be made available on request.

[6] https://www.cpni.gov.uk/counter-unmanned-aerial-vehicles

In respect to a national approach to UAVs, the future structure will no doubt require NPAS to operate the national program for UAVs rather than the central governance arrangements being managed by each police force. This national approach is already underway and it is inevitable that NPAS will take on that role. That approach will then provide a sound level of consistency and compatibility across the UK. Additional to this approach, the CAST is already conducting significant research into UAVs, which is also a national approach and coupled with the NPAS, the UAV environment will be correctly managed at the national level.

Fixed Wing UAVs and Rotary UAV

Of particular note, Inspector Trebess mentioned a Google X Wing[7] project that has been running in South Australia throughout 2016. The project relates to the use of UAVs that have rotors for vertical take-off/landing and hovering, but also has the capability to operate as a fixed wing for delivery of goods (payloads) into rural areas.

This was noted because the decision points around the employment of fixed wing UAVs or rotary UAVs elicits different outcomes due to the fact that fixed wing UAVs have a longer and higher endurance, whereas rotary UAVs have shorter endurance but can operate in small areas, can hover and are more manoeuvrable in tight locations. Each platform has its advantages and disadvantages, whilst a mixed mode UAV may provide a solution.

This project was mentioned because it has application in the metropolitan areas and provides an example of the type of technologies that are already being developed and tested.

The question for NCTPHQ is not “Will we employ UAVs”, the real question is defining exactly what the UAVs will be used for and which UAVs satisfy that need.

A big dilemma is choosing commercially available of the shelf as apposed to having a provider develop and build a police, or SAR or emergency management specific UAV that is purpose built (Bespoke) and which will be purchased on mass (multiple units).

Countering RPAS

The countering of UAVs is currently being managed by CAST and NCTPHQ will be provided those results.

Apart from directly employing IT equipment that counters UAVs, there is also the risk assessment approach. For example: assessing a sporting venue for vulnerability to UAV attack includes assessing the:

- Likely flight path to and from the location
- How is the venue vulnerable to UAVs
- What are the likely targets at the venue
- How is the air space at the venue managed

[7] https://blog.x.company/testing-in-the-australian-skies-5a71db1ed6fe

- What is the surrounding area like (i.e. open areas or residential / industrial
- Where might the UAV be operated from
- How far would the UAV have to fly before having to turn around and return to the operator
- Does the venue have bird netting that might prevent a UAV from entering.

In summary, UAV vulnerability assessments are tailored for UAV threats and should be undertaken by a UAV operator as that person will assess how they might conduct an attack if they were so inclined. The assessor should think about how they would carry out the task and in doing so the method can be identified and then countered, and or mitigation strategies could be implemented to reduce the likelihood of someone attempting to undertake the attack in the first place.

Mitigation strategies for responding to UAVs can include assessments of:

- What air space needs to be controlled
- Where should police be positioned to respond to the operator
- What technology to counter the UAVs could be operated in the area
- Will police UAVs be useful to track a UAV and follow it back to its operator.

Lessons Identified

Topic	Lesson Identified - National Counter Terrorism Policing HQ (NCTPHQ)	No.
Cost	Buying mid cost equipment means gaining great equipment that is highly capable and very durable instead of purchasing low cost throwaway non-durable equipment.	61
Equipment Turnover	Understanding that UAV equipment will need to be replaced every 2 years. Every year new and far more capable kit is coming out.	62
10% Rule for Funding (Savings)	Key outcomes of employing UAVs = time and money (10%). In regards to the tasks that UAVs can be employed for: a UAV can complete that task in 10% of the time it takes to do it without a UAV and it costs 10% of the overall cost to complete the task without a UAV.	63
Collaboration	It was identified that identifying an industry provider was critical and bringing that company into a collaborative approach who then provides: buying power, maintenance and parts programs, IT and downlink expertise through a 2 or 3 year program.	64
Media and Corporate Comms	It was identified that the media and corporate communications strategy to ensure that the community and internal police work units are gradually introduced to the capabilities to ensure that the public and organisation understand and accept this new technology.	65
Proof of Concept	The proof of concept has already been done by countless agencies across the world. The use of UAVs has been proven enough times to know that they have multiple uses in police and emergency services. The true task is to determine the user cases, capability requirements, UAVs that match the need, budget and human resources.	66

3.8 David Owen, North East Counter Terrorism Unit

Contacts

David Owen, North East Counter Terrorism Unit, Westhyorkshire Police

(Full details withheld)

Overview of the Organisation

The North East Counter Terrorism Unit (NE CTU) was set up in April 2007. It is one of five Counter Terrorism Units designed to strengthen the UK's response to the threat of terrorism.

West Yorkshire Police has responsibility for the North East CTU. Together with the other Units in Manchester, Birmingham, Thames Valley and London, the North East CTU helps to make sure that the police service in the UK are better equipped to prevent or respond to terrorist incidents and to investigate and prosecute those involved.

The NE CTU delivers essential, specialist support to police throughout the country, and in particular, forces in the North East region. It draws on a wide range of expertise including; skilled detectives, financial investigators, community contact teams, intelligence analysts, forensic specialists and high-tech investigators.

The Unit combines the very latest technology with dedicated resources. In doing so, it is largely self sufficient and can effectively co-ordinate enquiries and operations, without compromising the commitment of local forces to day to day policing.

The development of the CTU is not a reaction to an immediate or increased threat to West Yorkshire specifically, or the North East region, but part of national steps to increase counter terrorism capability[8].

The UAS component of this team means that they deploy UAS into investigations on as needs basis. The provision of UAS is new and operates at the lower end of the equipment that is currently available.

Current RPAS Operating Model

The NE CTU employs drones for forensic support as it provides an eye in the sky and an excellent platform for aerial imagery (photographic, video, 3D, 4D and low light – no light capabilities).

The operating model provides several members of the team being qualified as remote pilots with a central remote operating certificate that is central to their own operations.

[8] North East Counter Terrorism Unit

Their remote pilots were trained by one of the internal trainers, which means they have their own capacity to develop future pilots with internal training. The training pilot was trained via a third party provider (company), as he was the first to be trained as a pilot within their work unit.

Equipment being employed

The NE CTU has 3 DJI Inspires that all have the X3 and FPV camera systems.

The Inspires are used, as they are a mid range UAV with sound capability. They sufficiently provide the services that are needed at this point in time and are robust enough to operate in moderate conditions. The Inspire is an agile unit that performs well and is easy to use given that the aircraft self stabilises if you take your hands off of the controller.

This type of UAV was, at the time, the most suitable system due to the camera quality, ease of flying and ability to geo reference its location. The Ipad systems used to manage the flight is also easy to use and easy to integrate into all other IT systems being operated by the NE CTU.

The user cases for the Inspire include, but are not limited to:

- Assessing post blast incidents both at ground level and above ground level
- Assessing roof tops and high locations for any relevant evidence
- Assessing line of sight from high vantage points and or buildings
- Providing aerial 3D and 4D video and photographic support
- Ability to assess high risk incidents
- Ability to assess dangerous environments due to chemicals, gasses etc.
- Ability to conduct surveillance, and
- Ability to operate in the public domain without drawing unusual attention due to its commonality with hundreds of other members of the pubic.

There are no police markings on the UAV nor does it have any blue or red lights as such.

The Inspire is just another tool in the toolbox of the investigators, and it happens to be an effective one. At this point in time, given the CAA restrictions of having to fly within line of sight, below 400 ft. and in moderate conditions, the Inspire is sound and suitable platform.

In the future, if more specialised requirements are needed, other equipment would be assessed.

Countering RPAS

The NE CTU is not employing any form of counter UAV technology.

Lessons Identified

Topic	Lesson Identified - North East Counter Terrorism Unit, Westhyorkshire Police	No.
Understanding Capability	It was identified that a user friendly UAV was equally important as a UAV that satisfies the basic needs of the work unit.	67
Hands off Platform	The DJI Inspire allows for hands-off use, which means that if the operator takes her hands of the controls, the UAV stabilises and remains on station. This allows the operator to retain situational awareness at all times.	68
Simple UAV systems	Employing simple easy to use UAVs is best for work units where the use of UAVs is a supplementary capability to the main services being provided. This allows for remote pilots to operate them only when needed rather than requiring a high level of skills and experience in the use of UAVs.	69
Cost	The Inspire was a low cost option that provided the required levels of camera capabilities.	70
Single Platform Type	Maintaining a single UAV type allowed for easier training due to the fact that only one system is being used.	71
UAV matching Need	It was identified that successfully matching a UAV to the needs of the work unit were critical in the decision making process for selection of the most relevant UAV platform.	72

3.9 National Offenders Management Service (NOMS)

National Offender Management Service

Contacts

Joanna Parish, C-UAS Lead for National Offenders Management Service (NOMS)

joanna.parish@noms.gsi.gov.uk

Overview of the Organisation

The NOMS is a UK Government department that manages projects and strategic activities across the UK Prison and Probation Services, "*by making sure that people serve their sentences and orders that are handed out by courts, both in prisons and in the community*[9]".

Joanne Parish (Joanne) is the national representative of NOMS that is a member of the Cross-Government Working Group for counter-UAS (C-UAS), that is coordinated by Carl Davies from the UASCDC.

NOMS is involved to ensure the national program for drones management includes issues such as, but not limited to:

- Supporting, developing and implementing legislative powers and offences to manage the use of drones in, around and above prisons by offenders
- To work with stakeholders to ensure they are included in any future counter drone capability to defeat drones that are used in, around and above prisons by prisons personnel against unlawful use of drones by offenders
- Work with agencies to develop strategies and capabilities for preventing drones from dropping items (drugs and weapons) into prisons and to ensure that any response strategies to counter drones are aligned with the national approach
- To be involved in any future use of high end, high altitude (i.e. 70,000 feet) and long endurance (i.e. 1 month of sustained flight) drones, which are jointly managed by government departments (i.e. Intelligence agencies, Police, Fire and Prisons)
- To provide advice and information to the national working group as the research and planning is progressed
- To advice and guide NOMS and other prison related departments on the progress and direction of drones in the future.

During the course of the meeting, I was able to provide a direct link to our Victorian Corrections to ensure that any future work can be communicated between those departments.

The meeting identified a number of lessons that had been learnt over the previous 12 months by Joanne.

[9] https://www.gov.uk/government/organisations/national-offender-management-service

Lessons Identified

Topic	Lesson Identified - National Offenders Management Service (NOMS)	No.
Research	Establishing a research project in the first instance ensures a measured and methodical process as apposed to acquiring drones and then working out what to do with them.	73
Working Group	Corrections agencies must be included in any national working groups to ensure that the issues and factors affecting prisons are included into any future drone and counter drone capabilities. Failure to be involved from the outset results in failing to understand how other agencies will work within this realm and significant funding opportunities can be lost.	74
Internal Updates	It is critical that the national working groups leads, continually communicate and notify their own personnel on the progress of the project to ensure that they are all included and aware. Failure to maintain up to date reports within your own agency can result in some work units commencing or continuing their own research, which either causes risks and waisted time and funding.	75
Considerations	Ensure that all of the OHS, legal, privacy, data security and public opinions are known from the begging and managed continually.	76
Counter Drones Technology	The greatest challenge to Corrections agencies is that the majority of the drone's requirements relate to counter drones, whereas it is only Police agencies that generally need counter drone technology. Having access to counter drone capabilities can only be achieved when working closely with Police. This may be a significant struggle for other nations unless they are linked into a national approach.	77
Air Space above Prisons	A significant challenge for Prisons is that a powerful tool in the fight against drones at Prisons would be restricting the air space via the CAA, however, this is actually the most difficult to achieve given the complexities surrounding air space and the number of facilities in each country.	78
National Approach	The approach by the UK Home Office to implement this working group is the single most critical step in harnessing drone technologies and capabilities in the future. The opportunity to be involved in this working group is fundamental to the future engagement with all other agencies.	79
Access to Research	Being part of a national working group means that you instantly have access to the research, issues, requirements and lessons from all other agencies rather than facing this capability on your own.	80
Connection to International	Being linked to the National working group means that when any other agency across the world is in contact with this national group (such as this meeting with Craig Shepherd from Victoria, Australia) we can be immediately connected to that jurisdictions corrections	81

Corrections Agencies	office directly. *On this occasion, Craig Shepherd had connected NOMs to the Victorian Corrections Agency within 6 hours of our meeting and we had immediately discovered that Victoria was at the closing stages of developing their own legislative submission to Government, just like NOMS. This means we are now able to directly share information.*	
Incident Records	The single most prolific offence committed by drone users at Corrections facilities is the use of payloads (drugs and weapons) being dropped into facilities by drones. This means that police and emergency services have immediate access to large numbers of case studies for inclusion in their drone research and projects. This data is readily available due to the connection of NOMS into the national working group. No other agency is experiencing payload related offences via drones.	82
CAA Support	A significant benefit from being involved in a national working group is that all of the Civil Authority Authorities requirements are managed by the group instead of having manage those requirements as a standalone agency.	83

3.10 Attend the European Commercial UAV Conference and Exhibition

Contacts

Commercial UAV Show, Excel Centre, London

Overview of the Event

This event is a 2 day conference and UAV show is the largest UAV event in the UK. The 2016 show is the third of its type and show cases the most current equipment and technologies from agencies and companies from across the globe.

Attending this event provided me with three unique opportunities:

1. To observe the relevant emergency services (blue light) speakers in the dedicated Blue Light & Emergency Services Theatre
2. To speak (as a formal presenter) at the Blue Light & Emergency Services Theatre, and
3. To access the entire UAV show and other conference attractions during the 2 day event.

The show showcased new civilian and commercial applications for UAVs that are emerging globally that included: surveying, photography, mapping, GIS, emergency services, law enforcement, agriculture, utilities, infrastructure and additional applications across all of the 14 focus areas. There was:

- A facilitated series of discussions and case studies covering the broad variety of UAV applications utilised in civil and other operations
- Evaluation of UAV I.T applications
- Search and Rescue application Maritime / Land Search / Caves – Tunnels / Urban SAR equipment and technologies
- Trends in utilising UAVs that support Law Enforcement, Border Protection, Fisheries Enforcement

The exhibition floor included:

- **Demo Zone***:* a safe, netted large area on the exhibition floor where exhibitors who've booked 30 minute session demonstrate their UAV
- **User & University Pavilion***:* this popular part of the floor will showcase ideas, innovations and new technologies around drones
- **Poster Zone:** a first for 2016, the poster zone is open to researchers, academics, and individuals who have a particular project or research area that they'd like to share with the industry
- **Photo Gallery & Video Installation:** a video installation showcasing films shot from drone's-eye-view will celebrate the creativity and talent that UAVs can unlock. On top of this, there will be a gallery exploring the work of innovative

photographers who strive to capture nature and civilization from a new perspective. Visitors will have the opportunity to choose their favourite, with the winner announced at a drinks reception on the 19th of October

- **Photography Workshop***:* Running throughout the conference will be a workshop which aims to teach photographers, both amateur and professional, the tips and tricks for using UAVs to increase the tools in their photographic arsenal
- The exhibition floor also includes a dedicated Blue Light & Emergency Services Theatre, a Mapping and GIS Theatre, a UAV Innovation Theatre, and a Data and Analytics Theatre. In these theatres you can participate to specific sessions:
- **Blue Light & Emergency Services Theatre:** sessions in this area will cover the broad variety of UAV applications utilised in civil operations for blue light and emergency services
- **Mapping, Surveying & GIS Theatre:** sessions here will provide mapping, surveying and geospatial applications and case studies
- **Utilities and Infrastructure Theatre:** this theatre will cover key UAV applications across oil and gas, utilities, transport and other related sectors
- **Data and Analytics Theatre***:* learn how data from drones are used across several sectors, including archaeology, environment, surveying etc.

The event provided insights into the equipment, technologies and experiences of other agencies in the 14 focus areas that are listed in this report.

Equipment being employed

At the UAV exhibition, every drone currently available on the market was displayed and many of the smaller sub 20kg drones were demonstrated in a netted area at the event.

Attending the show in person was a great benefit in ensuring that I was up to date with what is currently available and what technologies are being employed by different agencies.

Some of the most relevant UAVs that suit police and emergency services that were showcased at the event were, but are not limited to:

<u>Rotary Systems</u>

- DJI Phantom (via www.dji.com)

- DJI Inspire (via www.dji.com)

- DJI Mavic Air (via www.dji.com)

- Parrot (via www.parrot.com)

- The Phoenix Series (60LE) - via (www.uavsolutions.com)

- Sparrow-Hawk (Indoor drone) – (via www.aeraccess.com)

- Aibot X6 (via www.aibotix.com)

- Micro Drone 3.0 (via www.microdrone.co.uk)

- (Indoor UAS) Elios Inspection Drone (via www.flyability.com)

- Black Hornet Nano Drone (via www.flir.com)

- (Small UAS) albris SenseFly (via www.senseFly.com)

- (Small UAS) Height Tech Inspector S (via www.heighttech.com)

- Typhoon Pro (via www.yuneec.uk)

- Ricopter (via www.riegl.com)

Fixed Wing Systems

- (Small UAS) RemoEye – 006A (www.uconsystem.com)

- (Small UAS) eBee SenseFly (via www.senseFly.com)

- (Larger UAS) – Bramor C4EYE) (via www.c-astral.com)

- (Small UAS) – Puma (via www.avinc.com)

- (Small UAS) - ArrowLite (via www.starkaerospace.com)

Cameras and Technology for UAVs

- **Sensors** - Dragon View (Stabilised, lightweight, EO/IR Pan-Tilt Sensor) via (www.uavsolutions.com)
- **Sensors** - Parrot UAV company – SenseFly – Sensor Optimised for Drone Applications (S.O.D.A) (via www.senseFly.com)
- **Data Management** - Parrot UAV company – SenseFly – Drone flight and data management systems (via www.senseFly.com)

Notable Observations and future directions for UAVs

During the course of the exhibition and conference, I noted the following key areas that are becoming more and more needed in the UAS/UAV/ RPAS/drones world:

- *(Indoor Operations)* The market for drones that can operate inside buildings / indoors and or underground is growing rapidly with police and emergency services, energy and mining companies as their target audiences.

- *(Pre-Programmed Missions)* The market for drones that fly a pre-programmed mission are becoming more readily available and easier to use via simple Iphone /Ipad technologies. These programs allow users to program a geo-referenced route that allows the user to simply press the go-button and the drone then flies the mission without any need for manual control from take off to landing.

- *(Small fixed wing drones)* The market for middle and smaller fixed wing drones is increasing as the need for large and extremely expensive drones is decreasing. This is due to the increasing capabilities of the smaller end fixed wing drones such as the Puma etc.

- *(Nano)* The Nano technology based drones are also becoming smaller and more capable of delivering high quality imagery. This provides industry and the police and emergency services with options for employing small, quiet and nimble drones for specialised work.

- *(Battery power)* The need for longer lasting battery systems for drones is probably the single most significant technological outcome that will change the industry in the future. When the battery problem is solved the drone industry will change as the endurance and size of drones will adapt to the battery power increase. This may in fact cause drones to significantly decrease in size, which may cause a boom in the Nano technologies and long endurance fixed wing drones.

- *(I.T Systems)* The increase in companies (the industry) that focus on systems that support drones is fast becoming a heavy growth industry. This industry is seeing: I.T Apps, downlinks, mission profiles, communications linkages, light weigh materials, camera systems, nigh vision (low light / no light) systems, 3D / 4D imagery, Counter UAV, terrain modelling, geo-referencing and geo biometrics, geo-fencing, data links, data analysis, digital surface modelling, orthomosaic raster, I.T integration and many more highly complex and I.T based programs, software and programming coming into the industry.

- *(Forward Looking Needs)* The industry is looking at drones that are more and more: *Flexible* - for the missions types that users require, *Timely* – with respect to accessing and analysing the data feeds from drones, *Efficient* – low cost and highly capable of replacing or enhancing existing technologies that are currently used to carry out tasks, *Discreet* – small, light weight, quiet and pollution free

drones that can carry out tasks with little to no impact on nature and the community.

- *(Security of data)* The need for secure (cyber safe) technologies is an increasing requirement of police and emergency services. This derives from the increasing need for such agencies to be fully compliant with Privacy and Data Security requirements and prevent companies like DJI (a Chinese company) from accessing data from drones and the missions they fly).

- *(Command and Control)* The need for integration between command and control facilities and or commanders in the field with live vision from drones in the sky. The need to increase live situational awareness is a highly desirable focus area for the police and emergency services areas.

- (*Payloads*) The growing need for drones to delivery payloads for specific missions. This includes advanced camera systems, environmental sampling (gas, explosives, drugs, vapours etc.). The police and emergency services require payloads to carry sensors into areas that may be toxic and or dangerous to humans.

- (*Follow me)* The need for drones to follow the operator constantly is becoming a growth industry with the drone industry. The ability to have a drone literally follow a target (self or otherwise) is becoming more prevalent in the sport and extreme activities industry (mountain biking, climbing, abseiling, running, canoeing etc.).

- *(Face recognition)* The need for drones to follow a face via face recognition and or to search crowds to locate a face/person in the future will become an extremely valuable tool in the policing, search and rescue and counter terrorism circles moving forward. This allows for a drone to scan environments for facial recognition that identifies humans in crowed places etc.

- *(Persistent Observation)* The need for tethered drones provides an opportunity for drones to be fixed in place above areas that require longer-term persistent surveillance / observations of incidents. This would enable a drone to be safely tethered to a building / vehicle or thing that ensures constant power to the drone, downlink from the drone and for safe operation of drone that is connected to a wire/tether. This is increasingly needed for providing ongoing (hours) of persistent observational and or surveillance in built up metropolitan areas where a tethered drone avoids the regulatory requirements of non-tethered drones.

- *(Camera systems)* The cameras being carried on the drones is fast becoming a key decision in the choice of which drone to purchase. This is because many agencies are now conducting research into the use and application of drones (user cases) and as such the specifications for the camera systems will sometimes drive the decision on the choice of drones, which will rely on the cameras that each drone will incorporate.

- *(Most commonly purchased systems)* the most commonly purchased drones world wide are the DJI products. Sales information from Parrot, during the show identified that they are one of the top 5 products being purchased world wide.

Note: Some of the observations listed above also translated into learning's that are also copied into the lessons learnt where relevant.

Interviews and discussions at the UAV show

During the 2 days of the show I had the opportunity to speak to numerous speakers at the conference along with multiple staff from the exhibitions. Of the multiple persons that I met, two conversations were particularly relevant are included into this report at sections 3.11 and 3.12. The two persons are listed below:

- Gemma Alcock, Managing Director of Skybound Rescuer (Private Company) who spoke about the work they were contracted to undertake for the Royal National Life Boat Institute (RNLI) organisation in the UK.
- Project team for the European Emergency Number Association and DJI Project (EENA Project)

Summary of UAV Show

Attending the UAV show provided a wealth of information, exposure to the global market of UAVs and access to speakers from across the UK and some from Europe. Attending such events is the most practical way to assess and evaluate the current trends and developments in the UAV environment.

Lessons Identified

Topic	Lesson Identified - Commercial UAV Show, Excel Centre, London	No.
Fixed wing vs. rotary wing UAS	It was identified by the Grand Forks County Sheriff that fixed wing UAS are capable of longer endurance when flying missions and are suitable for greater payloads with an increased ability to operate in poor weather or high wing conditions, whilst the small rotary UAS have less ability to manage poor weather and can carry less payloads. A downside to fixed wing is the take off / landing area requirements as apposed to vertical take off and landing with rotary. It was noted that the capabilities of fixed and rotary should be matched against the needs of the mission. Having both UAS types is a key factor in having a capable UAS unit.	84
Indoor UAVs	It was observed that (Indoor UAS) Elios Inspection Drone (via www.flyability.com) is an exceptionally practical UAV for conducting operations inside buildings or enclosed areas. This drone can be flown into an enclosed area, can bounce off walls and the floor and move through corridors and rooms whilst providing constant vision. Its outer plastic/rubber protection allows the rotors to be protected from within the ball whilst the outer materials do not restrict airflow being accessed by the rotors. This would be effective for fire, search and rescue, police and virtually all emergency services as it is exceptional robust, safe and effective.	85
Pre-Programmed Missions	Many drones have software that enable the user to pre-program a flight. This means that search and rescue personal could program a drone to fly pre-set grids for searching large areas. The operator then presses the go button and the drone flies the route as per the program with no need for support from the human. The operator can take control of the drone as needed to re-assess possible targets but the drone can fly the grids and return to the operator having flown the mission. This is exceptionally practical when routes are clearly definable and programmable. This means that the exact flight path with be flow at the pre-designated altitude, speed, grid and direction.	86
Nano Drones	The newly available Nano technology based drones are also becoming smaller and more capable of delivering high quality imagery. This provides industry and the police and emergency services with options for employing small, quiet and nimble drones for specialised work.	87
Payloads	There is a growing need for drones to delivery payloads for specific missions. This includes advanced camera systems, environmental sampling (gas, explosives, drugs, vapours etc.). The police and emergency services require payloads to carry sensors into areas that may be toxic and or dangerous to humans.	88
Follow me	The need for drones that can follow the operator constantly is becoming a growth industry with the drone industry. The ability to have a drone literally follow a target (self or otherwise) is becoming more prevalent. This capability could be extremely useful for emergency management training and exercising programs along with operations or tasks where the safety and security of personnel is paramount.	89

	(I.e. These drones could follow search and rescue personnel when entering dangerous areas that do not allow for observations by other team members such as cliffs, ravines). They can also be sued to follow tactical teams into areas where offenders might be present. Rescuers in floods waters and rapids could use them. They can also be used to provide vision of operations directly to a command post.	
Face recognition	The use of drones that can be loaded with face recognition software could follow individual humans and or to search crowds to locate a face/person in the future will become an extremely valuable tool in the policing, search and rescue and counter terrorism circles moving forward. This allows for a drone to scan environments for facial recognition that identifies humans in crowed places etc.	90
Balloons/ drones	The market for small to medium sized balloons with camera systems can be used in public places for persistent observation as they do not need to be flow, are tethered to the ground and can operate with limited powered requirements for long periods of time.	91

3.11 Royal National Life Boat Institute (RNLI) and Skybound Rescuer

Contacts

Gemma Alcock, Managing Director of Skybound Rescuer (Private Company). (skyboundrescuer@gmail.com) - Contracted to work on behalf of the Royal National Life Boat Institute (RNLI) organisation in the UK.

Overview of the Organisation

This section initially covers the RNLI then focuses on the Skybound Rescuer program that is being undertaken by Gemma Alcock.

RNLI

The Royal National Lifeboat Institution (RNLI) is the largest charity that saves lives at sea around the coasts of the UK, the Republic of Ireland, the Channel Islands and the Isle of Man as well as on some inland waterways. There are numerous other lifeboat services operating in the same area.

Founded in 1824 as the National Institution for the Preservation of Life from Shipwreck, the RNLI was granted a Royal Charter in 1860. It is a charity in the UK and in the Republic of Ireland. Queen Elizabeth II is Patron. The RNLI is principally funded by legacies and donations, and most of the members of its lifeboat crews are unpaid volunteers.

The RNLI has 237 lifeboat stations and operates 444 lifeboats. Crews rescued on average 22 people a day in 2015. RNLI Lifeguards operate on more than 200 beaches. They are paid by local authorities, while the RNLI provides equipment and training. The Institution also operates Flood Rescue Teams (FRT) nationally and internationally (iFRT), the latter prepared to travel to emergencies overseas at short notice. They are now looking into the use of drones and have contracted the Skybound Rescuer Company to carry out that research.

Skybound Rescuer

Skybound Rescuer (SR) works with a range of organisations across the UK to support them in their UAV capabilities and are directly linked with and are supporting the RNLI, NPCC, Dorset Police, Rescue Training Academy (flood rescue) and work with teams to identify the best capability needs and training methods

An example of the work they have performed for the RNLI is where the RNLI contracted Skybound Rescuer to identify the needs and requirements for UAVs by the RNLI. To do this, the RNLI put Gemma through their lifeboat training and took her through their search method algorithms so she could understand all of their current practices before she started looking at how a UAV could be retrofitted into their vessels and rescue assets. For them she created a specific specification for the type of UAV that would be most appropriate of their operations.

The main aims for The SkyBound Rescuer Project with RNLI are:

- To bring clarity about UAVs for the SAR community
- To provide the research and evidence necessary for effective SAR UAV use
- To find the best UAV characteristics for each response team
- To find out whether or not UAVs can compete with the sophistication of the SAR helicopters
- To find the best practices for UAV operations within SAR
- To find the best form of training for UAV SAR operations

Some of the other agencies Gemma is working with include the Texas Department of Public Safety (DPS) in Austin, Texas (USA) who is working on a new drone program that focuses on highway crash scene analysis, search and rescue, emergency assistance, crime-scene monitoring, and more. The department will purchase 17 unmanned aerial vehicles, the most expensive of which is Aeryon's SkyRanger. The SkyRanger is equipped with a sophisticated camera, has a flight time of 50 minutes, and costs $48,000. The Department, like many other agencies, universities and companies world wide are looking at how drones can support or enhance current capabilities.

They work with organisations in a variety of ways. For example, The SkyBound Rescuer Project has collaborated with Professional Rescue – a SAR academy – to offer a SAR UAV Master class for those responsible for strategy, response and tactical operations in the first responder and SAR world; to include SAR operators, government representatives, tactical SAR response staff and senior managers, fire and police services, flood incident managers, instructors, tactical advisers and those responsible for specialist rescue training or procurement of rescue response apparatus and services. It is an opportunity for managers and tacticians to gain understanding of this rapidly emerging new technology from experts in their fields.

The SkyBound Rescuer Project also offers a thorough consultancy service for organisations, such as The Royal National Lifeboat Institution, Dorset Police, Chief Fire Officers Association, and many more. Firstly, they work closely with clients to research into the current paradigm to learn where UAVs will be of most use and how they'd fit into the operations, creating a list of key performance criteria based on this research. Secondly, they examine the UAV market to find potential viable solutions available for the service based on their budgetary requirements; from fully off-the-shelf products to components or features of products.

Thirdly, they create a product design specification (including cost, performance, training, legal, etc.), which concisely lists exact characteristics of a UAV that best suits the organisation. Therefore, they will have a list of the most viable products they could buy tomorrow AND a list of requirements for the UAV industry to respond to, forming a better solution for future progression. Lastly, they create a comparison report whereby the clients current paradigm is compared to a UAV solution, which includes a cost comparison, a sustainability comparison, and a performance comparison. In short, they highlight what a UAV unit would look like for the clients individual operational needs.

And finally, they also work with organisations on smaller research questions, sometimes to merely answer questions such as: what's the best and most cost effective way to

stream the UAV's footage back to the control room in real-time? They understand that the language used by UAV professionals does not easily translate into SAR vernacularism; making it difficult to find the answers to even the simplest of questions. They are both very technical and specialised languages; the ability to understand both sides is a key strength to The SkyBound Rescuer Project.

In summary, organisations normally ask Gemma to seek results. The client provides problems and Gemma looks at what the options might be used for. For example, the RNLI asked what type of UAV that a specific payload might be able to be retrofitted into. Gemma then conducts research and finds the solution. As a result of that research, she developed and provided them with the specifications and requirements of the drone to be acquired to deliver the outcomes. The task is then to match the right drone to the job.

Lessons Identified

Topic	Lesson Identified - Skybound Rescuer & RNLI	No.
Capability based approach	The research project into drones should start with understanding the exact user cases that the drones would employed to achieve. Only then do the specifications be compiled.	92
External research companies	Sometimes there is a need to employ outside / external parties to conduct research where there is a knowledge gap within the agency. Organisational like the RNLI did not have internal expertise and as such they outsourced that research to the Skybound Rescuer company and have achieved significant results.	93
Search and Rescue focused companies	There are now numerous drone-based companies that are specialising in search and rescue, emergency management and police agencies as their primary focus area. Some of these companies are providing one or more of the following: research, subject matter expertise, technology solutions, drones and hardware, I.T support and or solutions, advice and or facilities for testing, to mention a few. Agencies should assess the requirements of their organisation then assess if they would benefit from outside companies who specialise in drones.	94
UAV and SAR terminology	The language used by UAV professionals does not easily translate into SAR vernacularism; making it difficult to find the answers to even the simplest of questions. They are both very technical and specialised languages; the ability to understand both sides is a key strength to The SkyBound Rescuer Project.	95
Determining the location of drones in flight	Recent experience has identified that the issue of maintaining situational awareness of the location of the drone that persons are operating can often be difficult. When the camera is facing forward whilst the drone is in flight allows for easy management and awareness of the drones location, but when the camera is being manoeuvred during flight the location of the drone can be hard to track.	96

3.12 2016 EENA & DJI Project

Contacts

EENA & DJI Project Team

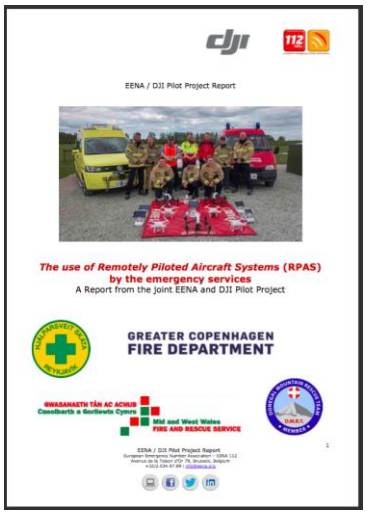
(Presentation provided at the UAV conference and one on one discussion with the team at the end of their presentation).

Overview of the Organisation

At the UAV Show one of the presentations was delivered by the EENA & DJI project team that focuses on drones and emergency management agencies. The four person team provided an overview of the project and the elements of the four agencies that participated in the project being: Mid and West Wales Fire and Rescue Service (UK), Donegal Mountain Rescue (Ireland), Greater Copenhagen Fire Department (Denmark) and Reykjavik SAR Team (Iceland). During the presentation they provided overviews of several of the key examples from the project and also talked about the White Paper that was only weeks away from being released following the end of their 12 month project. An overview of the four agencies is provided after the White Paper overview that is provided below.

White Paper Release[10]

November 10, 2016 – DJI, the world's leading maker of unmanned aerial vehicles, in partnership with European Emergency Number Association (EENA) released a white paper sharing insights and best practices from a year long project with the European emergency-response community promoting the safe integration of drones in emergency situations. A screen shot of the White Paper and its Table of contents is provided for refernence.



[10] https://www.dji.com/newsroom/news/dji-and-eena-release-white-paper-sharing-insights-for-improving-emergency-response-with-drones-in-first-responder-scenarios

The main goal of this project was to gain a more detailed understanding of the needs of first responders and how off-the-shelf platforms can meet those needs. The project validated that a drone has evolved from being a flying device to a data collection device. It has also become a decision making tool, with applications beyond just locating a missing person or getting a simple bird's eye view. This knowledge allows DJI to continue building more capable hardware and software platforms.

The project challenged the teams to identify best practices over the course of the project in 5 areas including: integration of RPAS in Standard Operating Procedure, training of teams of the use of RPAS, hardware needs and maintenance, logistics, and external framework for RPAS use.

Recommendations include having a minimum of two people using the RPAS, with one person controlling the unit and one person searching the video and when considering hardware making sure the platforms are reliable and have redundant systems.

During the training, one team found that while a five-person rescue team on foot needs an average of two hours to find a victim in one square kilometre, a drone can do the job in 20 minutes or less while taking additional active steps to achieve a successful rescue.

The project has provided a window into how RPAS are being used and may be used during emergency responses. They have seen that the pace of technological advancements will continue as the platforms become more intelligent, more resilient, more innovative and more impactful. This will lead to more and more RPAS Units being established leading to more user experience being shared along with best practice information. EENA will continue to focus on the topic, as they believe that the technology and what it can do help the emergency services to make more informed decisions. Ultimately it will lead to be better outcomes for the public.

The four first responder teams that participated as partners in the research project are: Mid and West Wales Fire and Rescue Service (UK), Donegal Mountain Rescue (Ireland), Greater Copenhagen Fire Department (Denmark) and Reykjavik SAR Team (Iceland). Between May and October 2016, the teams used Remotely Piloted Aircraft Systems (RPAS) technology for operations ranging from searching for missing people to putting out chemical fires.

Key challenges identified:

The key challenges below were identified at an early stage and the participants were challenged to identify best practices over the course of the project:

- Integration of RPAS in Standard Operating Procedure
- Training of teams on the use of RPAS
- Hardware needs and maintenance
- Logistics
- External framework for RPAS use

As noted above, the project team developed a white paper for release to the public in 2016. A snap shot overview of the four agencies and their involvement in the project along with some of the lessons learnt are provided below.

Donegal Mountain Rescue (Ireland)

Between October 2015 and October 2016, Donegal Mountain Rescue[11] participated in the EENA project. Drone testing in April conducted by DroneSAR, the Donegal-based developer of drone-mounted search-and-rescue mapping software, leading drone producer DJI, the rescue team and the European Emergency Number Association (EENA) recorded as much as an eightfold reduction time in locating casualties.

During the project it was identified that drones do not have to navigate terrain, look out for their own safety or struggle to see through dying light. They move quickly, so DroneSAR's technology could be the difference between life and death.

One scenario reconstructed by the team was a search for a man who had gone fishing in a mountain lake and failed to return home the next morning. The team plotted several potential rescue scenarios and headed out into the familiar terrain. It took them just two hours. With the drone, it took 40 minutes.

The team also identified that the drone is simular to another member of the team. It wont solve all of their problems but it strengthens thee team and the teams overall capability.

The drones potential was obvious as it can fly direct and defined flight paths, relay data and live images to its operators and rescue workers, as well as to anyone who logs

[11] http://www.mountainrescue.ie/about-mountain-rescue-ireland/

remotely into the system. The software allows teams to plot a mapped course, which the drone will automatically search. It has thermal imaging capability to spot people in the dark and the developers are now working on applying night vision. Drones could also be used to deliver payloads (mobile phones, water, first aid kit etc.) to stranded casualties. It was also identified that drones reduce some of the risks faced by rescuers, especially in resecures where the terrain is dangerous and or precarious. Risking a drone is cheaper than risking someone's life in certain circumstances. The task is to get more people in the search-and-rescue industry to see how drones can be beneficial. Cliff areas, bays and areas that are inaccessible or hard to get to are some of the more obvious locations where drones can be of benefit.

The main objective of a drone is to enhance the personal view and get a visual overview in advance of the team actually reaching it. Drones can send back live imagery, which allows rescuers to assess that imagery and inform the different search parties to go to different areas. A live view of remote or hard to reach areas is one of the things drones can be used for.

Another example is a drone would be dropping payloads to someone remotely to help them out while another area they're looking at is thermal imagery, giving it the ability to perform night searches using heat signals to find people. It was validated by the Donegal mountain rescue team that drones are really just an extra tool in the toolbox.

The team predominantly use a DJI phantom 4 and Inspire drone with the Zenmuse X3 and XT camera. Operating as a 2-3 person team comprising a drone operator, drone op "attendant" who works and prepares in advance of the operators needs and a team member to forward plan, navigate, and relay communications and progress to incident command[12].

Copenhagen Fire Brigade

GREATER COPENHAGEN
FIRE DEPARTMENT

The Copenhagen Fire Brigade has been utilising drones in their agency since 2013 and is currently involved in the EENA project.

In 2013, Copenhagen Fire Brigade launched a new project in cooperation with the University of Southern Denmark to implement drone support in their daily disaster management. Drones provide rapid ability to gain situational awareness of the scene, which is essential when saving lives in burning buildings. During the initial stages of the project, fire fighters imagined that drones might be able to navigate their way through burning buildings, searching for trapped persons. However, it was realised that this type of ability would be further into the future and as such it was identified that, at that point in time, gaining situational awareness and having the ability to use thermal imagery was still a great asset at that time.

Drones provided invaluable in dealing with roof fires or complex structures, for instance a shopping centre or large apartment building. They are often large, high and long, which

[12] White Paper.

makes it very hard to cover the whole area and to maintain situational awareness. This problem can be responded to through the application of drones. The Huginn X1 UAV was initially used in the role as it had an operational flight time of 25 minutes and could carry HD and thermal cameras at the same time. The thermal camera enabled the possibility to monitor the fire's progress, to determine whether the building's safety structures could withstand the fire and the drone was able to identify hazardous skylights that risk could a fire fighters safety.

It was identified by the Brigade that a drone equipped with chemical or asbestos detection sensors could reduce the major risks associated with those types of fires. As of now, the Huginn X1 is one of the few UAVs in the world with a basic analog chemical detection accessory kit [13]. It uses Chameleon chemical cassettes, by Morphix Technologies, to detect a given airborne chemical within the area. Sky-Watch is already looking into a digital solution, so that the information would be streamed in real-time to the control unit and Navigator. In the future it will be the data collected by the UAV that will be interesting and not the UAV platform itself – different sensors, which collect data and the afterwards data processing.

April 2016

In April 2016, EENA and DJI entered into a partnership for an in-depth analysis of how emergency services use drone technology with the aim to identify best practices in terms of operational, technical, safety, privacy and legal issues. As noted above, Copenhagen Fire Brigade was one of the four agencies involved.

Since Greater Copenhagen Fire Department began using a RPAS in 2014, Captain Thomas Sylvest has been the only pilot. At the start of 2017 they anticipate to have an additional 6 pilots, so they'll be available 24/7. The RPAS unit uses three different setups with the DJI Inspire - one with a Z3 zoom camera, a FLIR XT Thermal camera, and the ZT Zenmuse camera[14].

[13] https://iffmag.mdmpublishing.com/copenhagen-fire-brigade-benefits-from-drone-support/

[14] White Paper.

Mid and West Wales Fire and Rescue Service (UK)

Mid and West Wales Fire and Rescue Service makes up almost two-thirds of Wales, covering a predominantly rural area of 4,500 square miles (11,700 km2), comprising 58 stations and employing 1,200 staff. It is the third largest in the United Kingdom, behind the Scottish and Northern Ireland Fire Services. With the introduction of drones, the team are capable of deploying to incidents with a far greater ability to gain situational awareness and conduct rapid impact assessments, searches and use thermal imaging to in all sorts of terrain.

Reykjavik SAR Team (Iceland)

Hjálparsveit skáta í Reykjavík (REY-SAR), founded in 1932, is one of the largest and oldest search and rescue teams in Iceland. It is located in Reykjavík, the capital of Iceland, which is surrounded by mountains, woodland areas, lakes and rivers, lava fields, international airport and the ocean. This creates a diverse area of activity, which has resulted in the team adopting a wide range of capabilities that now include drones.

Drones have been successfully deployed in multiple incidents over the past year during the project. Their continued use has evolved and expanded during that time and continues to develop. The addition of a thermal camera was a game changer as it expanded the operational capability of the drones to 24/7 all year round. The thermal camera drone has been delivering positive results and with more use and more experience it will continue match and exceed expectations[15].

[15] White Paper.

Lessons Identified

Topic	Lesson Identified – EENA & DJI Project	No.
Drone specifications	It was validated that research into drones should commence with identifying the tasks that drones might be used for (user cases), then by identifying the specifications that the drone would need to provide to address the user cases. Only then does the researcher match a drone to the specifications that are validated as appropriate.	97
Integration of RPAS in SOPs	It is identified that, thanks to accessible and affordable technology, collecting data relating to the emergency has been made relatively easy. The challenge often relates to how to make the best use of that data, to get the relevant piece of information to the right person at the right time.	98
Weather resistant platforms	It was identified that the capability of the RPAS is sometimes hampered by the weather conditions, especially wind, low cloud and rain. Whilst it is sometimes difficult to completely weather proof the RPAS platform, the manufacturers are making efforts to improve the durability and capability of the hardware to be able to fly in difficult weather conditions. The skill levels of the Pilot can have an impact clearly on the decision to deploy or not but hopefully in the future technological advancements can see the RPAS being deployed in weather conditions that at the moment are beyond the safety limits.	99
RPAS bundles	Getting an RPAS system likely means also having to purchase additional items to support the operation. That can go from a storage/carrying case, to a smart device used in combination with the remote controller for live camera views (for DJI products, IOS or Android device, such as an iPad or Android tablet) and spare parts and accessories, such as propellers, extra power supply or batteries. RPAS manufacturers are encouraged to put together bundles for first responders that include everything they need from a hardware perspective and also provide them with options to add software solutions to the package. This will make the purchasing process easier and provide the customer with a strong package to get operations started and going.	100
Multi camera operations	At was identified that one of the restrictions in deploying drones is the time lost during an emergency response when the Pilot has to land and swap the cameras, as they needed between standard daytime cameras, to HD or thermal cameras. It is therefore recommended that the emergency services consider the use of a dual camera capability if the RPAS platform allows for this. Using both the regular camera and the thermal imaging camera on the RPAS at the same time would provide considerable flexibility, effectiveness and efficiency.	101
Stakeholder	As with any new technology, educating regulators and the public is important to build trust for the technology and to ensure a legislative	

Engagement	framework that is open for RPAS use. Developing an industry standard for first responder RPAS to use blue lights is widely supported by the community. Requirements to be able to operate RPAS at night and beyond visual line of sight are also achieved via suitable frameworks.	102
Integrated broadcasting capabilities	One of the many 'value add' capabilities that a RPAS unit can deliver is the use of the live data (images, video, telemetry) that it captures. The technology on-board the RPAS is advancing rapidly and the quality and stability of the images are tremendous. Whilst the SD-card on board the RPAS records the images and videos, getting this feed from the RPAS in almost 'real-time' to the Incident Commander is at this moment still a struggle for many emergency services and SAR teams. In order to this, the data must be transported securely and efficiently across a telecommunications network and for some scenarios 3G and 4G networks exist, for some there are no such networks available and maybe only satellite networks exist. Regardless of the telecommunications networks that are available, the RPAS manufacturers should ensure that the platform has the capability to send the data to the Incident Commander in a secure manner. Some 3rd party products exist at the moment to do this and they are indeed being used by some emergency services at the moment. However, the capital and operating costs may put the technology out of reach of many emergency services and therefore an integrated broadcasting capability should be built into the RPAS in the future.	103
Drop capabilities	It was identified that there are circumstances where the RPAS unit may need to drop an item(s) to the injured casualty such as a life-ring, thermal blanket, a mobile phone, a beacon marker etc. At the moment, the capability to do so is limited as the platform, and sometimes the legislation, does not permit this to happen. As a consequence, the platform manufacturers, together with other partners such as 3D printing technology providers, should make future platforms 'drop ready' or make them customizable to allow for drop capabilities to be added easily to them. The legislation may also need to be amended so it is recommended that the national Aviation Authorities look to make this capability possible for the emergency services in the future. Identification markers and safety lights	104
Multi person RPAS units	The RPAS unit must have a minimum of 2 persons. The Pilot focuses on the flight operation itself and is not tasked with other related items such as the overall management of the mission or even 'spotting'. Therefore it is recommended that the RPAS unit is at least a 2-person operation and in some cases such as lengthy and complex search missions may even need 3 or 4 persons in order to perform effectively. Fatigue and other externalities should also be a consideration towards having other Pilots available also to support the operation.	105
Logistics	That RPAS technology adds the most value when used directly after an incident, to get a quick situational overview and to find missing	

	people when time is critical. Therefore, making sure that the RPAS units are easily accessible is key. Basic recommendations include always inspecting the units for damage and making sure they are updated with latest firmware. Other key questions to address include where the units should be stored, how they are best transported to incident site, where they should be deployed and how battery management is best structured.	106
Training of teams on the use of RPAS	While the RPAS team needs to get in-depth training on how to operate the technology, the broader team, including responsible authorities and team members, need to understand how RPAS fit into the operation. The RPAS team needs to have a clear role and reporting structure within the broader mission.	107
Multi agency approach	Integrating drones into the central group of users: being police, fire and rescue, coast guard and search and rescue groups, HEMs. The secret is to develop a concept of operations that enables all services to access the same technology, the same training, the same equipment and the same mission profiles that determine how drones are used to conduct missions/tasks. If the central group of agencies apply this common platform, they are better placed to provide a surge capacity and interagency support. You can all learn from one another, whereas, If you have different equipment, the mission profiles change and you can learn less from others.	108
Weather proof drones	Drones need to be weather proof. Ensuring the drone can withstand rain and ice / snow conditions are critical to the employment of drones.	109
Marine graded drones	Several marine capable drones are now on the market and testing should be conducted to assess their capabilities against the capabilities of other drones to ensure the correct fleet of drones is accessible.	110
Purpose of Drones	The ENNA project validated that a drone has evolved from being a flying device to a data collection device.	111
SAR related outcomes	During the training, one team found that while a five-person rescue team on foot needs an average of two hours to find a victim in one square kilometre, a drone can do the job in 20 minutes or less while taking additional active steps to achieve a successful rescue.	112
Insights into the future	The project has provided a window into how RPAS are being used and may be used during emergency responses. They have seen that the pace of technological advancements will continue as the platforms become more intelligent, more resilient, more innovative and more impactful. This will lead to more and more RPAS Units being established leading to more user experience being shared along with best practice information. EENA will continue to focus on the topic, as they believe that the technology and what it can do help the emergency services to make more informed decisions. Ultimately it will lead to be better outcomes for the public.	113

3.13 Devon & Cornwall and Dorset Police Drone Unit

Contacts

Inspector Andrew Hamilton, Devon & Cornwall and Dorset Police, UK.

Overview of the Organisation

Devon & Cornwall and Dorset Police are a local police force that formed into an alliance across the three local areas.

The Alliance between Devon & Cornwall and Dorset Police may be the first full time drone unit to be established in the UK and it is intended that the unit will be established for operational duties some time in 2017. The unit will utilise commercially available off the shelf (COTS) drones and will generally be of the sub 5kg type of drone. The intention is to establish the unit with a number of local police being trained as remote pilots using these smaller sized drones as it reduces cost, reduces training and compliance requirements. The local area is not geographically large (approximately 9,000 km2, which in comparison to Victorias 227,436 km2) has, like much of the UK, limited woodland and coastal areas with few mountains. A diagram of the area is shown in red on the English map below.

Current RPAS Operating Model

The operating model will see a number of local police members being trained to remote pilot the aircraft with a Chief Remote Pilot being provided at the central drone unit. Only one drone unit with one chief remote pilot will be included with the pilots being selected from different areas across the police forces. Over the coming years following the official launch of the drone unit, it is intended that up to 20 officers could be trained use the sub 5 kg drones for operational policing and support to other emergency services.

Equipment being employed

The following equipment is currently being tested and used for training purposes. It is intended that this same equipment will be used when the unit becomes operational.

- DJI Inspire.

Summary of Operational Deployment

The project commenced with a research project to identify the concept of operations. Following the research, a 6 month trial of 4 x DJI Inspires between November 2015 and May 2016 was conducted.

The use of drones will generally focus around low level flying with operations being conducted within visual line of site. Whilst the drones will be used for general policing, the missions will typically include, but will not be limited to: tracking offenders, providing situational awareness at incidents, support road policing activities included crash investigations, coastal and woodland searches for missing persons, crime scene photography, public events and crimes relating to wildlife, to mention a few.

The UAV capability was initially established to provide support to police and to support other services due to the consistent inability to have helicopter support to critical tasks. This is often due to weather conditions whereby helicopter operations are not possible and or the cost of helicopter support outweighs the need. As such, the UAVs are seen as a support platform for tasks that either do not justify the cost and provision of a helicopter, the incident is occurring in a location that is suffering poor weather and or the helicopter is simply not available.

- Missing person search's
- Not pursuits
- Locating suspects
- Sieges
- Public order incidents/events
- Counter Terrorism patrols of small areas
- Collision investigation
- Forensic tasks

The first stage of the program was to bring the divisional work unit leaders together to discuss what user tasks they thought that UAVs could assist with.

One consideration for using drones in this area is the air space usage. This area is used by NPAS on occasions, HEMS aircraft (Helicopter Emergency Medical Support), the Coast Guard and military aircraft from defence bases and the Navy. As such, the 400ft maximum height of drones is absolutely critical, as manned aircraft generally don't operate below 1000 ft. anyway.

Following our research stage, we invested £20,000 into the capability. This is taxpayer's money so the value for money proposition had to match the amount funding being provided. As of October 2016, there are currently 6 trained police officers that are now licenced and are operating drones. The DJI Inspire drones supported the initial trial of drones in policing as they fit the budget and provided the level of capability that was sufficient for our current user cases. Following on from the trials, the current capability

employs a series of higher value and more capable camera systems that provide the additional capability to match the need.

One of the biggest challenges for police is the public perception of police using drones. As such the initial stages of the trial and the continuing capability is a media strategy. The media strategy includes Facebook, twitter, YouTube video clips, media and communications that go out to the public to via all of the available social media platforms to get the message across to the public. The aim was to educate the public and get our messages out there as to what we are using them for and what we are not. They develop media and press strategies both internally and externally, to raise the awareness of the drones and capabilities. The internal communications focused on informing the organisation on what drones can and cannot do and how to seek support from the unit.

Whilst focusing on the use of drones by police, the other drone activities they performed was the attendance at shops and businesses that sell drones. This was done to educate those staff and make sure when selling drones they were also providing all of the relevant regulatory requirements to the customers and that the customers knew what they can and cannot do with them. This assisted in reducing some of the illegal or improper use of drones by members of the public.

The focus in the first few years of using drones only includes the small end low cost drones that are easy to use by local police. This currently does not include high end long endurance drones.

A classic example of where the drones are useful is for attending fatal collisions where the aerial photos need to be taken whilst the scene is contained, however, waiting long periods of time for the helicopter to arrive and take 10 photographs is not the best use of time or resources. The drones however can be on scene quickly, take video and photo evidence from multiple angles and heights (2 ft. to 400 ft.) and are cheap to operate. This means that the road is closed for less time and the cost of the task is low.

In regards to the opportunity of sharing resources, our model is based on the same levels of training, same drones, same batteries, same cameras and same processes and evidence procedures across the three police forces. This means that we are completely interoperable and can support each other with personnel, equipment, drones, cameras and so on. This was a critical issue for us.

Another great use of drones is in contingency planning for major events or situations where the area in questions needs to be assessed. This might mean flying over a area or facility to assess risks and identify potential contingencies should issues occur and for searching areas to ensure that there are no risks or unwanted items in the area (bombs, weapons, persons, sharp objects, roof access options, line of vision from high level locations etc.

In natural emergencies we can use drones to search rivers and areas that would normally be dangerous for people to search and as such we can quickly identify areas of risk for our people, search areas to either locate missing persons and or clear those areas quickly to ensure the best use of resources.

Thermal cameras enable the drone units to be employed 24/7 and because the local police are equipped and trained in drones it means that the drones are easily used in quick time frame as they are literally packed in the rear of operational police vehicles.

Siege and firearm incidents are an example where drones are of high value. If a helicopter is onsite to provide vision of an area, and if the negotiators are trying to speak with the offenders, the presence of the helicopter sometimes means that the noise levels are high, it becomes hard to talk to the offenders, the offenders will know the helicopter is present, the situational awareness it provides is only as good as the fuel loads it can carry and the risk of shots being fired at the helicopter is increased. The drones however are quiet, can move around buildings and areas with ease, are of no real cost as they rely on battery power, can be constantly replaced and recharged with a second drone to take its place whilst being landed and recharged with batteries. Also, the offenders wont know they are there most of the time. This provides a broader scope for gaining situational awareness as you can get very close to the target and move the camera to all sorts of angles to gain the footage required.

Tethered drones are an option for us into the future. This means that the drone can be continually provided with power, the link is continuous to the control room and the risk to the public is reduced, as the drone is tethered and not free to fly from the required location.

Other technologies being looked at are drones with cameras that link with technologies such as automated number plate recognition software so that a drone can follow a target vehicle continually as it is locked onto the number plate. Where ever the number plate goes (attached to the car) the drone will follow. The future will see face recognition technology being employed and as such drones can follow the face in a crowd, which assist police tracking offenders or finding them in a crowd.

Putting speakers onto a drone could also mean that we could fly a drone towards a suicidal person and interact with that person rather than placing a police member at risk and or avoid the person from actually suiciding due to the arrival of a police member.

Air sampling equipment can be attached to the payload of a drone so that they can fly I into areas and take air samples. This will assist responders in knowing the risks and quality of air in areas. Air sampling can search for: gas, chemicals, explosives, drugs etc.

Video footage from the drone provides the ability to triage an area for injured and deceased persons, assess the locations of offenders and weapons in their possession.

Countering RPAS

There is no countering of RPAS capability in operation and the research in this field is being conducted by the Centre for Applied Science and Technology as they have the means and technology to conduct such research.

Lessons Identified

Topic	Lesson Identified - Devon & Cornwall and Dorset Police, UK	No.
Funding	The use of mid to low cost, sub 5kg drones provides a financially viable opportunity to enter the drone's space by avoiding high-end costs.	114
Equipment (Drones)	Most police forces will only need the off the shelf $5,000 drones as their budgets are low, but the capability is still achievable.	115
Training	Training remote pilots should be done with the low cost DJI products as crashing and bumping into objects can have high cost impacts on the more expensive and capable aircraft.	116
Research	It was identified that mapping out the drone research and development via defined project plans is critical to the success of the project.	117
Research	Establishing a research project in the first instance ensures a measured and methodical process as apposed to acquiring drones and then working out what to do with them.	118
Media strategy	It was identified that establishing a coordinated and progressive media and corporate communications strategies is critical to success of the introduction and ongoing management of drones into an agency.	119
Key locations	Identifying key locations to locate drones teams and equipment is essential in providing full coverage of the geographical area of the agencies responsibilities. This approach ensures that the terrain and layout of the area is assessed to identify the localities in which the teams should be based.	120
Compatibility of equipment	Ensuring the training, resources, drones, equipment, cameras and processes were exactly the same across the three police forces so as to increase the ability to support other police forces with drones, equipment (batteries) and cameras etc.	121
Tethered Drones	Tethered drones are an option for us into the future. This means that the drone can be continually provided with power, the link is continuous to the control room and the risk to the public is reduced, as the drone is tethered and not free to fly from the required location.	122
ANPR	Other technologies being looked at are drones with cameras that link with technologies such as automated number plate recognition software so that a drone can follow a target vehicle continually as it is locked onto the number plate. Where ever the number plate	

	goes (attached to the car) the drone will follow. The future will see face recognition technology being employed and as such drones can follow the face in a crowd, which assist police tracking offenders or finding them in a crowd.	123
Speakers	Putting speakers onto a drone could also mean that we could fly a drone towards a suicidal person and interact with that person rather than placing a police member at risk and or avoid the person from actually suiciding due to the arrival of a police member.	124
Air sampling	Air sampling equipment can be attached to the payload of a drone so that they can fly I into areas and take air samples. This will assist responders in knowing the risks and quality of air in areas. Air sampling can search for: gas, chemicals, explosives, drugs etc.	125
Forward Triage	Video footage from the drone provides the ability to triage an area for injured and deceased persons, assess the locations of offenders and weapons in their possession.	126

3.14 Northamptonshire Police & Fire Rescue

Contacts

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Kevin Hardwick, Joint Operations Team, Northamptonshire Police & Fire and Rescue Service

Overview of the Organisation

Northamptonshire Police, Fire and Rescue merged into a single agency as part of the UKs move towards amalgamating Police and fire services. This move is partly due to funding and resourcing issues within municipalities.

The Northamptonshire is now (both police and fire & rescue) in possession of drones and are working together to delivery a heightened level of situational awareness to incidents that occur within the Shire.

The move towards drones results from a past firearms incident in which the debrief highlighted the need for a greater level of vision. A decision was made to investigate the application and use of UAVs into the future. Under the UK model of interoperability (JENSEN) project, the Northampton Fire & Rescue with Police applied for funding from the Home office to establish a capability. Coupled with financial support from local donations and with funding from the Home office the Northampton's purchased 2 Inspire DJIs.

The agencies now have the use of the new Command vehicle, which was delivered on the 20th of October. This vehicle, which is the most advanced command vehicle in the world, can receive direct downlink from UAVs, helicopters and their own mast/camera that also has FLIR. The vehicle has an additional remote deployable camera with FLIR capability with 2 other hand held FLIR cameras that also link back to the command vehicle.

<u>Missions</u>

There is no existing mission typology as the capability is only recently been developed and it is standard that Fire and rescue resources turn out to tasks with Police.

Current RPAS Operating Model

As at October 2016, 3 fire and rescue personnel are trained along with 2 police. This capability will grow over time and the joint agency approach will acquire additional units on an as needs basis based on availability of funding at the time. The current capability is not a UAV unit as such because it is a capability that exists on top of their current roles

and functions. It would be beneficial to have an actual UAV unit and whilst that approach would provide continual support in the future, there simply aren't enough resources to establish a full time unit at present.

When the teams are deploying to tasks, they have access to risk assessment documents, however, at this point in time, they don't currently use these as their risk assessment, but do use it more as a conversation reference with a direction from management to deploy. Once they are satisfied with the need to deploy from a flying perspective, they will deploy. There isn't a risk assessment template being used at present but they will implement it on an as needs basis is.

Equipment being employed

The equipment incudes 2 DJI Inspires with a UAV kit for spares.

The UAV kits include additional batteries and equipment to support the UAVs along with spare blades, mission systems, SD cards, recording capabilities and all of the relevant documentation. The footage, once recovered and downloaded from the SD cards is loaded in the Police IT system where all of the data is stored. The data, if required by investigators can be accessed via the police system, or by copying to CD/DVD disks.

Summary of Operational Deployment

Currently, the teams are pretty much deploying the capability to any tasks that they determine is viable and useful. They are only 3 months into the operational side of their capability so they are within a period of learning and development.

Their training was provided by an outside provider who trained them in the use of the Inspire. Once they gained their certification from the CAA, they commenced operations, but still don't have their own internal training capability, as there are not enough resources nor time to develop a training capability.

The operating models allows for several police and several fire & rescue personnel to be cross-trained in the equipment. The number and selection of personnel is balanced to ensure that there is sufficient capability (trained personnel) to deploy drones on any given day. In this model, it does not matter if it is a police or fire person attending as they work together and support one another via the joint facility that they work within.

The members have deployed to the following tasks:

- Searches for missing persons in rural and metropolitan areas
- House, building fires
- Hazmat situations
- Vehicle accidents
- Industrial incidents / accidents
- Searching for evidence in difficult to access areas
- Parkland fires and other woodlands related fire incidents
- Persons trapped in/near flood waters
- Natural events such as floods and weather events (damage related missions

- Searches for an offender who was jumping fences and climbing on houses after an armed robbery
- Some public events, demonstrations
- Training of personnel and exercising internally and with other agencies
- General operational duties where the aerial vision increases situational awareness.

Use of DJI Inspires

The benefits of using the DJI Inspires include:

- Simple and easy to use drones that require limited manual control
- Known products that provide multiple online (YouTube etc.) information, blogs and general access to leanings from other users world wide
- Easy access to spare parts and servicing given that they are commonly available
- Low cost and easy to replace
- Quick to prepare for use and deployment
- Low level of I.T knowledge required to manage the systems
- Easy to use downlink and data storage
- Small and easy to pack away into a backpack for easy storage and carriage
- Simply battery systems and easy to charge, easy to acquire additional batteries
- Good warranty
- Has been easy to train police and fire & rescue personnel
- Use of the Inspire is reasonable in windy conditions
- Provides very good camera and thermal imaging

Deficiencies in using DJI Inspire

- Not suitable for raining or poor weather conditions
- Limited to within line of sight
- Can be difficult to maintain awareness of the drone whilst in flight if other Inspires are being flow in the same areas
- Limited battery time of about 25 minutes dependant on wind conditions
- Offenders will easily know the capabilities of the Inspire as they are commonly purchased
- Is not suitable for flying in doors
- Noise output is minimal but is easily heard by offenders if not flown at a reasonable height
- Minimal ability to attach payloads

In summary, the DJI Inspire has provided the Northamptonshire police and fire & rescue with a significant number of tasks whether they be for police or fire related incidents. The operating model provides a number of trained personal across both agencies and they use the same equipment. They are not yet resourced to provide a full time drones unit but their geographical area and demographics do not necessary necessitate a full time unit at that point in time.

The use of drones has been extremely beneficial, useful and the capability will grow.

During the visit to the Northamptonshire Police, Fire & Rescue facility, I was provided with copies of the following documents that were interesting and relevant to police and emergency services in Australia. The documents are listed below and a brief summary of the documents is provided for reference.

Privacy Impact Assessment

The PIA was conducted on the use of drones by Northamptonshire Police, Fire & Rescue along with the police response to unlawful use of drones by the public. The document provides an overview of the legislative policy and authorities, description of personal information and the range of issues and risks that might exist in the local context. The document will be used as a reference tool for the Victoria Police PIA that will be conducted in late 2016. This document is available for viewing on request.

Job Tasks

Each time a drone is tasked to an incident, a job task is completed. This is a template document that records all of the relevant information about the tasks and the use of the drone.

The templates are available if requested.

Lessons Identified

Topic	Lesson Identified - Northamptonshire Police, Fire and Rescue	No.
DJI Inspire Benefits of use	The benefits of using the DJI Inspires include: Simple and easy to use drones that require limited manual control ○ Known products that provide multiple online (YouTube etc.) information, blogs and general access to leanings from other users world wide ○ Easy access to spare parts and servicing given that they are commonly available ○ Low cost and easy to replace ○ Quick to prepare for use and deployment ○ Low level of I.T knowledge required to manage the systems ○ Easy to use downlink and data storage ○ Small and easy to pack away into a backpack for easy storage and carriage ○ Simply battery systems and easy to charge, easy to acquire additional batteries ○ Good warranty ○ Has been easy to train police and fire & rescue personnel ○ Use of the Inspire is reasonable in windy conditions ○ Provides very good camera and thermal imaging	126
DJI Inspire Issues with use	Deficiencies in using DJI Inspire ○ Not suitable for raining or poor weather conditions ○ Limited to within line of sight ○ Can be difficult to maintain awareness of the drone whilst in flight if other Inspires are being flow in the same areas ○ Limited battery time of about 25 minutes dependant on wind conditions ○ Offenders will easily know the capabilities of the Inspire as they are commonly purchased ○ Is not suitable for flying in doors ○ Noise output is minimal but is easily heard by offenders if not flown at a reasonable height ○ Minimal ability to attach payloads	127

Commonalities	Using the exact same equipment by both agencies provides a greater level of support to both agencies and the community.	128
Joint Training	Joint training between the agencies in use of drones is extremely beneficial as each tasks is different and both agency personnel have the advantage of learning from the other.	129
Payloads	It was identified that the ability to carry payloads for non-camera related items would is highly beneficial (such as sensors).	130

3.15 Police Scotland Air Support Unit - Glasgow

Contacts

Police Constable (PC) Stuart Neilson – Police Air Support Unit, Police Scotland.

Inspector Nicholas Whyte, Operational Support Division, Air Support Unit, Police Scotland.

Overview of the Organisation

The Police Aviation Support Unit incorporates the helicopter base in Glasgow and is now the portfolio holder for the UAV project for Police Scotland. The portfolio is in its first year of operation and is designed to conduct research and identify the future operating model for the organisation.

Operational deployment of UAVs may occur in late 2017 or early 2018 given that the user cases and equipment requirements will need a thorough evaluation. The purpose of the portfolio is to ensure that all avenues have been assessed and that all options are considered. As can be seen in the summary of the portfolio that is detailed below, the first year or two of operations of a UAV capability would include small sub 5 kg off the shelf products that are deployed in an overt capability.

RPAS Research Project

The UAV program for Police Scotland was tasked to the Inspector in charge of the Operational Support Division – Air Support Unit (Inspector Nicholas Whyte) in 2015, which includes the Police Aviation Support Unit that is based in Glasgow, Scotland.

It was identified in 2015 that the project would take several years of research and establishment and would need a full time police member to be tasked to work on the project full time. As a result of the project being tasked to the Air Support Unit, PC Stuart Neilson was requested to undertake this project. Stuart had previously worked as Tactical Flight Officer with the Air Support Unit for several years and had recently been working with their tactical teams and firearms teams in another area of their organisation.

Stuart commenced duties on the UAV project and undertook the following program of works.

The first step was to establish a consultation document. They sent a report to all of the Police Scotland Divisional Heads and Divisional Commanders with the following questions:

- What areas of police business do you cover
- How would you deploy a UAV operationally
- Do you think UAVs would benefit police Scotland

- Do you have any concerns regarding the use of UAVs
- Do you have any additional comments about the use of UAVs

As a result of this initial survey, we received an overwhelming response from across the organisation that included, but was not limited to:

- General policing
- Operational support
- CT
- Basically everybody

Some areas simply did not return the survey but most others did. They received some extremely good replies form some work units that included some very good ideas along with a number of really stupid ideas.

This informed the direction of the work that needed to be carried out. The overwhelming response was excellent and extremely supporting of the concept of using UAVs to support policing.

The common themes that we thought would be common such as missing persons, sieges, traffic accidents, and other general policing was validated. It was also expected that some would suggest UAVs for pursuit and dangerous driving incidents, however, as most understand, that would require substantially large and long endurance equipment to be used and that would include beyond line of sight, which we are not initially looking at.

Another consideration was understanding and then communicating to the organisation that this capability would not replace the need for helicopters, but would support them by not having to deploy helicopters to as many of the basic photographic tasks that are frequently requested. This would free up valuable helicopter assets and funding to focus on more pressing tasks and as such the UAVs could do the low level mundane tasks.

The Scottish Civil Aviation Authority is the regulator for all UAVs and the rules and regulations governing UAVs is extremely simular to that in Australia. They include all of the same basic rules and there is little difference.

There are however, some new European guidelines that are planned for roll out in 2016/17 that will come out as a prototype document (a proposal). This will primarily affect hobbyists and UAV racing groups, but will not really affect police. This is due to the significant level of engagement and liaison that we have with the CAA who understand the very high levels that the Aviation Support Unit work under. They already understand that any UAV work units in Police Scotland would include highly trained and dedicated UAV operators that would completely comply with all UAV requirements.

In Scotland, the CAA manages all of the approvals to undertake aerial work, which relates to commercial operations and requires those performing commercial activities to have an operation certificate and to train all of their pilots along the same program as the commercial operators. This is for two reasons.

Firstly, police are not a commercial operation and secondly because the CAA understands the rigorous controls that would be placed around the operations. However, whilst the CAA would not require us to operate under those rules and guidelines, it has been nationally agreed, and we also agree, that we will in fact comply with all of those requirements so as to ensure that we are fully compliant in all regards.

The consultation document told us what our members would use UAVs for, when we would use them and where we would use them.

Cost was then the next big topic to be explored and how we would the use of UAVs to reduce unnecessary costs for operations and tasks that could be performed by UAVs and what would be the up front and ongoing costs of operating a UAV capability.

Stuart then conducted a full review/audit on the entire requests for service and operational tasks that the aviation unit helicopters were tasked with. The data collection period was between 1 March 2015 and 31 December 2015. This was done in order to gain a full picture of the:

- Task types
- Incidents that require response
- Duration of tasks (flying time)
- Locations of tasks
- The task outcomes
- Task equipment requirements, and
- Who requested the task.

This was done to identify what tasks could be attended to by UAVs, and which tasks need to be attended to by the helicopter.

I.e. what is the helicopter been used for and what can the UAVs possibly do to ensure the best use of aerial assets.

The data provided a clear picture of the service demand across all of the police divisions across the country. The statistics and type of service demand was evaluated to understand what tasks were being attended to in which areas. This means that they could identify all tasks that a UAV could attend to and where they are generally being tasked to. This was a way to identify the service demand that UAVs could attend to in place of the helicopter.

One of the great outcomes from the data was that they could identify the area where the helicopters had difficulty getting into, such as ravines, gorges, forested areas, mountain areas that were experiencing poor weather and other locations that were not well suited for helicopters. Through assessing the data, they identified areas that would normally struggle to gain helicopter support and as such those areas were identified as relevant locations to base a UAV capability.

The data clearly identified the primary locations where UAVs should be based across the country and how many might be needed to match the service demand.

In early 2016, an additional review was conducted on a six month period of data and the data produced the same response. This meant that the service demand was consistent in both type and location.

A significant factor was that much of the country provides adverse weather conditions in the colder months and at other times the weather is simply unpredictable. As such, UAVs can often provide an alternative aerial solution for police.

One significant dilemma in determining service demand in the more rural and remote areas is, do they actually request the helicopter services or do they not requested the

services because they know they wont or cant be supported. This question is difficult to answer and would be a typical questions asked by any police and emergency service because many rural remote areas simply don't request something that rarely arrives. This means that the true service demand in those areas in unknown as you can only assess data that is provided. Not requesting a service because you know it won't be provided is a service demand that is not accessible. If on the other hand, a separate survey was sent to all police, requesting that they estimate the number of times they needed the service, the data would be subjective instead of objective and as such it would be guesswork only. Given that they knew that there would be a high percentage of times that aerial support would have been requested, they simply included this fact into their summaries and noted that the true service demand data is simply not available.

The additional factor is that crime in the rural areas is different from the crime in the metropolitan areas. The suggestion is that a UAV capability should be located in Aberdeen, Inverness, Glasgow, Edinburgh and this way there would be an interim measure to manage the demand. The other factor is the drive times between locations where UAVs would be located to support the smaller rural areas that maybe wouldn't have much service demand.

In the longer term, we would expect to see UAVs located in all major towns so that the locals can use and deploy the smaller UAV types such as DJI sub 5 kg UAVs that are easily maintained and flown. The task types would be:

- Missing persons
- Firearms incidents
- Football (Soccer events)
- Public order
- Public safety.

One other factor in determining the service demand and incident types was our approach that included what was realistic and excluded what we thought was fabulous and exciting, yet probably unrealistic.

Additional factors in the service demand and incident types that might be relevant for UAVs were:

- Built up areas
- High rise buildings
- Critical Infrastructure.

In the 2016 data sets (3 months each) we estimated that the use of UAVs would save approximately £90,000 in flying hours for the helicopters that could have been reallocated to more critical incidents, which would require a helicopter instead of a UAV.

As a result of this data, we have clearly identified a broad range of tasks and incident (user cases) where we can deploy a UAV.

Some of the operational considerations for deploying UAVs is that it would take longer for a two person team in a vehicle to attend some locations across Scotland in comparison to a helicopter, but the cost is significantly different. Naturally, urgent tasks would still be attended to by the helicopter but some of the non urgent tasks could be managed by the UAV team. Additionally, there are many occasions when 2 aerial asset

are required, however, we only operate one helicopter in Scotland as such UAVs would still go to helicopter related incidents due to fact the helicopter is simply not available.

The next part of the research strategy was to identify the size, type and capability of the UAVs that would be purchased. Then the media strategies would need to be written and be ready for use both in the lead up to using UAVs for the first time and for the ongoing media and corporate communications requirements.

Scotland, like many counties has a large number of persons it the public that will immediately look to the negatives of using UAVs, with comments that UAVs are 'big brother' and that their privacy would be impacted. We need to manage this and in doing so we are ready to start our media drip feed process that openly advertises our overt UAVs and shows what tasks they would be used for. In the begging the missing person's tasks and any emergency management tasks will be used to openly advertise the fact that we used a UAV, thus gradually introducing the idea to the community in positive and important news stories.

In order to differentiate the police UAV from any others was to put a blue flashing light onto the UAV and have police written onto it. This option first began as a joke but was later identified as a good positive way to show that the police are present and that the UAV is being used by police instead of offenders. Potentially all of the police UAVs would be black and yellow to match the police colours.

Additionally, when deploying a UAV, there will be two uniformed police officers in a fully marked vehicle who will be operating it. This will ensure 100% transparency and openness that they are operating it and so we cannot be seen to be hiding it. Whilst that approach does not cater for any covert operations, the intention is to be overt for the first 12 months or so and then the covert operations could be considered.

In early 2016, Stuart visited Andrew Hamilton from Devon & Dorset and Cornwall Police to assess their operation, which included DJI Inspire UAVs. The DJI Phantom was being used for base training but the Inspire has great cameras for HD video and stills and is capable to manage some of the operations that would be carried out in the first year or two in Scotland. It is only when you need to cover vast areas that you need to invest in long range, beyond line of sight fixed wing options.

The only downside of the Inspire is that it cannot fly in rain or very poor weather and until a night vision camera is available it wont be the best option. The other requirement for our operation is that we need to be able to have a payload that allows the unit to carry both day and night capable cameras to avoid having to land and switch out cameras. The camera is the real asset here and the UAV is just the means to carry the camera in to the air.

In regards to training they are looking at seeking professional UAV training companies to ensure that the initial teams are trained by industry experts. From that point we have the option where we can train our personnel through an internal training capability.

In regards to operating in busy areas and the CAA requirements, they have found that through maintaining a strong working relationship with the CAA that they can find solutions to problems. For example: When wanting to operate a UAV at a major soccer event, the risks of a UAV dropping from the air and landing on a person is avoided by

operating the UAV over the top of a grand stand where it would only fall onto the roof if it lost signal or power. These risk based solutions are options that the CAA are more than supportive of. This is an example where risk = solution + support from the CAA is critical.

The process of risk based solution management is that we identify all of the user cases and look at the locations where UAVs would be needed. We then look at the pathway that the UAV would take and we consider the options. Another example is that if they wanted to fly a UAV down a street to a target address they could fly over the house roofs rather than over persons and as such avoid flying over people.

As of now, in 2016, we are finding that the technology is increasing, but the UAVs need to be able to fly in rain, poor weather, night and in other difficult scenarios.

It is anticipated that the UAV capability should be approved in late 2017, until that time, the project will work towards gaining approval to establish the capability.

Countering RPAS

The countering of UAVs is part of the research project and will be researched in due course.

Marine / water suitable drones

Some systems are designed to fly as a normal drone, but when you need to check under the surface of the water, you can land onto the water. This drone will then partially submerge and allow the camera to go under the water. They camera can then be controlled to look below the surface and provides vision into the police link.

SwellPro's waterproof "splash drones" were designed primarily for fishermen, but ambitious filmmakers and at least a few clumsy photographers could all benefit from a drone that can shoot above and below the waves.

The splash drones come in two different versions: Fisherman and Auto. The entry-level Fisherman was designed for "long fishing line delivery and bait dropping," and comes equipped with an SAR fishing line release mechanism, waterproof camera, video transmitter, and FPV monitor.

The more expensive Auto version is a bit more filmmaker friendly, and includes a waterproof GoPro gimbal, a fishing line release rig, a ground station, and that same FPV monitor. It was designed for stabilized aerial filming over the water or in the rain and can

perform some automatic functions like “mission planning” and “follow-me” via the ground station.

This type of drone would be extremely useful in a range of circumstances and its 100% waterproofing means it would be extremely useful in Scotland due to its weather conditions.

Training of staff

It is anticipated that the initial training will be provided by an outside provider to ensure that the initial personnel are highly skilled in this capability. In the near future, it would be beneficial to have our primary staff trained as trainers so that they can work with remote pilots to continually develop their skills and experience.

Future operating model

It is anticipated that after the RPAS project is approved for implementation, the first year would see 2 or 3 personnel being attached to the unit to set it up and year 2 would see it expanding into the regional areas.

Lessons Identified

Topic	Lesson Identified - Police Air Support Unit, Police Scotland	No.
Funding	The use of mid to low cost, sub 20kg drones provides a financially viable opportunity to enter the drone's space by avoiding high-end costs.	131
Training	Training remote pilots should be done with the low cost DJI products as crashing and bumping into objects can have high cost impacts on the more expensive and capable aircraft.	132
Research	Mapping out the drone research and development via defined project plans is critical to the success of the project.	133
Research	Establishing a research project in the first instance ensures a measured and methodical process as apposed to acquiring drones and then working out what to do with them.	134
Scoping Decisions	When planning begins for a drones capability, the tiers of capability need to be understood and articulated so that the user cases can match the levels of capability that currently exist. I.e. Identifying user requirements for local operations below 400feet, Vs. user requirements for beyond line of sight offshore user requirements.	135
Central Management	A critical factor in the management of a drones unit is to ensure that the central coordination and management unit is centralised with one management team. All operational work units then deploy locally under the umbrella of a central coordination unit (such as NPAS in the UK).	136
Planning Approach	The Police Scotland mirrors the UK model as it begins with the user requirements as apposed to the technical requirements. Technical requirements come second as they are the solution to the user requirements. The third stage is the business case, which is centred on the technical requirements.	137
Offence / Incident Types	Identifying the offence/event types that UAVs will be deployed is critical to identify the needs of the organisation.	138
UAV operating Bases	Understanding the potential locations around the country/state is critical as it informs the size and scope of the overall capability.	139
Size and Scale	Understanding the scale and size of the UAV capability is defined by the needs of each different area and its incident/offence types	

of the Capability	along with its demographics.	140
Cameras / payloads	It was identified that the true value of a UAV is the camera that it carries. The payload capability of the UAV must match the camera that is needed to be used during the operation. The camera drives the mission and the UAV provides the ability for that camera to be operated in the air.	141
Considerations	Ensure that all of the OHS, legal, privacy, data security and public opinions are known from the begging and managed continually.	142
Considerations	Management of the Civil Aviation Authorities (CAA) legal and regulatory requirements requires continual attention and as such dedicated resources are required.	143
Equipment (Drones)	Knowing the true and realistic capabilities of each drone is critical as the specifications and capabilities listed by the manufacturer are not always correct and are not written for the type of work that police will employ them for.	144
Resources	Having to purchase multiple drone types requires increased training and resourcing needs. Limiting the number of drones models/types is critical.	145
Resources	Drones are a new capability and as such they need dedicated staff to grow and mature with the capability, human resources need to be either permanently attached to the drone unit or spend a significant amount of their time working with the capability.	146
Expectations	A true challenge in the development of state or national programs is ensuring that the expectations of stakeholders and government sponsors are managed and constantly addressed. The aviation industry is complex and heavily regulated and progress takes time.	147
CAA (Aviation Authorities)	In many cases, the regulations surrounding drones are at the early stages and it must be noted that the aviation authorities around the world are also playing catch up and trying to keep pace with rapidly advancing drone technologies. As such, it is important to build relationships with the CAA to help them progress with your team as apposed to blocking your progress.	148
Weather and the Environment	Understanding the environment and the weather and geographical layout is critical in understanding the capability requirements of UAVs that can match the environment that they will be deployed within.	149
Weather Protection	It was identified that the UAVs need to be weather resistant (rain, snow etc.) otherwise they can be of little use in Scotland and areas that experience poor weather conditions.	150

Constant night and day camera capability	The camera system must incorporate both day and night vision capabilities and or the UAV must be capable of carrying both day and night vision capable cameras. The need to land the UAV and switch payloads (cameras) is not an option and as such both camera capabilities must be available at all times during flight.	151
Media Management	It was identified that a strategic approach to managing the media is critical in the lead up and implementation of a UAV capability. Ensuring that positive UAV stories are proactively provided to the media is essential to the need of avoiding backlash or negative responses to the use of UAVs by police and emergency services.	152
Funding	In comparison to other methods for policing that are currently employed, drones are cheap to purchase and extremely cheap to run.	153
Considerations	Media and public focused communications can streamline the implementation of a drones unit as the public will be aware of their future application, and as such, when implementation occurs it is no surprise to the public and is readily accepted.	154
Rural Support	It was identified that UAVs can provide a sound aerial support capability to regions or rural areas of a country or state that normally don't receive much support from helicopter air support units due to the remoteness and distance from metropolitan areas.	155

3.16 National Police Aviation Service (NPAS)

Contacts

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Overview of the Organisation

The National Police Air Service (NPAS) provides borderless air support to the 46 police forces of England and Wales. The National Operations Centre for NPAS, which is also the headquarters for the NPAS senior management team are located in West Yorkshire.

Note: NPAS does not include Scotland.

Across the nation, each base consists of a Base Manager, Pilots and Tactical Flight Officers (TFO). Each crew consists of one pilot and two Tactical Flight Officers. The Tactical Flight Officers (TFO's) operate all the police role and mission equipment, communicate with police on the ground and command and control a large number of incidents attended.

NPAS carry out a variety of tasks for the police forces of England and Wales including: Searching for missing people

- Critical incidents
  Operational follows and vehicle pursuit
- Tracking and locating suspects
- Public order
- High profile patrols
- National response to counter terrorism
- Photographic tasks
- Crime reduction and hotspot policing
- VIP escorts and security duties
- Transportation of personnel and equipment
- Command and control
- Situational awareness
- Live video stream

Note: They do not currently manage RPAS, however, they do managed incidents where RPAS interact with Aviation.

It was also noted by the Home Office personnel that NPAS may be required to manage the national drones project over the coming years due to the need for a nationally centralised drones capability with management teams in place.

NPAS management did state during meetings in Wakefield (NPAS HQ) that the future operating models for RPAS in the UK would more than likely see the NPAS as the national central RPAS coordinator and that each of the police forces would be linked to the

national PRAS team under this centralised governance structure. This approach would provide a sound, national approach to both manned and unmanned aviation for police.

Currently, NPAS are only engaged with the RPAS capability on the periphery, but would soon be engaged in those conversations.

Much of the conversations at the NPAS HQ ware based around the future of NPAS and RPAS as noted above, but also the interaction between the NPAS helicopter and drones being used by the public along with the discussions around aviation policing as a whole.

Lessons Identified

Topic	Lesson Identified - National Police Air Service (NPAS)	No.
National centralised coordination	It was clearly identified that the NPAS would be the best fit for managing a national coordination and or governance structure across the police forces and their drone units. This would enable a nationally structure and consistent approach to be adopted and maintained.	156
Alignment with Air Support	It was identified that air support units like NPAS and Victoria Police Air Wing should be aligned with the drones project, work units etc. as they are closely aligned in many areas, such as: relationships with CASA – CAA, air space, tasking the best asset to an aerial tasks (tasking and coordination) and other aviation related topics and issues.	157
Chief Pilot and Chief remote Pilot	The linkage between the Air Support Chief Pilot and the Chief Remote Pilot should be created to maintain connection between their role and functions is strong.	158

3.17 Lippitts Hill NPAS Base - London

Contacts

Andrew Hutchinson, Lippitts Hill NPAS Air Base Manager

Overview of the Organisation

Lippitts Hill is located approximately 20 km north of central London and hanger's three EC145 helicopters, which is a part of the NPAS. Refer to section 3.16 for an overview of NPAS as a whole. The Lippitts Hill base services the greater London area.

Current RPAS Operating Model

Whilst the personnel at Lippitts Hill do not manage or operate any drones as such, they are having to deal with and mange the issues relating to drones on a frequent basis given their frequency and use by the public. Andrew Hutchinson, who is the base manager stated when I met with him that they have had to make some changes to their flying standard operating procedures to accommodate the use of drones by the public, and in the near future they will have to look at how they work / fly and operate in an environment where a police drone unit is employing drones to the same task.

This is an issue that Victoria Police will also have to deal with, due to the fact that drones are soon to be used by police and will at times be deployed to the same tasks.

According to Andrew, some tasks / incidents that may require both helicopters and drones to respond, include but are not limited to:

- Searching for missing persons both lost persons and suicidal persons
- Searching woodland areas where drones can fly under the tree canopy whilst helicopters fly above the canopy
- Attending siege and critical incidents where drones can fly between buildings and or close to buildings whilst the helicopters fly at 1500 ft. above the location for the more holistic approach
- Attending incidents near tall structures or buildings where the helicopter viewpoint is constantly obscured by tall buildings
- Attending to flood water incidents where drones can fly close to water, trees and near rivers and enclosed areas (such as caves or ravines) whilst helicopters cover the higher and more exposed areas

In order to ensure that the deployment of both assets is safe and efficient, the coordination, management and training to achieve this must be thoroughly explored. Andrew also noted that there might in fact be times when helicopter crews might need

to land and use drones themselves to complete tasks that cant completed from the higher altitude that helicopters require.

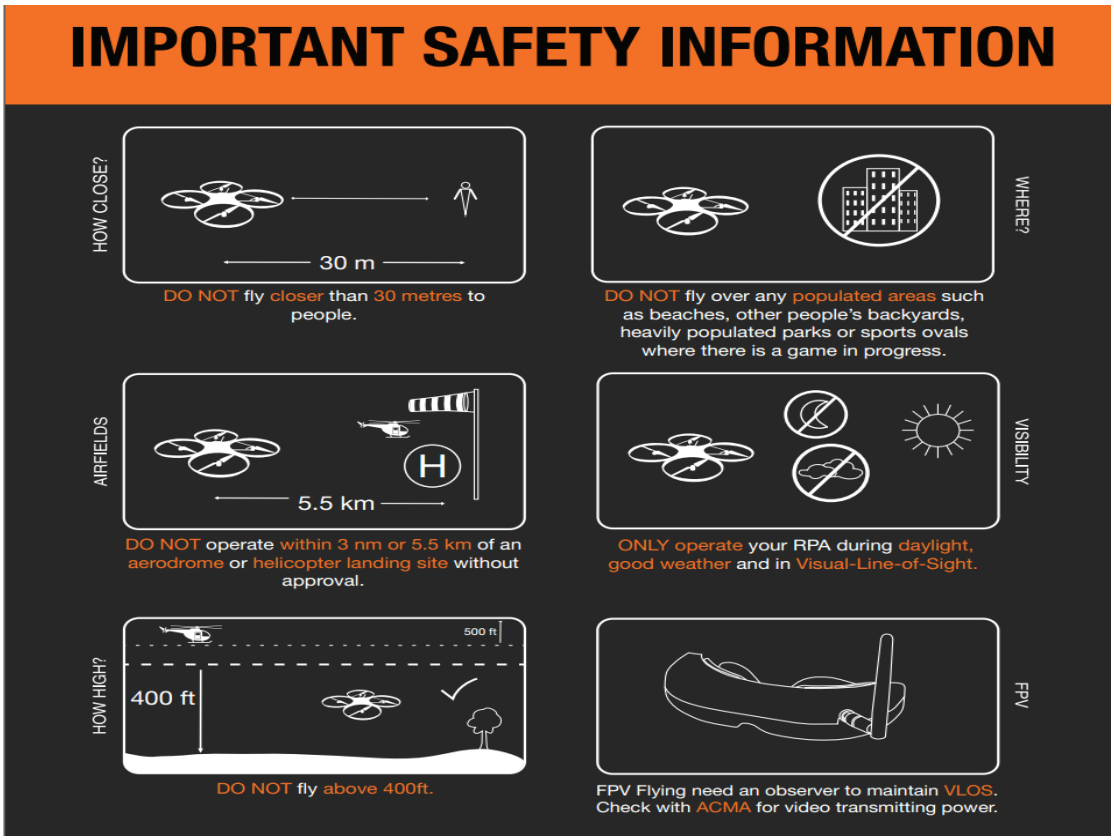
Whilst the Lippitts Hill base are not yet carrying out that exploration or research, they are looking to see if other police forces have undertaken any such research.

Lessons Identified

Topic	Lesson Identified - Lippitts Hill NPAS Base - London	No.
Deploying helicopters and drones	It was noted that the opportunity to deploy both helicopters and drones to incidents and tasks would more than likely become commonplace in the near future. In order for this to be conducted safely and efficiently, the deployment model would need to be researched.	159

4 CASA Regulations in Australia

The document below provides the necessary information for the use of RPAS in Australia and is provided for reference.



5 Conclusion

This study tour provided the opportunity to investigate the application of RPAS across England and Scotland.

As can be seen in this report, the contacts that were made in the lead up to the application process for this scholarship changed slightly between the time of planning and submitting my application and the time that I was coordinating the actual travel and coordination of the meetings. When further liaison was made with the initial contacts, and when I could confirm that I would in fact be attending, those contacts undertook additional enquiries on my behalf, which further expanded the opportunities with those countries. This was typical of Police and Emergency Service organisations in that we all look after one another and go out of our way to link people together.

The opportunity to attend the National level Cross-Government Working Group for Counter-UAS (sponsored by the UK Home Office) is an example of the flow on effect of attending other countries and investing time, funding and subject matter expertise in our endeavours to learn and acquire knowledge. It is only through physically attending these countries that the real learning's and knowledge can be acquired. The relationships we develop and the information sharing we provide enables each country (Australia, Scotland and England to benefit from each other's research and learning's.

During the past months I have shared multiple documents with the contacts I have made and in turn they have shared many documents with us. The benefits derived from the Emergency Services Foundation Scholarship program cannot be fully explained in words in any report, however, the outcomes can be quantified into "Shared Learning's".

The support provided to me whilst in-country was extraordinary and provided greater opportunities whilst on site. Thus is the advantage of factoring in extra time in-country for the unexpected opportunities that arise when people get to know you.

The project initially focused on 14 key services that PRAS can provided to police and emergency services.

Through the study tour, I was able to validate that police and emergency services in the UK are in fact looking at the same focus areas and at each location it was clear that they are all planning on using RPAS to support these same areas. This provided validation that we are heading in the right direction. The 14 focus areas are provided below as a reminder of where we started.

1. Counter Terrorisms and bomb response including post blast analysis
2. General policing and law enforcement including public demonstrations and events
3. Forensics / crime scene / disaster victim identification and Hazmat
4. Search and Rescue (land / marine / caves and tunnels / urban)
5. Emergency Management support (disaster and emergency management response)
6. Chemical, Biological and Radiological multi agency response
7. Road collision incidents response, road policing and fatal collision investigation

8. Photographic and video support
9. High risk, critical incident management and active shooter response including paramedic response and triage
10. Thermal imaging for night time and low light-no light situations
11. Victim location and identification in remote areas and or high risk environments
12. Maritime emergency management and law enforcement
13. Tactical response operations
14. Exercise management.

5.1 Recommendations

Listed below are several higher-level recommendations for reference.

1. It is recommended that Emergency Management Victoria (EMV) should consider re-establishing a state based RPAS working group and invite all state agencies including CASA to participate in the working group. This will enable all state based agencies to work together to identify:

- Opportunities to operate simular or same equipment
- Combine training opportunities and reduce duplication in training trainers
- Share operating procedures and documentation
- Work collectively with CASA
- Provide support, or gain support from other agencies that are more advanced or less advanced than others
- Assess the operating locations and capabilities of agency RPAS capabilities to assess resourcing requirements.

2. That a workshop be conducted to provide Victorian agencies with a project update from Victoria Police regarding the pending development of a PRAS unit. This will enable other agencies to share in the recently acquired knowledge and documents that Victoria Police is using to develop a concept of operations for the Police Air Wing to establish the unit.

3. That a State level list of RPAS assets owned by agencies be created and maintained to ensure a constant information sharing process can be created. This would enable agencies to learn from others that have acquired RPAS assets that they themselves intend to acquire.

4. Agency personnel should consider placing agency markings on RPAS aircraft, as it may be beneficial in ensuring the public are not alarmed when a RPAS aircraft is being operated nearby. This would also assist persons who are being rescued and or agency personnel from knowing that an RPAS aircraft operating in their area is in fact from an agency and not a nuisance operator.

5.2 Lessons Learnt

Throughout this document, the lessons learnt were provided and linked directly to each agency. The full list of all lessons learnt was not provided in a separate document as the lessons learnt pages are easily located and collated for those persons who choose to do so.

5.3 RPAS Categories

The diagram below shows the sub categories that sit within the five RPAS categories. The table provides an example of the type of RPAS technology that is currently available within each of the categories for context purposes. The pricing in the table refers only to the outright cost of the RPA vehicle itself and does not include additional equipment required to support that craft. The weight and size of each sub category is provided for reference.

RPAS 'Category' Examples			Approx. Weight	Approx. Size
A_1	DJI Phantom 4 Pro*	$3,250	1.4kg	35cm
A_2	DJI Inspire 2*	$11,100	4kg	60cm
A_3	DJI Mavic*	$2,500	743g	33.5cm
B_1	Aerialtronics Zenith ATX8	$60,000 +	6.4kg	60cm
B_2	Aeyron Skyranger	$100,000+	4kg	102cm
C_1	AE Wasp	$700,000+	1.3kg	102cm
C_2	Prox Dynamics PD100	$100,000+	18g	15cm
D	Airbus Zephyr HAPS	$???	65kg	25m
E	Smart Balloon	$20k +	5kg	1.8m

*Category 'A' figures include 2 x spare batteries, car battery charger (not Inspire 2), battery safe-bags and hard-case for transport.

Operating Model Options

The following operating model options are provided as the study tour helped to identify what the potential operation models could look like.

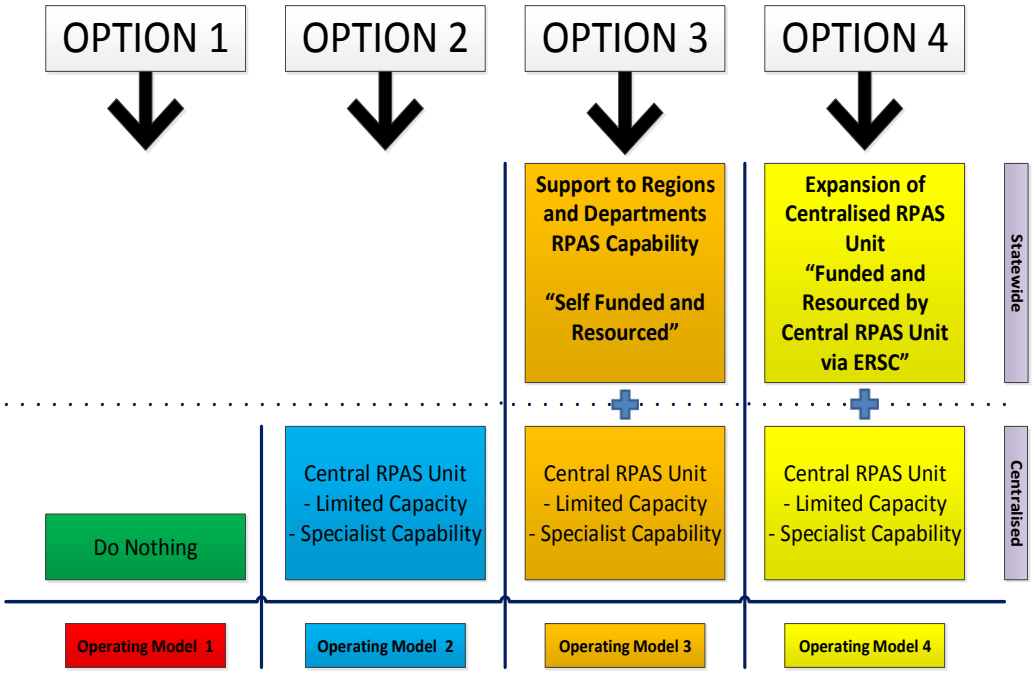
Model 1: Do nothing.

Operating Model 2: Create a Centralised RPAS Unit, providing limited capacity but with specialist capabilities to work units such as those noted in the needs analysis, along with a limited capacity to support the regions.

Operating Model 3: Create a Centralised RPAS Unit, providing limited capacity but with specialist capabilities to work units such as those noted in the needs analysis, with the additional ability to directly support the regions and or work unit based RPAS teams who are self-funded & resourced.

Operating Model 4: Create a Centralised RPAS Unit providing state-wide capacity with specialist capabilities, which have additional 'RPAS teams' housed or based at remote locations, yet funded and resourced by the central RPAS unit.

The diagram blow depicts the four options.



5.4 Terms and Abbreviations

Terms and Abbreviations	Meaning
ACP	Aviation Capability Program
CASA	Civil Aviation Safety Authority
Drone	A pilotless radio-controlled aircraft used for reconnaissance or bombing (Collins English Dictionary).
RPAS	Remote Piloted Aircraft & Systems – Includes 'flying craft' (piloted from the ground), and all associated parts (such as control panel/ system/ screen).
UAS	Unmanned Aerial Systems – Includes the 'flying craft' (includes semi-autonomous) and all associated parts.
UAV	Unmanned Aerial Vehicle – The craft itself, which flies, does not include controlling equipment.
ReOC	Remote Operating Certificate – The certificate issued by CASA to permit an organisation to operate RPAS in a commercial environment
VLOS	Visual Line of Sight
Central RPAS Unit	An office location where the Chief Remote Pilot and Chief Maintenance officer reside, and coordinate all methods of operations conducted under the ReOC
Team	A 'team' encompasses the minimum required to operate an RPAS – which is 2 x RePL licensed employees, equipment and RPAS

End of Report