CBRNe Enabled Drones – The State of Play and Problematic Future

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ABSTRACT
Unmanned Aerial Vehicles (UAVs) from both foreign military and non-state actors are becoming an increasing threat to maritime vessels. The small size and manoeuvrability of UAVs has broadened their appeal, causing significant disruption to a variety of locations such as airports and aircraft carriers, as well as potentially posing direct threat to life. UAVs have ushered in an era of low-cost and easily accessible weapons that can deliver a Chemical, Biological, Radiological, Nuclear and Explosive (CBRNe) payload from a remote location. This paper discusses this present and future threat to maritime vessels, and the mitigation strategies available. A CBRNe UAV attack can have a significant impact on a maritime vessel. Without adequate sensors to detect a UAV or the subsequent CBRNe payload, the attack could result in; loss of life, loss of the vessel and a time-consuming and costly decontamination effort. The threat posed by UAVs will only increase in the future as the technology advances and the expense declines. A safe future for military and commercial maritime vessels increasingly depends on an organisation's ability to remove or react to a CBRNe threat. The placement of suitable detectors is therefore a key element of protection, allowing for a quick response time once the threat is detected.

1. INTRODUCTION – THE PRESENT THREAT

Unmanned Aerial Vehicles (UAVs) have become commonplace in both military and commercial applications. UAVs are already extensively used by a number of military forces including the ADF. Systems previously used include the ScanEagle, Wasp, Skylark, Shadow and Heron UAV. [5]. The reduction in cost of buying or building an UAV has narrowed the capability gap between non-state actors and conventional military forces by providing an accessible airborne capability. For non-state actors, UAVs are an extremely attractive option to deliver a payload in a maritime environment. They can be purchased at a relatively low cost and can therefore be seen as expendable. UAVs can be modified or custom made with open-source information, and specialised training is not required for operation.

UAVs are already being using by state and non-state groups due to their accessibility. In Ukraine drones have been used by government forces and separatists for intelligence and reconnaissance gathering efforts. Similar trends have been seen in Iran and Syria, with sightings of UAVs dropping what have reported to be explosive payloads. In October 2016, the Islamic State skilled two Kurdish soldiers using an armed UAV. [9]

In 2016 and 2017 the US reported a hostile interaction with a Sadegh-1 drone in close range of an F/A-18E Super Hornet trying to land on USS Nimitz. This was of particular concern as the

UAV has weapon capability. [10] In 2017, Islamic State documents were obtained which detailed the network's UAV programme. The devices used were commercially available but reconfigured to carry small bombs and munitions. [11] In August 2018, an alleged assassination attempt on President Nicolas Maduro of Venezuela took place in Caracas. Two DJI M600 UAVs each carrying 1kg of C-4 explosive were used. President Maduro was unharmed. [1]. The first suspected UAV swarm attacks were witnessed in 2018 at an airbase in Syria and a naval station on the Mediterranean Sea. [10, 11]

The Islamic State have previously released videos that show UAV footage from above the battlefield demonstrating their Intelligence, Surveillance and Reconnaissance (ISR) capabilities. The Lebanese militant group Hezbollah and Hamas, the Palestinian group that operates in the Gaza strip, are confirmed to have military UAVs in their arsenal supplied by Iran [11]. However, a whole host of other non-state groups have used UAVs in a military use through the rise and popularity of commercial systems. New America's World of Drones database details non-state groups which have deployed UAVs including: Isis, Hezbollah, Hamas, Houthi rebels, Libyan rebels, various Syrian rebel groups, the Revolutionary Armed Forces of Colombia (Farc) and Colombian and Mexican drug cartels. [1, 11]

Therefore it is essential to appreciate that weaponised UAVs are not a distant or possible threat, but a clear and present one, and a threat that is likely to grow swiftly as ever-more sophisticated technology becomes ever-more accessible. While terrorist groups cannot match armed forces in conventional weapons particularly in the air domain, UAVs have changed the battlespace. They provide a strategic benefit by providing an airborne capability. They are easy to adapt and can provide a range of capabilities including but not limited to; surveillance, offensive, disruptive, and smuggling goods. As far as the military is concerned, UAVs can be equipped with explosives or weapons which are remotely piloted creating an ever changing threat for armed forces. The risk that a UAV will be used for terrorist attacks is of high concern for those in charge of counter-terrorism measures.

2. THE MARITIME THREAT – CBRNE PAYLOADS

CBRN attacks provide a huge threat to maritime vessels. A payload could be dropped onto or near a vessel, or fitted with explosives and detonated nearby. Depending on the weapon chosen, the resulting impact could result in an expensive and time consuming decontamination effort, to the loss of the vessel and the loss of life. A UAV carrying a potential CBRNe threat situated downwind or above the vessel would pose a significant threat to the vessel and crew if the payload was released. Ultimately the damage incurred could result is mission failure. The resulting impact of an attack could all be achieved be a single low cost UAV operated from a remote location from a single non-state actor.

The present threat is an example of symmetric warfare where low level technology is capable of causing significant damage to large scale maritime vessels. The risk posed is comparable to the current crisis faced by governments and institutions with regards to hacking.

While the purchase of UAVs in not controlled and training is a simple matter, the CBRNe element is under much stricter regulation. There are a number of international treaties and organisations that manage the proliferation and control of such substances. A complete list of

CBRN treaties, organisation and regimes relating to disarmament, arms control and non-proliferation of weapons of mass destruction are detailed by the Nuclear Threat Initiative. [2]

Radiological and nuclear threats can both cause mass destruction but are highly unlikely to be delivered by UAV in a maritime setting, due to their difficultly to obtain and control. Two particular conventions to highlight are the Chemical Weapons Convention (CWC) and the Biological and Toxins Weapons Convention (BTWC).

The Chemical Weapons Convention (CWC), enforced by the Organisation for the Prohibition of Chemical Weapons (OPCW), details specific substances that are controlled in terms of development, production, stockpiling and the use of Chemical Weapons. [3] A number of chemicals that can be used in an attack are in common use in the manufacturing industry and can also be produced by non-state actors. The Biological and Toxins Weapons Convention (BTWC) enforced by the United Nations prohibits the development, production and stockpiling of bacteriological and toxin weapons. [4]

3. DETECTION OF THE THREAT

Maritime vessels in the Australian Defence Force (ADF) and other military forces are currently equipped with CBRN detectors that warn crew when a threat is detected. CBRN detectors are commonplace on maritime vessels, substantially predating the recent rise in the use of UAVs. The placement of CBRN detectors on-board a vessel can be key to rapidly detecting a threat in order to protect the crew member and to contain the attack. The quicker the agent can be detected, the more chance that no crew will be harmed and a decontamination effort will be effectively and efficiently carried out. CBRN detectors are needed in conjunction with technologies to remove the threat of a UAV in case a different method is used or the attack is not detected by the vessel. The risk previously foreseen would be the vessel travelling through an area in which a CBRN agent had been released. UAVs add a new element to this space allowing for the threat to be dropped onto or near the vessel with potentially very little warning.

The detection methods currently available to detect drones are:

- Radio-frequency;
- Infrared;
- Acoustic; and
- Visual.

Military vessels are generally equipped with radar and a form of electro-optical device for tracking or scanning. Civilian ships are generally equipped with navigational radar which will be less likely to detect an UAV.

4. ELIMATING THE THREAT

Once a UAV has been detected, the threat must be removed. RC Protocol Manipulation is a series of steps that can be used to remove the threat posed by a UAV. [6].

Soft kill level 1: detection and monitoring – watching to ensure the UAV is not a threat. In a maritime environment the monitoring period may be drastically reduced to that of an urban environment such as when the vessel is alongside due to its perceived risk.

Soft kill level 2: taking control of the UAV – if technology is available on-board to achieve this, the UAV can be taken away from where it will cause the most disruption. Technology to achieve this is unlikely to be available at sea and also unlikely it could would be at an acceptable state of readiness.

Hard kill level 1: projectiles and kinetics – this includes nets dropped by other UAVs and bullets. Nets have recently been trailed, however this solution is unlikely to be made available on-board due to the readiness level required. Bullets are a realistic and available method of UAV neutralisation depending on the distance from the vessel.

Hard kill level 2: Lasers, magnetic, and other means. Semi-active laser targeting has been considered as a potential solution. This is a considered a good solution for surface-to-air strikes.

One popularly considered option is jamming the signals for the device. For operations occurring in line of site, radio-frequency is used, and beyond this it is maintained using satellite.

The Dutch police have trained birds of prey to take down UAVs in an urban setting. This technique allegedly causes no harm to the bird and could be a potential solution for vessels alongside, although their applicability at sea is dubious. [7]

The Hard Kill Challenge in New Mexico enables a range of Defence contractors to test novel technology during the course of a competition. Systems involved in the 2017 competition included high-energy weapons and an attack UAV utilising a net to drop onto hostile drones. [8]

5. CURRENT PROTECTION METHODS

During a demonstration the US Navy shot down a UAV with a laser over the Persian Gulf. Raytheon is pitching is C-RAM air defence system as a UAV countermeasure. Northrop Grumman is altering its G/ATOR air defence system to monitor UACs, as is Lockheed Martin and its An/TPQ-53 radar. [6]

6. FUTURE THREAT

The popularity of UAV use in military and commercial settings has led to a number of debates on what has been called 'killer robots'. [12, 13, 14] UAVs controlled by AI could be capable of undertaking missions without human direction which has caused much debate on the ethics of such systems for state use. Ethical concerns are highly unlikely to be considered by non-state actors.

7. ADVANCED DRONE TECHNOLOGY

UAV swarms have already been used as an offensive tactic, however coupled with a CBRN or explosive payload this could produce devastating effects and prove difficult to protect against. It is already possible to build a UAV with 3D printing however this space has not been fully utilised. Advances in autonomy, optical navigation, AI and mounted weapons all create opportunities and problems for protecting against this threat.

8. FUTURE OF THE PROTECTION SPACE

The protection space of the future is critical in protecting life and assets. The wide availability of UAVs make it difficult to develop ways to counter against them. Military and commercial efforts are trying to develop technologies to spot unmanned aircraft.

Radar is currently been used to detect UAVs however as previously discussed it is difficult to distinguish smaller devices from birds, therefore calibration of detection needs to be altered. It is important that fine calibration does not produce excessive false positives which may encourage poor behaviour and lead to ignoring future signals and alarms. Radar may be able to be used in conjunction with other technologies in order to effectively detect these systems.

Black Dart is an annual event held in California where anti-UAV specialists gather to test weapons against pilotless aircraft. [15] This event highlights the growing need for a protective solution against such devices.

The acquisition systems of most developed countries produce large, expensive weapons, which provide an easy target for UAVs. In order to produce new technology, governments and militaries undergo an onerous process to bring novel systems into service. The regulation of this process limits rapid and reactive development in order to bring new technology into service. Non-state actors have fewer barriers of this nature and can take greater risks with technology although have a much lower financial backing.

The Royal Navy is currently looking into ‘laser beam riding’ where a low-power beam carrying encoded information is directed to the specified target. A missile is launched and it then ‘rides’ the beam to the target. The low power and narrow frequency of the beam make it difficult for the target to detect, inhibiting counter measures. This technology has been proposed as a solution to fast in-shore attack craft, drones and shore installations. [10]

Much recent effort has been focused on how to protect against UAVs however importance still needs to be placed on the detection of CBRN agents. It is entirely possible a UAV may be able to release its payload close enough to a vessel, or even onto the vessel while undetected or unmanaged. CBRN detectors while present on most maritime vessels must be able to detect the threat covering its area. The placement of such sensors has become of increasing importance as a number of military forces have looked into the best combination of sensor placement to be able to detect a threat in the vast majority of instances.

9. CONCLUSIONS

UAVs are now commonplace in the battlefield for surveillance and intelligence gathering, and are increasingly being adapted to carry weapons. A number of non-state actors have taken advantage of this technology, using UAVs to deliver a CBRNe payload.

The combined effect of a CBRNe weapon and an UAV as a delivery method have already been used by non-state actors. UAV technology is becoming more advanced and more readily available.

Countering UAV technology requires solutions that will be effective over a wide range of circumstances in order to be effective on-board a vessel.

Advances in technology have been seen in the soft and hard kill categories over the past few years, with the US military organising events to test solutions to the ever expanding problem. UAVs armed with a CBRNe payload may require a new tactical angle to remove the threat as the dispersion of the payload too close to the vessel would have the intended outcome of the assailant.

As well as the development of soft and hard kill technologies it is important that the placement of sensors on vessels are intelligently chosen if a CBRNe threat has been released with or without the knowledge of the crew. Ensuring these sensors cover the area of the boat will help to save lives and the cost of a decontamination operation.

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