Unmanned Ambitions

Security implications of growing proliferation in emerging military drone markets

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1. Executive Summary

Unmanned military systems have become commonplace in the arsenals of armed forces all around the globe. With the weaponisation of unmanned aerial vehicles (UAVs), commonly known as drones, States, and non-state actors, have gained a deadly new tool for the use of lethal force, in and outside of the battlefield. The unique capabilities of drones facilitate better intelligence gathering, surveillance, target acquisition, and reconnaissance (ISTAR) and improve situational awareness for militaries. At the same time, armed drones are extensively used for close-air support in conflicts and clandestine targeted killing operations outside conflict zones, raising grave concerns among human rights organisations, survivors of drone strikes, UN Special Rapporteurs and national parliaments about the lowered threshold for the use of force, and the potential for setting an alarming precedent of extrajudicial executions The perceived low risks of deploying drones has, to date, lead to a number of cross-border incidents that on some occasions have escalated and triggered the use of lethal force. At the time of writing, over 90 States are in possession of military drones, 24 have armed versions, and we have witnessed the use of armed drones in 13 countries. What will the future of warfare look like with the steadily growing proliferation and use of military drones, and what does this mean for the control of arms exports? This report seeks to address these questions by looking at emerging drone industries and the resulting implications for proliferation, security and international arms control mechanisms.

In recent years, drones in all shapes and sizes have entered into use, and defence industries have boosted their investments in research and development for both platforms and payload. Of the currently 450 drone manufacturers globally, two-thirds are working on military drones in the hope to gain a substantial slice of the drone market, projected to be worth US$21 billion by 2021. The current market for sophisticated high-tech military drones continues to be dominated by the United States, Israel and China, but other States are stepping up their game in the development of military drones quickly. There is a growing interest among armed forces, particularly in the middle and lower segment range of drones, which are not dependent on complex satellite systems but can still play an effective role in military operations through both ISTAR and targeted strike capability, as smaller lethal payloads are developed for handheld drones. Countries like Iran, Turkey, Ukraine, Pakistan and South Africa each have made strides to capture a specific segment of the military drone market, while defence industries from Latin-America, Eastern Europe and Asia are also catching up to this segment of the market. This report has identified 21 States producing over 60 different types of military drones in the middle and lower segments of drone technology, based on research from open-sources, business

promotion materials and drone expositions. This list is far from exhaustive, and more types and technological developments are to be expected.

The pressing question now is this: who will develop the AK-47 version of the drone? A version that is cheap and easy to produce and operate, and that can be used by a wide range of State and non-state actors. Combined with near-future developments such as swarming technology, cheaper production materials, longer endurance capabilities, autonomy and miniaturisation, the battlefield could witness a significant change in warfare tactics and methods, including the need for counter-drone technologies.

Further exacerbating this growing precarity is the fact that militant non-state actors are quick to realize the benefits of drones as a militarily advantageous tool. Reports highlighting how hostile groups harness the potential of cheap, over-the-counter technologies to build their own systems, capable of reconnaissance as well as armed attacks in Iraq, Syria, Yemen, Israel and Ukraine indicate that this trend is likely to continue with greater frequency. Recent accounts of armed drone use by Mexican drug cartels, as well as the use of a drone for an attempted assassination of the Venezuelan president in August 2018 underscore this concern further.

The implications of the growing use and proliferation of military drones have been tackled at various national and international levels. Resolutions were passed in national parliaments, the European Parliament and at the NATO parliamentary assembly, while UN institutions and Special Rapporteurs have produced reports that address the legal implications and proliferation concerns. At the same time, initiatives such as the US-led Joint Declaration on Armed UAVs have garnered some attention, yet have so far failed to effectively address criticisms raised by the aforementioned actors and human rights groups. The concern is, that policy will continue to lag ever further behind practice, and that this may lead to greater levels of human rights violations through targeted killings with armed drones. This, in turn, would undermine regional stability, as cross-border tensions may rise with drone misuse, and the potential for non-state actors to acquire drone technology will almost certainly increase. Addressing the concerns over the increased proliferation and use of dual-use of military drone technologies requires a joint, multi-lateral effort by states, industry and civil society to strengthen export controls and prevent misuse. PAX, therefore, drafted a set of recommendations for states, international organisations and civil society working toward an effective framework to address this pressing issue.♦

2. Introduction

When the United States (US) launched their first Hellfire missile from an MQ-9 unmanned aerial vehicle (UAV) in October 2001, a new path for the use of remote lethal force was forged. UAVs, more commonly known as drones, have since changed the way wars are fought considerably. Although remote control technology had existed for decades prior to 2001, it was primarily used for target practice and intelligence gathering. The drone's ability to loiter over a territory for an extended period of time, paired with strike capacity, gave armed forces a unique set of tools and capabilities. Once this added value was recognised, drones of all shapes and sizes became a must-have technology and were sought to be integrated in military operations across the globe. Today, military drones give armed forces considerable advantages with their capacity for increased situational awareness, data collection, target designation and strike capability. However, the drone soon acquired notoriety as a deadly tool in the Central Intelligence Agency's (CIA) operations to hunt down and kill suspected terrorists in territories outside of official theatres of US wars, including Pakistan, Somalia and Yemen. Scores of civilians have been killed in CIA strikes, and many more have been wounded or displaced, causing outrage and prompting vigorous debates over the legality and effectiveness of lethal drones strikes.[1]

2.1 Dangerous developments

The many benefits drones offer for military operations, and the increased interest in using them has spurred investment from the defence industry in drones and related technologies and has led to the development and application of a diverse set of drones for and by militaries across the globe. More than 90 states are currently estimated to have acquired military drones, ranging from small portable Nano drones that provide nimble access to tight, inhospitable spaces, to much larger drones technologies the size of a passenger plane, which carry high-tech sensors for surveillance and are capable of loitering for extended periods of time. Armed non-state actors and terrorist groups have by now taken advantage of drone technologies for their own purposes, improvising with commercial or military platforms equipped with explosives, as Hezbollah demonstrated as early as 2006.[2] It was so-called Islamic State which refined and exploited the full potential of the technology by using cheap, off-the-shelf commercial drones to shoot propaganda videos and later on equipped them with small home-made munitions for terror attacks. Other armed groups in Syria and Iraq and even the Iraqi army followed suit in utilising and modifying commercial drones for armed use. This, in turn, has prompted a number of counter-drone measures by armed forces to provide security from this new threat.[3] We are still at the beginning of what will be a rapid drone and counter-drone development, however, it is clear that both, states and non-state actors will continue to invest heavily in this new technology.

The use of armed drones, in particular for targeted killings outside the traditional battle field by the US, signalled a worrisome trends, which has been criticised by human rights groups, drone strike survivors, Unites Nations Special Rapporteurs and states alike.[4] A main area of critique is that the practice of extra-judiciary killing of individuals could set a precedent for other states to follow if there is no strong push-back by the international community. With numerous drone strikes occurring outside of the remit of traditional battlefields, shrouded in secrecy and vague policies, drone wars, which is a disturbing dimension of contemporary warfare that should be challenged. Victims of drone strikes have consistently appealed for justice, transparency, accountability and reparations, yet their calls were largely met with silence.[5] Such a practice should not become a norm and needs to be called into question by as many vocal advocates as possible.[6] To let such a norm stand would mean to remove barriers for other states to use lethal force outside the battlefield, with little to no measures for accountability. Moreover, unrestricted use of drones outside the battlefield may also result in more cross-border drone operations and an escalation of force.[7] Critics highlight that the riskless nature of drone warfare may lower the threshold for states to use force in combating the rise of armed non-state groups and incentivise states to use armed drones as a show of strength to their constituencies. However, research has clearly shown that drones are at most 'weak substitutes for traditional counter-insurgency' methods and fail to adequately address the wider socio-political issues that provide fertile grounds for armed groups to thrive on.[8] This narrow focus on technological solutions for tactical military success reveals a type of techno-fetishism in lieu of a more comprehensive strategic approach to dealing with security threats.[9]

The trend toward an increased use of military drones, the advent of swarm technology, the production of ever-smaller drones, easier access to cheap drone technology, a pronounced interest by non-state actors and terrorist groups to use lethal drone technology and an unwavering commitment to high investment in developing new drone technology calls for an urgent and serious multilateral engagement on how we establish adequate norms and best practice for the production, acquisition and use of drones. Ongoing debates within UN forums and other expert groups are becoming more focused on working toward solutions to proliferation and export control issues, as well as the security challenges that will arise from increased production and use.[10] This is a productive step forward, however, there is more to be done, still.

2.2 Structure

This report focuses on the role emerging drone producing countries are likely to play in global markets and the security and export control challenges that will arise from their contribution to global drone proliferation. Our research is based on a wide range of sources, including media reports, open source documentation, defence industry market reports, research papers from think tanks and other expert groups, attendance of major defence industry shows and product specification and information from manufacturers. The report is structured in seven parts. The first section offers a general overview of current drone capabilities, relevant markets and major producers. In the second section, we focus specifically on military capabilities and uses. Chapter four provides a brief overview of the key emerging markets for drone production. This is followed by a discussion of existing international export controls for drones and drone technology. The report is brought to a close with a look to the future and discusses what developments in drone technology will likely be on the horizon and what security implications this might have. Finally, we issue a set of recommendations in conclusion.♦

3. Drone Capabilities and Markets

Drone use has become ubiquitous. They range from small, inexpensive models, primarily aimed at hobbyists and enthusiasts, to large, complex systems, operated by first-tier military organisations and can broadly be classified by 'user', 'purpose' and 'physical and technical characteristics'. Drones serve an ever-increasing range of applications in modern society. Drone users include hobbyists, commercial organisations (the range of uses here is potentially endless, from the energy sector, to agriculture, security, media, entertainment, insurance industries, telecommunications, mining and others), government agencies (infrastructural agencies, transport, border/internal security, emergency services and others), academia and, of course, military and intelligence organisations. This is not an exhaustive list, and as new and affordable drone technologies emerge on the market, the list of possible users expands accordingly.

The number of uses to which drones can be put is as extensive as their potential users, from artistic photography, to wildlife monitoring, to the delivery of goods, to crowd control measures by police, among many other uses. In military contexts, the purpose for most drones is intelligence gathering, reconnaissance, surveillance, target acquisition and/or identifying decoys or booby traps. Determining the purpose of a given system may be meaningful for certain purpose-built drones (aerial video drones or delivery drones, for example). However, many drone systems may be used for a variety of purposes and most components for a drone system can be utilised in a multitude of ways. For example, an infrared camera could be used to identify and track an enemy combatant, or it could be used to identify environmental soil damage.

Finally, drones may be classified according to their specific physical and technical characteristics. This includes distinguishable features such as size, weight, control surfaces, and means of lift (e.g. rotary wing vs. fixed wing), but it also includes those elements that may not be immediately obvious: power source (e.g. battery vs. solid or liquid fuel), means of propulsion (e.g. jet engine vs. motor), speed, agility, internal payload size, maximum range, method and distance of communications, means of remote control, level of autonomy, sensors, and so on. How these different aspects are combined is unique to any given model and provides a useful technical description of a drone and its capabilities.

3.1 Growing markets for commercial and military drones

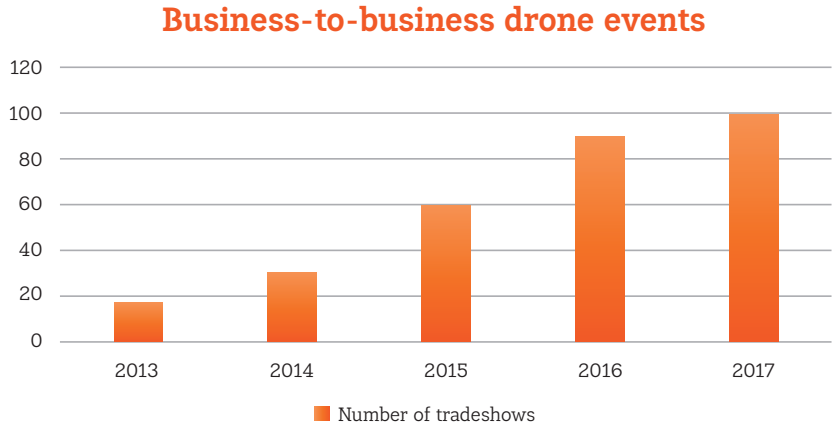
The current global drone production market can be divided into commercial manufacturers and military manufacturers. Commercial manufacturers develop and produce drones primarily for commercial purposes, with the largest manufacturers located in China, France, Israel and the US.[11] However, while some of these manufacturers produce their drones exclusively for industrial and non-military applications, significant capital is often made available by government bodies (usually defence organisations) to commercial manufacturers for research and development, so that there is a considerable overlap in commercial and military applications of the drones developed. Drone manufacturers are keen to capitalise on the tremendous size and value of the military market for drones and a growing number of commercial producers have begun to entirely or primarily develop technologies for the defence market. According to UAV Global, in January 2018, there were over 450 known manufacturers, 300 of which were working on military drones.[12]

Nonetheless, the civilian drone market remains financially significant. A 2015 market research report forecast global sales of commercial drones to reach US$5bn by 2021.[13] [14] The US is predicted to lead this development with 1.4 million commercial drones expected to be deployed by 2025. Chinese firms are also prominent in the civil drone segment, with Da-Jiang Innovations Science and Technology Co. Ltd (DJI) as a leading producer of small, hobby drone technologies. Commercial sector drones, including for the agricultural sector, are also set to grow within the EU. Due to a more restrictive legislative framework, this development is somewhat hampered, yet not enough to prevent any significant growth in the near future.[15] The market for military drone technology is experiencing unfettered growth. This is spurred, on one hand, by the substantial increase in interest by the US military over the past two decades, historically driven by conflicts in Iraq and Afghanistan and now focused globally, and by a general trend towards information warfare and net-centric systems on the other. Net-centric warfare entails a more data-driven approach in which armed or strike-enabled drones are part of a wider electronic network of military systems capable of processing large amounts of data collected by sensors, satellites and information sources. This data is then incorporated into analyses and decision-making. For the Fiscal Year (FY) 2019 budget, the US Department of Defense (DoD) has requested approximately US$9.39 billion for unmanned systems and associated technologies. This proposal includes funding for the procurement of 3,447 new air, ground, and sea drones. The FY 2019 budget proposal represents a significant expansion in drone spending compared to the FY 2018 budget proposal, which requested approximately US$7.5 billion for drone-related spending and orders for 807 drones.[16] A 2017 report produced by the defence market analysts Teal Group indicated that sales for military drones are expected to follow recent patterns of high-tech arms procurement worldwide, with the US as the market leader, followed by the Asia-Pacific area and then Europe.[17]

A visible and tangible indicator of increased interest in both military and commercial drone systems is the growing presence of, and focus on, drones at trade shows, expositions and conferences of national and international importance. A review of commercial business-to-business events identified 17 drone events in 2013. This number increased to 30 in 2014 and then doubled in 2015 to 60. In 2016 there were 90 such events and over 100 in 2017.[18] At the time of writing this report, there have already been more than 100 drone events confirmed for 2018.[19] This does not include the numerous tradeshows and events that focus more broadly on defence and security products and at which there has been a similar increase in the prominence of drone technology as a feature.

The latest locally made MALE Unmanned Aircraft System is displayed during the 2017 Taipei Aerospace and Defense Technology Exhibition at the World Trade Center in Taipei on August 16, 2017. Around 140 local and international exhibitors, including Taiwan's defence ministry, took part in the three-day exhibition.

It is important to note, however, that manufacturers tend to showcase their full range of products at such tradeshows, even those that are still 'in development', so as to increase their market presence. This means that a fair number of advanced, autonomous systems may well never be deployed in a real-world context.[20] Nonetheless, advances made in developing the more fanciful systems may well flow into a range of successor systems or into other technical areas.[21]



3.2 Market leaders

At present, the US is market leader in the production of military UAVs, followed by Israel. China, in contrast, leads the market for the production of non-military drones, which are increasingly used for non-civilian applications as well. US DoD fleet size projections show a steady growth of around four per cent per annum. This includes the entire drone fleet across naval, land and air domains. If these projections continue to be met, drones are poised to account for approximately half of all US military aircrafts by 2035 (not including the 'optionally-

piloted' systems). In addition, in an attempt to maintain foothold on the armed drone market, the US has recently loosened the rules for drone exports, making it easier for US companies to directly sell armed drones to a wider range of willing buyers. In contrast, under the Obama administration, only a limited selection of like-minded countries was able to gain access to armed US drones, including a selection of European countries.[22] The European military drone fleet is also forecast to grow by approximately four per cent annually, set to make up more than a third of European military aircrafts by 2050, with a total of 3,000 drones to the fleet.

The largest exporter of military drones to date is Israel, which sells its technologies to recipients in China, India and the UK, among others. It is estimated that between 2010 and 2014, Israel exported approximately 165 drones to countries abroad. The US comes in at a close second, with 132 exports of its drone systems.[23] China is quickly catching up to the market leaders as it has a strong record in exporting defence technologies and is likely to become an influential player on the global market for drone developments in the future.[24] The country's willingness to sell its technologies with fewer restrictions and at a lower price will contribute significantly to the trend of increased global proliferation and use of military drones by smaller countries and less powerful militaries. However, as a relative newcomer to the military drone market, China has yet to build a reputation and prove its worth as a relevant supplier of drone technology, and it is possible that the lower price point for its systems might be perceived as a compromise in quality and reliability. To date, none of the leading militaries have taken up Chinese drone technologies and neither the US nor Israel have experienced an impact on their business by the new market entrant.[25] Nonetheless, the leading producers and exporters are alert to the fact that China has a strong track record in the defence sector and it is likely that their drone products will proliferate over time.

Estimates suggest that 78 countries are currently using drones solely for intelligence, surveillance and reconnaissance (ISR) purposes, while at least 14 countries are reported to have used armed drones at the time of writing.[1] Another 10 countries have companies or armed forces that have acquired, displayed, developed, or ran test-flights of armed drones.[26] This number is growing steadily. Italy was granted permission by the US to arm its fleet of MQ-9 Reaper drones; Morocco recently procured three Israeli Heron /Harfang drones from France; and Chinese Wing Loong II drones have reportedly been sold to buyers in the United Arab Emirates (UAE), Saudi Arabia, Egypt, Kazakhstan, Myanmar and Pakistan, with the option to be armed.[27] In Europe, Germany has recently signed a leasing contract for the Israeli Heron TP drone system, while Belgium and The Netherlands are each in the process of acquiring MQ-9 Reaper systems. Russia, while working on a weapons-capable drone prototype, has not yet accepted an armed drone into general service, although the country is rumoured to have armed some of their drones in an ad hoc fashion in the past.[28] According to the New America Foundation, nine countries have repeatedly used armed drones in combat: Azerbaijan, Iran, Iraq, Israel, Nigeria, Pakistan, Turkey, the United Kingdom and the US. In addition, there are unconfirmed reports that the UAE are operating armed Wing Loong drones in Libya and Yemen.[29] [30] Moreover, there are at least 26 countries involved in developing or manufacturing indigenous armed drone capabilities, including North Korea, Russia and Saudi Arabia.[31]

[1] The New America Foundation puts the figure at 28, but this number includes countries participating in the nEUROn UCAV project, which is an experimental 'technology demonstrator'.

It is worthwhile to note that not all large-scale users of drone technologies are also manufacturers. According to data published by the Stockholm International Peace Research Institute (SIPRI), between 2010 and 2014, the UK was the largest importer of drone systems, having acquired 55 drones from Israel and six from the US. The US permitted sales of their armed systems, such as the MQ1 Predator and the MQ9 Reaper, to other countries only in 2015. Since then, General Atomics' combat proven Reaper drones have been sold to the UK, Italy, Spain, The Netherlands and France. However, only France, Italy and the UK are presently permitted to arm their MQ9 Reaper fleet for combat. Interest in acquiring the system[32], and in arming existing acquisitions by other nations is high.[33]

Armed non-state actors have only limited capacities to acquire military-grade drone technology from major producers and often modify drones produced by commercial manufacturers, often taking a creative approach to construct a Do-It-Yourself (DIY) drone from whichever scraps, surplus materials and other parts they are able to acquire on open or black markets. A range of eclectic materials have been found in an abandoned drone workshop of so-called Islamic State, including fuselages and Styrofoam wings; cheap commercially-available quad-copters that were gutted for their batteries and cameras and a gyroscope, usually intended for a domestic market, indicating that this might have been used as a make-shift navigation tool.[34]

Commercial drones have been used to transport contraband and illegal goods.[35] In conflict zones, they are weaponised with relative ease, by strapping an explosive device onto it or modified conventional munitions, to be guided to a designated location.[36] On January 6th 2018, the Russian Defence Ministry announced that it had been targeted by Syrian armed groups, who had launched an attack on a Russian airfield and a further attack on a Naval CSS point, by a swarm of 13 DIY drones. Each appeared to have been constructed from a small engine, cheap plywood, equipped with a number of small rockets. The makeshift drones had a range of over 50 km, utilising GPS♦ guidance.[37] ♦

Presentation of DIY build drones used by Syrian armed group for attack on Russian Air Force stationed at Latakia Air Base, Syria, 2018.

4. Developments in Military Drone Production

The use of drones has become pervasive in most modern armies, and drones are increasingly deployed and used at lower organisational levels than early unmanned systems were. Drones in current military service range from highly complex and expensive systems to comparatively economical 'disposable' technologies, and vary considerably in design to reflect this range of capabilities. Smaller drones can be hand-held and battery powered, while other portable systems might be powered by multiple smaller rotors, such as quad-copters, or be rail/tube-launched with a fixed wing design. Larger drones have a wingspan of many metres and require a more expansive clearing, such as a runway, unless they utilise vertical take-off.

Unsurprisingly, the use of drones has transformed the way in which military operations are planned and executed, giving commanders an array of new tools that have the capacity to increase their chances of success considerably. An obvious benefit of drones is that fewer military personnel need to be placed directly in harm's way. Moreover, drones offer a lower-cost alternative to operating manned combat aircrafts. In most cases, the cost of training and supporting an individual is more expensive than procuring and maintaining a drone; if the system replaces numerous personnel, savings increase accordingly. For example, a 2012 assessment gave an estimated cost per hour of flight for a USAF MQ-9 Reaper drone as US$3,250, compared to an estimated US$16,500 for an F-35 Joint Strike Fighter.[38] Nonetheless, the costs of using drones can easily add up as real-time analysis of images, data collection and evaluation, and more frequent and longer deployment times drive up drone-related expenses incrementally.

In many cases, drones can help reduce the risk of mission as a smaller, potentially quieter drone might be able to replace a far larger and more conspicuous airframe (manned or unmanned). Drones have proven to be an excellent means for reconnaissance missions, able to more easily infiltrate dangerous locations and difficult terrain. As more efficient power sources are developed, drones will be able to travel ever-further and loiter for ever-longer periods of time, increasing the overall range far past human capacity – where a human would begin to show fatigue and deteriorate in performance, the drone system can continue the task with no detriment to its performance.[39] Combined with a typically faster speed of deployment, drones

make for an attractive option for a number of information-gathering missions. In many of the conflicts involving Western countries, the balance of power is asymmetric, with one side holding significantly more capabilities than the other. As a result, lowering total mission cost has been a point of considerable interest to professional armed forces and policymakers.

However, there is potential for drones, armed or otherwise, to be utilised in a contested environment, where all parties are relatively equally matched. The current conflict in Syria has provided an example where, in June 2017, a US Air Force F-15 fighter aircraft shot down two Iranian Shaheed129 combat drones; another Iranian drone was destroyed over Pakistan by a JF-17 multirole combat aircraft. These examples highlight the vulnerability of modern drones to conventional airpower, and show that consideration needs to be given to protecting such assets during flight. As early as 2002, Predator drones were being equipped by the United States with air-to-air missiles for self-defence in southern Iraq, however this experiment was short-lived due to poor results[40], and it is unclear whether this was continued or replicated with other drones. US drone development continued to focus on how best to utilise the limited payload capacity of the aircraft, opting for greater ground-attack capability and accepting that any direct air-to-air engagement would be rare. Over a decade later, efforts are still underway to give drones the capability to engage in air-to-air combat, as a number of ongoing projects, such as the nEUROn drone (EU), the Taranis (UK), the X-47B (US), Sharp Sword (China) and the AR-10 (Russia), demonstrate. Moreover, the US has recently disclosed that it has entered into contracted the equipment of its MQ-9 Reaper with air-to-air missile capability.[41]

Autonomy and Automation in drones

More advanced drone systems are frequently related to the concepts of automation and autonomy. Often the terms are conflated or read as synonymous. There is, however a significant difference in these two terms. Automation requires that a human operator decide the course of action for the drone system. With automated systems, a human is always in the loop, tracking the course and making the decision for action, supervising the process throughout. Autonomy in weapons systems is notoriously difficult to define, with a number of stages of autonomy in place within existing systems, from semi-supervised autonomy, in which the systems follows an adaptable-rule based logic, usually within a controlled environment, where a human exerts some form of control and remains on-the-loop, to unsupervised, systems where human operators no longer control the decision-making process, or is out of the loop. Full autonomy would mean that the drone system decides and acts independently from human decision making, whereby the human leaves a certain course of action entirely to a system. This would, however, require a very sophisticated, artificially intelligent system, capable of operating in a complex, open environment. Such systems are not yet in operation.

As technologies become increasingly independent from human determination, we are moving toward greater levels of autonomy in drone systems. Systems like the UK's Taranis, which is designed to be able to operate without human

control for an extended period of time are the heralds of future systems in which the drone system decides on a specific action without human interference, in other words without a human in or on the loop. Whilst most drones contain some level of autonomous decision capability for minor courses of actions, current systems are, however, best described as automated systems in which the human remains in the loop.

Whether full autonomy for drone systems (or indeed any unmanned system) should be permitted is a highly controversial and fiercely debated topic. Most would agree that some adequate form of human control should always be required for weapons systems capable of causing death or inflicting pain and suffering. However, as technologies for target identification and information analysis become more sophisticated, this may change. And it remains to be seen if the human can meaningfully intervene or exert supervisory control over systems that possess far greater and faster processing power than a human has. For missile defence systems, for example, for which speed of reaction is critical, programmable equipment is already understood to outperform human operators under some conditions.[42]

4.1 Drones on the battlefield

Currently, drones primarily fulfil intelligence, surveillance, target acquisition and reconnaissance (ISTAR) functions. This involves the use of various sensors, such as infrared, radar, radio frequencies, thermographic, and sound, to gather information about the target territory, local conditions and possible targets, including individuals. There are two types of drone systems that are used for longer periods of surveillance (typically 24 and over): the Medium-Altitude, Long-Endurance (MALE) drone and the High-Altitude, Long-Endurance (HALE) drone. MALE drone systems usually have a top altitude of between 25,000 and 50,00 feet and can loiter for up to 24 hours. HALE systems, as the name suggests, may fly as high as 60,000 feet and can last as long as 32 hours. However, these are not strict parameters, as the Predator-B, for example, is considered a MALE drone even though it is advertised as having an endurance of 27 hours. This type of classification for drone technology emerged through their primary use as ISTAR platforms, nonetheless, as the primary mission purpose for drones changes over time, the classification system might adapt as well.

Beyond ISTAR capabilities, drones may be used for further actions, including targeting. Once a target has been identified, the system may be used to loiter to monitor the targets' movements and gather further intelligence. For this, the drone either stays in the air in a holding pattern, or hovers, if its capabilities permit this. Once a targeting decision is made, the operator may engage the target using an on-board weapon system, or, if the warhead is integrated into to the drone itself[43], it could manoeuvre itself towards the target and explode the munitions upon impact, in a 'sacrificial mission' (see below). In some cases, a drone may also be used to conduct an electronic attack, jamming an enemy's detection capability, or designating targets for artillery on a position in order to provide support to troops on the ground.

4.2 Loitering munitions

Loitering munitions, sometimes improperly referred to as 'suicide drone'[44], are widely considered a subset of drones which fill the capability gap between conventional guided munitions and unmanned aviation – in other words, the drone is also the missile. Equipped with infrared cameras and high-res electronic optical sensors, they are designed to remain over a predetermined area for a given period of time (typically measured in hours) before engaging a target and detonating on impact. Although any drone could have an explosive charge attached to it and be utilised in a sacrificial mission (indeed, this has been evidenced by the use of cheap off-the-shelf commercial quad-copters for this purpose), purpose-built loitering munitions tend to have some common characteristics. These include an integral warhead, in-flight controls and on-board sensors, as well as limited or non-existent recovery systems. However, it is not clear that such features will remain diagnostic in the future, as this category of hybrid drone-munitions is rapidly evolving. The size and weight of loitering munitions is comparatively small allowing for portability. This gives ground forces, including infantry, an ability to engage targets with more precision than other munitions. Loitering munitions may contribute to reducing collateral damage by introducing smart targeting, however, as industry development moves toward greater autonomy, the question of human supervision and control for lethal action looms large. The Harpy drone, for example, was designed to include a self-navigating targeting system for enemy radars. Some experts argue against classifying loitering munitions as drones, as they do not have recovery capability, yet for arms export controls, there is a case to be made to include them in the broader drone category, as the platform used to carry the explosives performs exactly like an unmanned system, including flight guidance, propulsion, materials and navigation. The only aspect missing is a landing function.

Poland's loitering munitions called 'Warmate'.

Different types of warhead for the 'Warmate'.

4.3 Other uses

There are a number of other ways in which drone systems can be used in military operations, including their use as a sacrificial decoy, where the drone generates bogus signals so as to confuse the enemy. They may also see use in search and rescue missions, where advanced sensors are used to locate missing persons. The uses listed above are not exhaustive and as the capabilities of drone technologies improve, the range of tasks will likely expand to include a wider range of mission options.

As highlighted earlier, drones comprise an increasingly larger proportion of many militaries' aircraft fleets. It is unlikely that manned aircraft will become completely obsolete any time soon, but the relatively elaborate safety and training requirements may render them a less attractive option for many tasks in military operations. A critical advantage provided by drones is the ability to see Beyond Visual Line of Sight (BVLOS), and as communication systems improve, this is likely to be leveraged further, overcoming problems with lost links procedures, spectrum management, and detect and avoid systems.[45]

Notable in this development is the advent of ever-smaller systems. Nano drones, such as the Black Hornet, are small enough to fit in a pocket and can be operated by personnel without specialist training. Micro drones[46], roughly the size of a quad-copter, are increasingly prevalent and are rapidly becoming more affordable, effective, and robust enough to withstand use in combat or field conditions. The ability of smaller drone systems to 'peek' around corners or over walls has immediate and obvious benefits, and small unit tactics are already adjusting quickly to exploit this advantage.

Another crucial development in drone technology is the use of algorithmic information architectures. Machine learning, combined with critical data generated from interconnected sensors and 'big data' analysis will steadily enhance the speed and effectiveness of drone use. Google has been contracted by US DoD (under protest of many employees) to develop artificial intelligence for a more efficient analysis of drone footage, as part of the Algorithmic Warfare Cross-Functional Team, also known as 'Project Maven'. Newer unmanned combat aircraft are already in development and are integrating systems architectures to take advantage of cutting edge developments in sensors and data sharing. It is likely that a future where troops on the ground are supported by drones in ways identical to manned fighter jets is on the not-too-distant horizon. However, there is an understandable reluctance toward embracing drone technology as a substitute for manned support, as concerns about bias, a perceived risk of fratricide and a scepticism toward drones as able to withstand modern air defence systems (due to a limited ability to evade radar, a lack of counter-measures and limited manoeuvrability) continue to be prevalent.[47]

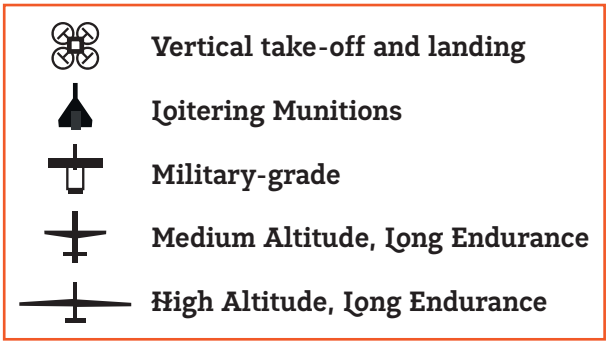
As drone technologies develop with unprecedented speed, so do counter-drone defence systems. There are now over 230 counter-UAV products, produced in 33 different countries.[48] Some existing countermeasures include radar-based detection systems (e.g. Obsidian), laser-based directed-energy weapons (e.g. Dragonfire), non-kinetic radio frequency disruption (e.g. DroneDefender), nets (e.g. Skywall), electronic countermeasures (e.g. Drone Shield and Avtobaza), and even animals (such as birds of prey).[49]

Advances in drone technology are already providing additional benefits for other military systems. As unmanned aerial technologies develop, unmanned land, sea, and sub-sea systems are also likely to proliferate, and practice and doctrine will follow suit. For example, there is now a focus on Unmanned Underwater Vehicles (UUV), where automated vehicles could execute tasks such as extending the effective range of sensors or weapons, act as mine countermeasures or even serve as decoys. According to a 2016 US Naval Institute news report, Commander of US Submarine Force Pacific Rear, Admiral Fritz Roegge, declared that the US Navy would have a functioning UUV squadron by 2019.[50] ♦

5. Emerging Drone Markets

While the current UAV market is dominated by large aerospace companies in China, France, İsrael and the US, there are a number of new states entering into the market for drone production and distribution. This new area of growth is likely to challenge the dominance of traditional drone producers, and further increase the speed of drone proliferation. İn this report, we focus on a number of new producers in emerging drone markets that have demonstrated the will and capability to accommodate the growing demand for military drones. Most of these emerging drone producers aim to serve a specific segment of the market by manufacturing small and medium type drones, which have the capacity to be armed and can be operated without a high-tech infrastructure. There are a number of reasons potential buyers might look to non-traditional manufacturers for their future drone acquisitions. An expanding network of drone manufacturers also means less dependency on only a handful of providers. Where buyers acquire systems from the US, for example, they also acquire interoperability with the entire technologies that constitute the drone network. Those buyers seeking to remain independent from the main manufacturers, will likely look to new markets to circumvent being beholden to a specific network. Moreover, countries that fall short of meeting export restrictions requirements for drone acquisition from leading producers are likely to look elsewhere to have their needs met. China is currently one of the major exporters of armed versions of medium and larger type of military drones, and has sold them to at least five states in the Middle East and North Africa, and a number of other states in East and Central Asia. Critically, China is currently not part of any existing arms export control agreement that covers military drones.

In our research, we have come across various emerging producers which have developed, or are developing, a multitude of different types of drones. In order to easily differentiate between these various types of drones we will use separate categories. These categories will be applied when discussing each development of a drone producing state.



The icons on the right depict the five categories of drones that the countries discussed below have developed or are developing. These categories are not discrete, but are intended to give a better overview of the scale of capabilities for each country.

‘Vertical take-off and landing’ refers to both quadcopters, including militarised versions of quadcopters available to consumers, and rotary wing drones. ‘Loitering munitions’, indicates those drones that are designed to directly crash into targets, as detailed in section 3. ‘Military-grade’ denotes those drones that are not available to the public but are commonly used by militaries for ISTAR missions and, sometimes, for the destruction of targets through the use of projectiles. ‘Medium Altitude, Long Endurance’ (MALE) drones, are the category of drones that can carry out the tasks described in section 3, operating for over 24 hours, at altitudes of above 10,000 and up to 30,000 feet. Lastly, ‘High Altitude, Long Endurance’ (HALE) drones are those capable of reaching altitudes above 30,000 feet for up to 32 hours, and are mostly used for intelligence, surveillance and reconnaissance.

5.1 İndia

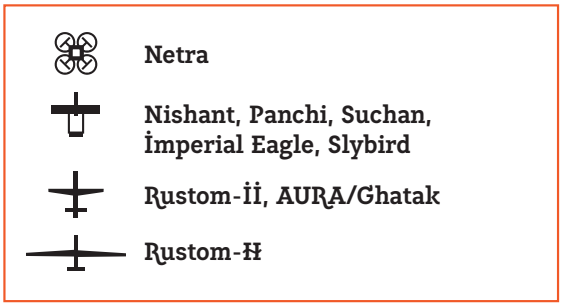
INDUSTRY OVERVIEW

Initially, India’s experience in developing drones was limited to its own line of targeting drones, and the country had acquired Israeli-made UAVs before starting its own development processes. In 2016, India’s Ministry of Defence finalised a plan to acquire over 5000 UAVs, including VTOL, tactical, MALE and HALE drones within a decade for about 3 billion US dollars. However, drone development programs in India have suffered delays for several reasons, such as “technological difficulties faced due to complexities of engine system, non-availability of raw materials, critical components, lack of infrastructure, manufacturing and test facilities within the country” and a lack of skilled manpower.[51] Despite these restrictions, Indian companies such as the Defence Research & Development Organisation (DRDO) have successfully developed several drones, though they are mostly limited to the small and medium categories.

The Rustom-1 UAV at Republic Day Parade 2012

CAPABILITIES

The Nishant, Panchi, Suchan, Slybird and Imperial Eagle are all unarmed tactical drones, of which the Netra and Imperial Eagle have been the most successful. Both fully autonomous, the Imperial Eagle is launched by hand while the Netra is a quadcopter taking off vertically. [52]



DRDO is also supposedly working on delivering both HALE and MALE versions. The MALE version, the Rustom-II successfully flown in February 2018, carries intelligence equipment and sensors, and can reportedly only operate within line of sight ranges of 250 km.[53] The Rustom-H, developed after the Indian navy announced its interest in a HALE maritime UAV, was supposed to fly in 2014, but only a model has been revealed to the public so far. [54] The status of the HALE drone is unclear but in 2017, India purchased 22 US-made Guardians (maritime versions of the MQ-9 Reaper). Lastly, other ambitious plans include a solar-powered drone and the AURA/Ghatak, an autonomous tactical stealth aircraft, which is being developed by Indian firms and expected to have a flying prototype by 2023. [55]

USE

Due to lack of capability, India has not carried out any drone strikes so far. However, neighbouring countries Pakistan and China have reported incidents involving Indian surveillance drones. Since 2016, Pakistan has claimed on several occasions[56] to have shot down an "Indian spy drone".[57] In 2017, China expressed its "strong dissatisfaction" after an Indian drone crashed in their territory.[58]

5.2 İran

INDUSTRY OVERVIEW

Iran developed a number of first-generation drones during the Iran-Iraq War, including the Ababil and Mohajer. However, after the conflict ended in 1988, Iran was no longer able to procure weapons and equipment from its traditional allies, and began to develop its own indigenous defence sector.

Despite crippling international sanctions, government investment has been steady, and the range of drones now developed is significant, with a trend towards matching their Western counterparts in capability (e.g. MALE surveillance drones, armed combat drones, and stealth technology). Due to military action by hostile countries, Iran was able to capture a number of drones and use them to reverse engineer their technology; this included a US Sentinel RQ-170 in December 2011, and a US Scan Eagle in September 2013. As further proof of its commitment to developing militarised drones, Iran recently unveiled an air defence base specifically assigned to its drone fleet. A counter-drone weapon has been deployed from this post[59]; however, the base is possibly only a temporary installation.[60] Iran's drone development has been compounded by the work that the country has conducted in Syria, alongside Russia, and their respective industries are likely

to collaborate in the future.[61] If and when formal sanctions and embargoes on Iran are lifted, its drone programmes are likely to be developed further. When combined with the political will to export military material, this may allow Iran to position itself as a more significant global supplier.

CAPABILITIES

The Iranian Air Force has two drones in active service, the Shahed-129 and the Ababil. The former is Iran's first MALE surveillance drone capable of carrying out reconnaissance and combat missions, with a claim of being able to mount up to eight missiles. This system is likely to have been copied off the US MQ-1 Predator. However, the Shahed's range is limited by low-grade communications and a lack of satcom. The Ababil series includes the Ababil-S medium-range reconnaissance and surveillance drone and the short- to medium-range Ababil-T attack drone.[62] Additional drones include the Mohadjer series, a range of tactical surveillance drones developed during the height of the Iran-Iraq war by the Qods Aviation Industry Company, that continue to be used by various branches of the Iranian military today.[63] Another notable development is the new Simorgh series, which includes the Saequel, including the armed Mohadjer-6, a long-range drone capable of carrying four precision-guided bombs, modelled on the US stealth RQ-170 Sentinel captured in 2011, and also the larger Shahed 171, which is jet powered and designed for reconnaissance missions.[64]

Current developments reportedly include the Karrar, a turbojet-propelled UAV capable of reconnaissance and strike missions, which is able to follow a preprogramed GPS navigation route. With five hardpoints to hang munitions on, it can carry multiple munitions configurations (e.g. a 500lb bomb, two 250 lb. bombs[65], or four anti-ship missiles[66]).

USE

Iran has routinely displayed its fleet of drones at exhibitions and in parades, and has been vocal about their capabilities, as a way to demonstrate their power to both their own population as well as the international community. The use of Iranian drones has been identified in various regional conflicts, including Turkey[67], Pakistan[68], the Persian Gulf[69], and Syria[70]. In the Syria

© AFP PHOTO / ATTA KENARE

Iranians walk past Iran's Shahed 129 drone displayed during celebrations in Tehran to mark the 37th anniversary of the Islamic revolution on February 11, 2016.

conflict, there has been evidence of close cooperation with Russia since 2013.[71] In February 2018, an Iranian drone was launched from Syria, allegedly into Israeli airspace, where it was destroyed. This prompted significant escalation in the region. In the domestic context, drones have been used for reconnaissance, surveillance, and target identification missions to support counterterrorism efforts in border areas,[72] for environmental protection[73], and for marine lifesaving missions[74].

5.3 Pakistan

INDUSTRY OVERVIEW

Burraq, Shahpar, Uqab, Satuma

Having actively sought to acquire foreign drones in the early 2000s, it wasn't until the mid-2000s that the Pakistani Air Force partnered with local industry to produce their own indigenous designs. This appears to have been driven by an understanding that the US would not export the MQ-1 Predator to Pakistan, citing technological security concerns. Pakistan turned to the Chinese market; however, they found that the alternative options did not meet the desired capability requirements. In 2015, Pakistan's first domestic drone development project was completed, and the Burraq was showcased.

Pakistani military personnel stand beside a drone on a transporter during a Pakistan Day military parade in Islamabad on March 23, 2017.

Pakistan has collaborated with Italian company Selex ES and Turkish Aerospace Industries (TAI) on drone production but it has also demonstrated evident indigenous capabilities. The country currently has two significant manufacturers, NESCOM and Satuma. NESCOM produces four variants of drones, including a combat UAV. Satuma produces a further seven, and offers an additional focus on training and target drones. Global Industrial Defence Solutions (GIDS) produces an additional four ISTAR models in service with the Pakistani armed forces.[7] GIDS are also considering developing a MALE variant of the Shahpar drone.[76] Finally, Integrated Dynamics produces a range of surveillance systems.

CAPABILITIES

The NESCOM Burraq is a combat drone armed with a laser-guided air-to-surface missile, capable of engaging moving and stationary targets. It also serves a secondary ISR role. It has been speculated that the Burraq may be a variant or development of the Chinese Rainbow CH-3 unmanned combat aerial vehicle.[77] Similarly, the GIDS Shahpar can be deployed for real-time reconnaissance and surveillance, monitoring, target acquisition, situational awareness, as well as disaster management missions. It also has automated guidance and tracking capacity, and automatic take-off and landing functions. The GIDS Uqab II is a tactical short-range system with an operational range of 150 km and a maximum altitude of 10,000 ft. It is fitted with a pan-tilt-zoom camera and can downlink digital video in real time. Uqab drones have GPS-based navigation and tracking systems that can be pre-programmed and altered during flight. They can also be operated in manual control and use conventional take-off and landing.[78]

USE

Most drones are used in counter-insurgency operations in the Federally Administered Tribal Areas, North-West Pakistan. In December 2017, the Pakistani Air Force was ordered to shoot down any drones that enter Pakistani airspace.[79] This action was unsurprising; twice that year they had shot down foreign drones, an Iranian drone in June[80] and an Indian drone in October.[81] Moreover, Pakistan's relationship with the US continued to deteriorate resulting in a reduction in the overall military presence in the area. On March 6th, 2018, another "Indian spy drone" was downed after entering Pakistani airspace.[82]

5.4 Russia

INDUSTRY OVERVIEW

Russia has historically developed militairy drones, but throughout the early and mid-2000's the military seemed relatively uninterested in them.[83] Russia's weakness in military drone capabilities was exposed during its conflict with Georgia in 2008, and Moscow subsequently launched a range of programmes to address its drone capabilities shortfall. Initially, domestic efforts yielded limited results and Russia turned to Israel for solutions. In 2009, Russia ordered a number of drones from Israel Aerospace Industries (IAI), including the BirdEye 400 mini-drone, eight I-View Mk 150 close-range tactical drones and two Searcher II long-endurance multirole drones for delivery in November 2010. In June 2012, the Russian government announced its plans to produce a range of unmanned air systems domestically, for which they entered into a joint venture with IAI to build UAV technologies within Russia[84]. This joint venture saw the production of the Forpost, a licensed Russian version of the Israeli Searcher II.[85] In parallel, Russia has also sought to develop its own MALE drone program.[86]

VRT300

Orlan, Navofchik-2, Granat, Korsat, Forpost, Eleron

Orion-E, Okhotnik-B, Altair, Altius-M

CAPABILITIES

To date, Russia's indigenous systems are primarily comprised of small, micro-tactical, and surveillance UAV, such as the Eleron and Orlan series, the Navodchik-2, the Korsar[87], the Granat, and vertical take-off rotary wing drones such as the VRT300.[88] Russia's forays into developing

MALE drone capabilities have thus far produced prototypes of the Altair and Altius-M drones.[89] Some sources also describe these systems as HALE systems, however, their exact capabilities are not known at this point. A further MALE UAV, the Orion-E, has undergone flight-testing and is expected to be ready for deployment by 2020.[90] Lastly, a 'heavy' stealth drone similar to the American X-47B, called the Okhotnik, is being developed by Sukhoi, a major Russian arms producer, and is also expected to enter in to service in 2020.[91] Nonetheless, despite Russia having showcased these drone systems during expos and military parades, not all have actually been seen in active deployment to date.

The Forpost UAV, Russia's licensed copy of the Israeli Searcher 2, at MAKS International Air Show in 2011.

USE

Russian tactical drones, like the Orlan and Eleron, have been spotted and shot down in both Syria[92], and the Ukraine[93]. Russian drone systems appear to be used mostly in Syria. In late 2017, the Russian Ministry of Defence reported it had deployed around 80 drones in Syria, for a total of 14,000 flights.[94] The majority of these flights were made by the "Orlan, Granat, Eleron and Taxion families", although the most widely deployed drone was the Forpost. Russia has also gained experience in counter-drone measures after Russian bases in Syria were attacked by drone swarms in early 2018.[95] Russia is reported to have found ways to jam and impede US drones in Syria.[96]

5.5 South-Africa

INDUSTRY OVERVIEW

South Africa has a long-standing history of developing drone technology. In the 1970's, the Council for Scientific and Industrial Research (CSIR), together with Kentron (now Denel Dynamics) developed Champion, a small, lightweight surveillance drone, which saw its first

Skunk

Seeker, Vulture

Viper 1000C, Bateleur

flight in 1977.[97] In 1987, the Seeker 1 system was operationally launched, followed by the Seeker II. During the Angolan War, these drones were used for tactical surveillance and artillery spotting missions, but after the conflict ended, the operating squadron was disbanded and further drone development slowed significantly. In the 1990s, Advanced Technologies and Engineering (ATE, now Paramount Advanced Technologies) introduced the ATE Vulture, a drone that could to be operated deep within bush territory without the need for a runway. [98]

An armed Seeker 400 drone, manufactured by South African company Denel Dynamics, flies over Cape Town Stadium, in 2014.

Despite South Africa's initial position as one of the first global leaders in the drone sector, two decades of reduced investment has hampered its position in the global market considerably. Currently, the military market within South Africa is dominated by Denel Dynamics and Paramount Advanced Technologies, which have produced the Seeker and Vulture respectively.[99] However, the government is developing a new defence industry strategy, which, if implemented, is likely to include more funding, as well as support for greater international engagement.[100] There are number of other civilian-focused manufacturers that also produce military drones, such as Ultimate Unmanned Systems.

CAPABILITIES

The Seeker 400 is a multi-mission, multi-role, ISTAR system able to provide target location, artillery fire support, electronic intelligence and electronic support measures, with additional plans to equip the drone with a 25 kg precision guided munition.[101] The Vulture[102] is a surveillance and target acquisition drone, fully automated in launch, flight and recovery, with an automated return-to-base feature.[104] Under development by Denel Dynamics is the Bateleur, initially designed to support maritime operation as a MALE drone, comparable in scope to the US MQ-1 Predator. It is likely to receive an upgrade, increasing its maximum range to 3500 km. Another MALE UAV is being produced by Ultimate Unmanned Systems, which showcased the Viper1000c in 2016, a large fixed-wing drone with an endurance of 28-hours and a total payload capacity of up to 350 kg.[105]

Notably, in the non-military market, Desert Wolf produce the Skunk, a non-lethal crowd / riot control copter designed to carry four high-capacity paintball guns alongside cameras, strobe

lights, eye-safe lasers and a loudhailer. It is currently being upgraded to carry non-lethal grenades such as flashbangs and CS gas.[106]

USE

South Africa's drone use remains primarily domestic, with military use being limited to border patrol, anti-piracy and smuggling operations, search and rescue missions, law enforcement operations, and battlefield support. In March 2016, it was confirmed that the South African Airforce (SAAF) had plans to re-activate the No.10 Squadron, which used to operate Scout and Seeker drones, and there is a MALE drone procurement tender that is yet to be released.[107] Use within the civilian market is expanding rapidly, and drones are now being utilised in mining (RocketMine), environmental cleaning (RanMarine), agriculture (AMS, Aerobotics), farming (DroneClouds), supply chain logistics (DroneScan), and wildlife conservation (UDS). There is some frustration within the commercial industry, as drone developers currently find it difficult to obtain permission to undertake test flights without direct cooperation with the SAAF.[108]

5.6 South America

INDUSTRY OVERVIEW

Across South America, there is a reasonably common trend towards indigenous development and employment of military drones. The teams involved in the development, as well as their funding levels, are small compared to other nations engaged in drone development. As a result, South American countries often collaborate with other nations. For example, Brazil worked with Israel Aerospace Industries for three years to develop their own MALE drone,[109] Caçador, Peru worked with South Korea to develop a training simulator for drone pilot instructions[110], and the Colombian governments worked with Spain, along with

Atlante, Horus, Aukán, Ricuk, Amaru

Caçador, Vigia 2B, Atlante II

The Brazilian Apoena1000 drone, produced by Xmobots, made its first succesful flight on the 18th of November, 2008.

CIAC and Airbus, to develop Atlante II for their militaries and eventual export.[111] South America is also in the early stages of developing the necessary infrastructure to support a growing drone industry and use. Argentina, for example, is currently opening their first operations centre at a reactivated air base in order to support tests and flights.[112]

CAPABILITIES

The Brazilian Caçador is a MALE drone, adapted from the Israeli Heron 1. The Caçador is capable of taking on a range of roles including border control, supporting oil and gas industries, and engaging in precision agriculture and military missions.[113] In contrast, the Horus FT-100, a Brazilian miniature UAV, is used for target acquisition, reconnaissance and perimeter security, as well as a range of civil applications. Equipped with a limited degree of automation the system allows for waypoint navigation, loitering, and automatic take-off and landing.[114] An undisclosed African military customer marked the first international export of this model.[115]

The Argentine Airforce has developed the Aukán[116], a high definition multi-sensor system that can track targets in motion and is designed to support military operations, community assistance tasks, disaster situations, logistic support, as well as other government functions.[117] Argentine also unveiled the Vigia 2B MALE UAV which was announced in August 2017. This model is a larger version of the smaller 2A that was previously in development and promises to offer up to 15 hours of autonomy.[118]

Colombia, together with Spain, has developed the indigenous Atlante II, a Predator-type MALE drone. The government-owned CIAC and Airbus Defence & Space have worked towards this new UAV, manufactured in Columbia[119] to replace the previous IRIS drone project, which was abandoned due to weight issues.[120]

Lastly, the Peruvian Air Force developed the Ricuk Observer[121] for surveillance missions. This drone has a roam capacity of up to an hour, with a maximum altitude of 500m. In contrast, the larger Amaru, currently in development, has a longer flight time of up to five hours, can reach an altitude of 1,000m, with a range of 50k. This UAV has improved sensors to enable recognition and intelligence tasks, and additional automation to allow for independent flight and landings.[122]

USE

With limited engagement by South American countries in global conflicts, drones are primarily used to support government security. This includes border patrols, monitoring of anti-smuggling and criminal activity, as well as for disaster relief and other national emergencies. Colombia, Brazil, and Chile have major cities that use drones in municipal surveillance, guarding hard-to-reach locations and controlling crowds in major events; most of the systems used for these purposes are not domestically produced systems. Nonetheless, there has already been some evidence of increased tensions within the region as a result of increased drone use. Paraguay, for example, is taking exception to unauthorised flights by Brazilian drones in Paraguayan airspace and is taking action to curtail such flights with jamming devices and interception UAVs of their own.[123]

5.7 Turkey

INDUSTRY OVERVIEW

Strained diplomatic ties between Turkey and the traditional Western powers have delayed a number of drone sales indefinitely.[124] As a result, Turkey's defence sector is pushing to advance projects that decrease the country's dependence on foreign powers, and increase the potential for Turkey to become an exporter itself. The government has stated that they intend to expand the Turkish UAV (TUAV) programme and produce significantly larger and more powerful drones, with the aim to become one of the world's leading drone producers. [125]

An armed Turkish-made Bayraktar TB2 MALE UAV, produced by Baykar Makina.

CAPABILITIES

In addition to Israeli Harpy and Heron drones, Turkey uses a range of indigenous drones. The Turkish Air Force employs drones from the Anka series, a MALE drone system with automatic take-off and landing capacity and autonomous flight capability.[126] Its primary tasks were initially all-weather ISTAR missions, but it has subsequently been upgraded to carry smart micro-munitions, each with a 10 kg warhead. [127]

Kargu, Aplagu

Bayraktar-mini

Anka, Bayraktar

The Turkish Army uses a range of drones; the Bayraktar TB2 is a semi-autonomous MALE drone capable of conducting ISR missions, as well as being equipped with laser target designators, and its own smart micro-munitions or long-range anti-tank missiles (Baykar Makina),[128] the Alpagu (fixed wing) and Kargu (rotary-wing) are portable loitering munitions capable of conducting 'sacrifice' attacks on personnel or light vehicles. They can be deployed within 45 seconds by a single operator. With autonomous modes that can detect, track, and identify, these loitering munitions are developed to be compatible for use with other munitions as part of a swarm. The production of both systems reportedly commenced in October 2017, although the expected date of entry into service has not yet been verified.

USE

There has a growing demand from the Turkish Air Force for drones in their campaigns in northern Syria against the Kurdish People's Protection Unit (YPG) and strikes against the Kurdistan Worker's Party (PKK) in south-east of Turkey and north of Iraq. In the asymmetric fight against Kurdish insurgents and hostile Islamist groups in Syria, there has been a growing appetite for drones due to their reduced cost and risk to a pilot and drone use has increased significantly with the introduction of the Bayraktar UAV in 2015, followed by the Anka in 2016. Sources report that approximately 600 PKK militants have been either killed, wounded or captured with the assistance of armed drones since September 2016.[129] As a compounding factor, the failed coup against Erdogan in 2016 drastically reduced Turkey's military strength and manpower, and as of June 2017, there was only one pilot for every two F-16 aircrafts.[130] Domestically, the Turkish National Police has used drones for anti-terrorist operation as well as for border protection.[131]

5.8 Ukraine

INDUSTRY OVERVIEW

Prior to the Russian annexation of Crimea, Ukraine's military did not field any modern drones, and their Soviet-era Tupulev Tu-143 systems proved inadequate and easily destroyed. A lack of money and other resources briefly saw the use of civilian drone systems for use in military operations, however, these too proved to be of limited effectiveness.[132] A Ukrainian company reportedly acquired loitering munitions systems (Warmate), from Poland, however, the exact details of the transaction or the number of munitions purchased is not clear.[133]

PC-1

Yatagan-2, Sokil

DP-1, A1-CM, Furia, AN-BK-1 Horlytsia

The Ukrainian-made 'People's Drone' PD-1

In late 2014, a range of small, commercially developed drones began to surface, built by private manufacturers and in part financed through crowd-sourcing initiatives. It is reported that there are some 30 different kinds of these small, tactical drones in use.[134] Generally, the country's

drones fall into one of three categories: domestic systems procured under the Government Defense Procurement and Acquisition Program 2015; foreign-supplied systems procured by the government, or provided under military aid programs; and drone and UAV capabilities that were manufactured, procured, and provided to security agencies by volunteer and sponsor organisations.[135] The scope and standards of domestic drone systems, along with their associated manufacturers have evolved considerably in recent years. Some senior US commanders have recognised some Ukrainian capabilities as possibly superior to their own.[136]

CAPABILITIES

One of the smallest drones commonly used in the Ukraine is the A1-CM Furia (Fury) made by Athlone Air. It is widely used to conduct artillery reconnaissance[137], is capable of automated flight[138], and supported by multiple satellite navigation systems.[139] A similar small drone is the PD-1 (People's Drone) manufactured by UkrSpetc Systems.[140] The PD-1 is a gas-powered drone designed for surveillance, aerial photography, agriculture, search and rescue, and public safety. Its capabilities include automatic take-off and landing, as well as auto-return in case of signal loss, with a Vertical Take Off and Landing (VTOL) conversion kit announced on 6th February 2018. [141]

The largest drone produced to date in the Ukraine is the AN-BK-1 Horlytsia (Turtle Dove), it is designed to be an ISTAR asset with the option of carrying a 50 kg payload to attack ground targets.[142] The smaller Yatagan-2 (Scimitar) drone is a portable loitering munitions system with a 12 km range, designed to loiter over the battlefield and attack targets on impact with its 1 kg warhead. If the target is not engaged, it will return to its base.[143] The announcement by the Ukrainian National Security and Defense Council (NSDC) in September 2017, revealing the successful test of the new Sokil drone system, which can carry high-explosive, blast fragmentation, or thermobaric munitions, illustrates the new trend toward sacrificial drones further.[144]

USE

With the conflict between the Crimean separatists and the Ukrainian government still unresolved, the primary use of drones remains within Crimea. The tactical systems are largely used for ISTAR roles, such as target search and location measurements, as well as missile and artillery fire adjustment. Loitering munitions have also been used, minimising the disadvantage of low survivability rates for conventional drones. Quad-copters were tested as an option, however, they were rapidly abandoned again as they proved to have low terminal accuracy, high sensitivity to side winds, short operational ranges and endurance, and a lower speed relative to their fixed-wing counterparts.

5.9 Other Notable States

ARMENIA

Krunk, Baze, Azniv, X55

Armenia has developed a number of indigenous drone systems, however, none of these have been armed to date. It has, however, used these drones in the conflict with Azerbaijan. The first drone developed was the Krunk (Crane) drone, which was announced in June 2011. The Krunk system is a medium sized, short ranged reconnaissance drone utilised in various military exercises, and mostly for

artillery targeting. This was followed by a range of smaller drones, such as the Baze, the Azniv, and then the X-55 in 2015. The latter is reportedly based on the Russian Ptero-5E system.[145] In June 2017, the Armenia UAV company Lab LLC unveiled 4 new models, including a rotary model that allows for vertical take-off and landing, and provides intelligence capabilities. [146]

AZERBAIJAN

Zarba

In Azerbaijan, drones have emerged as one of the most notable focal points for the upsurge in defence spending, with Israeli models being favoured to date. Israeli firms Elbit Systems, Israeli Aerospace Industries (IAI) and Aeronautics have all supplied Azerbaijan with a range of drones. These include Aeronautics' Orbiter 2M mini-drone, Elbit's Hermes 450 long-endurance tactical drone (reported to have been acquired, but unconfirmed) and IAI's Heron MALE drone. In the country's short conflict over Nagorno-Karabakh in April 2016, Azeri forces deployed IAI Harop loitering munitions, indicating that the country was deploying the systems operationally. Additionally, Azerbaijan has reportedly manufactured the Israeli Orbiter 1K armed loitering unmanned air vehicle under licence as the locally named Zarba. [147]

BELARUS

Busel M-50, Berkut-1/2, Mosquito BP-12

Belar YS-EX, Buvestnik MB

In 2017, Belarus showcased various military drones, ranging from the Belar YS-EX drone, a MALE system, capable of carrying a 280 kg payload, to the Burevestnik MB long-range UAV. This model can be equipped with loitering munitions. Other Belarus drones are the smaller Busel M-50 ISR drone, the Berkut-1/2 and the Mosquito BP-12 portable drone.[148]

NIGERIA

Tsaigumi

The Nigeria Air Force (NAF) operates a variety of foreign drones in their fight with Boko-Haram, including the Chinese CH-3

The Nigerian Air Force first five UAV domestically trained pilots pose with a Chinese CH-3 drone in 2018.

and a number of Israeli Aerostar systems.[150] Nigeria also has an agreement with the Portuguese firm UAVision for the manufacture of small drone systems. However, in February 2018, the NAF unveiled its own indigenous UAV system, the Tsaigumi, the first Nigerian armed drone capable of ISR missions over land and sea.[151]

MEXICO

Mexico is the 10th largest exporter in the aerospace sector, however the Mexican industry deals primarily in components and not complete drone systems. They do, however, possess a range of indigenous drones, including the G1 Guerrero, Ehecatl, Gavilan and S45 Balam medium-range ISR drones, all produced by Hydra Technologies. This stock is in addition to the drone systems the Air Force has purchased internationally (three Israeli Hermes 450s and an Arcturus T-20).[149]

Ehécatl, Gavilán, Guerrero, Balam

POLAND

Poland's WB Groups' aim is to develop a family of UAV systems. To date, produced three types of drones to cover a range of light roles; the Flyeye (a hand-launched reconnaissance drone), the FT-5 LOS (a fully autonomous medium range tactical drone), and the Warmate (a small, multi-role system that can also be fitted with an explosive warhead).[152]

Warmate

FlyEye, FT-5 LOS

SAUDI ARABIA

In 2014, Saudi research centres such as the King Abdul Aziz City for Science and Technology (KACST) produced the Saker UAV, which can be used for surveillance, although they are not specifically made for military use.[153] Since then, Saudi Arabia has also acquired Chinese CH-4 drones. In 2017, KACST signed a deal to open a CH-4 production facility in Saudi Arabia to supply other Chinese clients in the Middle East.[154] However, this didn't stop Saudi Arabia from producing its own MALE

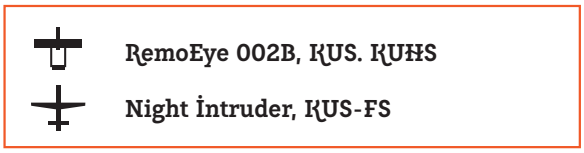
Saker

Saqr 1

Reveal of the Saqr-1 by KACST in Riyadh, 2017.

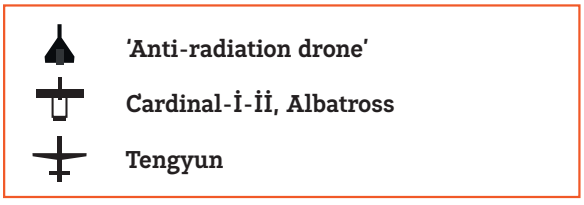
drone, the Saqr 1, which, according to analysts, does not seem to be based on the CH-4.[155]

SOUTH KOREA



The continued threat of North Korean aggression has motivated South Korea to develop and purchase a number of drones with a range of capabilities. In addition to developing their own HALE capabilities, the country has also purchased 4 Global Hawk HALE drones from the US. This is in addition to its own MALE drone, the RQ-101 AKA Night Intruder (to be replaced with the Israeli Heron); the RemoEye 002B, a close-range ISTAR drone[156]; and the current development of 5 further systems (helicopter, fixed wing tactical, the KUS-FS MALE, stealth combat drone, and hybrid multicopter).[157]

TAIWAN



Taiwan recently saw a significant increase in its defence spending (to nearly 3% of GDP), as a measure to deter hostile action by China. This spending increase was accompanied by the specific requirement to develop and produce a fleet of drones that can be used for both reconnaissance and offensive operations.[158] With Chinese bombers flying just outside the Taiwanese air defence zone, Taiwan is worried that arms supplies could be curtailed if the US succumbs to pressure from Beijing.[159] Given the political and military tensions in the region, technical specifications for many Taiwanese drones are rarely published in the public domain. The public display of military capability, however, plays a significant role in deterrence.

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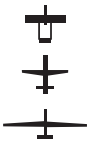
The Cardinal, Albatross, and NCSIST drones at a show in Taiwan.

The Chungshan Institute of Science and Technology (CIST) has produced the Cardinal II, a small drone designed to provide real-time ISTAR information for battalion level combat troops[160]; and the Albatross, a surveillance and reconnaissance UAV that can provide artillery adjustment, target acquisition and designation, battlefield damage assessments, and can act as a communications relay. It is rumoured to be in service with airborne Special Forces.[161] Additionally, CIST is reportedly developing the Tengyun MALE drone, which has been spotted to have laser- or radar-guided missiles attached.[162] Although not confirmed by the Taiwanese government to be standard specifications, this addition would increase its role from surveillance and multi-functional jamming missions to direct combat engagement. Furthermore, an anti-radiation loitering munitions system was exhibited at the 2017 Taipei Aerospace & Defense Technology Exhibition. Still unnamed, this drone is a 'fire-and-forget' all-weather, day/night autonomous weapon system, launched from a ground vehicle, with a maximum speed of 185 km/h and a range of nearly 300 km. The system is designed to target enemy radar and air defence systems.[163]

UNITED ARAB EMIRATES

ADCOM Systems, a company based in the UAE, produces the Yabhon family of UAVs with its signature S-shaped designs. This includes the Smart Eye, Hazim-15, and United 40 MALE drones, as well as the smaller Yabhon-H and the Flash-20.[164] The Flash-20 has reportedly already been sold to Nigeria[165], while Algeria has expressed interest in the United 40 type.[166] In 2015, the company announced that it was opening a factory in the UK to produce MALE United 40 drones.[167] Lastly, ADCOM has also developed the Global Yabhon, a HALE drone indended to compete with the US' Global Hawk. Its design was revealed in 2010[168], a mock-up was introduced in 2013, and that same year a Russian website reported that Azerbaijan was interested in purchasing the HALE drone.[169] However, there appear to have been no new developments concerning the Global Yabhon since then.



YABHON-H, Flash 20

United 40, Smart-Eye, Hazim-15

Global Yabhon

The United Arab Emirates' 'Yahbon United 40' shown at MAKS airshow, held at Ramenskoye Airport, Russia, in 2013.

VENEZUELA

Venezolano, Arpia

Venezuela reportedly received twelve Mohajer 2 drones directly from Iran in 2008, following a defence co-operation agreement signed in 2007. In Venezuelan military service these drones are known under the designation Sant Arpia. The vehicles are reported to have satellite communications enabling them to process real-time data. Four examples of a drone known as the CAVIM ANT-3X Venezolano, developed entirely in Venezuela, are also reported to have entered military service in 2013.[170]

Conclusion

The last decade has seen a spike in interest in the global drone market and a growing number of emerging producers have entered the market, mostly active in the middle segment of drone technology. The high-tech division for drones affords more capabilities, including satellite-linked systems, control beyond-line-of-sight (BLOS) and long flight endurance, however, they all require considerable resources and capacities to operate and maintain, which is why the US, China, and Israel are currently market leaders in this category. Emerging producers are gearing up for a more accessible type of military drone, which can also more easily be maintained. Potential drone buyers may want to operate their armed or ISR drone independently from existing US, Chinese, or Israeli satellite systems, as this could limit or interfere with their operations. The new middle-range of drone capabilities offers BLOS capacity using radio-controlled systems and a flight range of approximately 200 km, depending on transmitter strength, thus adequate potential for states seeking to acquire military-grade drones, independent from the traditional networks. Our research confirms that the majority of new producers focus on the production of short- to medium-range military drone types, which are affordable and easy to operate and maintain. There are, however, technological limitations to the effectiveness of this new segment of drones. High-tech drones, such as the MQ-9 Reaper, have advanced and sustainable propulsion systems, making them fuel and cost-efficient. Moreover, they are equipped with special sensors, cameras and control systems, and have high-grade weapons technologies and guidance systems, making them ideally suitable for the job they are designed to do. Producers in emerging markets such as Iran or Turkey, are lagging behind in these capabilities, although progress is made continuously and steadily.

Iran and Turkey are presently the leading producers in this segment of the market, with growing interest from Russia and the UAE to get ahead in this division as well. Among the new producers, payload and engine/endurance capability poses the largest obstacle to a significant military capability that could boost the export-potential of their drones. However, considering the current rapid pace of technology proliferation, combined with the growing market potential of drones, it is likely that, in the coming five to ten years, these emerging producers will be able to grab a larger share of the drone-pie. ♦

6. International Export Controls for Military Drones

Controlling the export of weapons and weapons-related technologies has been a long-standing challenge for the international community. Each state has its own incentive to tighten or loosen the rules for the export of arms. For example, states have raised concerns over human rights or regional stability as an argument to limit the sale of arms. Other states use arms sales to promote their defence industry, or as leverage in support of their geo-political interests. Drones and related technologies are considered a cross-cutting challenge in relation to export controls, as it is not a definitive weapon. The drone itself is a platform, while the payload defines its use. For example, the use is determined by the types of weapons a drone is able to discharge, the technologies it uses to guide weapons to their intended target, and the specific systems it uses to collect intelligence and to perform surveillance. As their overall capabilities increase, and with it their utility for military purposes, there are good arguments to be made for stricter controls on drones and related technologies across the spectrum. While drones offer a range of military advantages, their use in cross-border operations or counter-terrorism missions may also undermine regional security and potentially contribute substantially to serious violations of international law.

6.1 Multilateral mechanisms

There are several international mechanisms in place that take the export of drones and related technologies into consideration. However, they vary widely in scope, participation rates and degree of relevance.[171] For example, a number of states have signed agreements and treaties to address their concern that drones, among other platforms, could potentially be used as delivery vehicles for nuclear, chemical, or biological weapons. One of these treaties is the Missile Technology Control Regime (MTCR), a voluntary partnership between 35 countries, which aims to prevent the proliferation of weapons of mass destruction and the means by which they are delivered, both missiles and drones (armed and unarmed).[172] The MTCR differentiates between two categories of delivery vehicles: Category II covers platforms with a range of at least 300 km, while Category I covers vehicles that are capable of carrying 500 kg payloads over 300 km.[173] The US is currently seeking to adapt the MTCR in order to accommodate the

sales of drones. This is discussed in greater detail below.

Similar and in addition to the MTCR, there is also UNSC Resolution 1540, which prohibits states from aiding non-state actors in the acquisition of weapons of mass destruction or any technology that might be used to deliver such weapons. This resolution was adapted in 2013 to include the use of drones as delivery vehicles, so that states now have a mandatory duty to report unmanned systems in their obligations to meet the requirements of Resolution 1540.[174]

Another important international mechanism for the control of arms export is the Arms Trade Treaty (ATT). The ATT prohibits the export of weapons and/or ammunition if there is a risk that it they might be used to, e.g., violate international humanitarian law, international human rights law, or to facilitate terrorism.[175] This, broadly, also includes the control of armed drones. The ATT control list of weapons is linked with the UN Register of Conventional Arms. Armed drones are in principle covered under the category 'unmanned combat aerial vehicles' (UCAV).[176] This excludes a range of other military drones that are strike-enabled or can be used in other ways to boost military effectiveness or contain specific military technology. Although the ATT is ratified by 94 states, its effectiveness is hampered by the fact that major drone-producing states such as the US, China, and Israel, have either not signed or ratified the treaty.

Export control of drones is also captured in the Wassenaar Arrangement, an agreement between 41 states, which stipulates export controls for conventional weapons, dual-use goods, and related technologies.[177] The aim of this export control regime is to prevent weapons from falling in the hands of terrorists or those states which might use them to "commit or facilitate the violation and suppression of human rights and fundamental freedoms or the laws of armed conflict", and to prevent "destabilising accumulations of arms".[178] States participating in the Arrangement have agreed to maintain national export controls on goods and technologies listed specifically in the Wassenaar document, to report on the transfers and denials of such to non-participating states, and to exchange information on sensitive dual-goods and technologies.[179] With regards to drones, the Wassenaar agreement specifically mentions, "unmanned aerial vehicles, specially designed, modified, or equipped for military use including electronic warfare, suppression of air defence systems, or reconnaissance missions, as well as systems for the control and receiving of information from the unmanned aerial vehicles".[180] In short, states adhering to the Wassenaar agreement will have to maintain controls, and issue reports on any exports of drones and related technologies to non-participating states.

6.2 US initiatives

In February 2015, the Obama administration established a new domestic policy for the international sale, transfer, and use of drones produced in the US.[181] This new policy included "stringent conditions" for the sale of drones, including stipulations for how they would need to be used by recipient states. For example, states buying US-made drones would have to agree to use them in accordance with "international law, including international humanitarian law and international human rights law."

The policy was intended to be part of a broader US drone policy review, which included "plans to work with other countries to shape international standards for the sale, transfer, and subsequent use of military UAS"[182] and in October 2016, the US, together with 53 other states,

issued the 'Joint Declaration for the Export and Subsequent Use of Armed or Strike-Enabled Unmanned Aerial Vehicles'.[183] The Joint Declaration stipulates five principles relating to the applicability of international law, transparency regarding export, and standards on the use of armed drones. The document is also intended to serve as a basis for further discussions on the use and export of armed drones, which are held in the summer of 2018. However at the time of publication of this report in August 2018, the initiative has not seen any progress.[184]

The Joint Declaration has been criticised by civil society groups for both the content as well as the process leading up to the final draft. The process lacked transparency as civil society groups were excluded from the negotiations, and participating states "were presented with fixed texts with limited opportunity to discuss or change the content".[185] Moreover, non-governmental groups object to the text of the Joint Declaration, as it contains ambiguous language, loopholes, and only asks for voluntary commitments. As a result it fails to adequately address the threats the current use and proliferation of armed drones pose to existing legal and moral principles.

Rather than restricting the sale of military drones, the US has seemingly sought to ease restrictions since February 2015, widening the group of appropriate buyers to include not only closely allied nations, but also states that make a pledge to only use US drones in accordance with international law.[186] In 2017, the Trump administration further loosened domestic regulations for the export of armed drones, and also took aim at overhauling the requirements contained in the MTCR.[187] The MTCR currently categorises drones the same way as it does missiles. This means that if a country wishes to export a drone that can carry 500 kg payloads for more than 300 kilometres, it will need to present a very compelling reason to be able to do so. US officials have proposed changes that would shift drones into a category with far less restrictive export controls. This push for changes is reportedly taking place "under heavy pressure from American manufacturers and in defiance of human rights advocates who warn of the risk of fuelling instability."[188] This is likely spurred by the fact that military drone manufacturers in China and Israel, neither of whom are members of the MTCR, are able to sell their technologies with fewer restrictions than the US, and have been gaining a larger share of the global market for military drones. [189]

6.3 Multilateral discussions on armed drones

UN disarmament bodies are concerned about the widespread proliferation of drones, not least as they pose a risk to international peace and security. The lowered cost benefit drones offer, financially, as well as in terms of risk to operators' lives, is acknowledged as a key contributing factor for the increase in proliferation and the High-Representative for Disarmament Affairs has called for increased "transparency, oversight, and accountability in the development, acquisition, stockpiling, transfer and use of armed drones." [190] In 2015, the UNODA provided an initial study on this matter, which proposed that the UN Institute for Disarmament Research (UNIDIR) should work towards identifying multilateral frameworks within which states would be able to engage with the issue of drone proliferation more extensively.[191] UNIDIR hosted a series of meetings with states, international organisations and civil society to find productive ways to move this discussion forward.

UNIDIR released a 2017 study, which provides several recommendations on how the international community should resolve the challenges posed by the use of armed drones. [192]

For example, the report identified the need for "transparent and inclusive multilateral processes to develop international standards applicable to armed drones",[193] noting that such a process should not only focus on controlling the acquisition process but should also engage with the issues posed by the use of drones in greater depth. With regard to the international process led by the US, the so-called Joint Declaration, the study concluded that it was better if a UN-process would take charge of developing standards and principles for the use of armed drones, as it would involve all concerned states. To this end, it is suggested that states take steps to "put forward a UN General Assembly resolution that highlights both use and proliferation" and "establishes a mandate for the development of standards to improve the transparency, oversight and accountability of armed UAVs in all their aspects".[194]

6.4 Conclusion

The proliferation of drones and the weakening of drone export control regimes pose a joint challenge to international law and international security. The capabilities provided by this relatively new and affordable technology, combined with un-checked practices and uses that lack clear frameworks and limitations are undermining international legal regimes designed to help maintain international peace and stability and protect civilian life.[195]

This predicament is exacerbated by the rise of emerging drone producers covered in this report. As new manufacturers enter the global market and contribute to proliferation and mass adoption, there is a real danger that more and more states begin using drones in ways that erode international law and undermine international security. Moreover, the odds that rival actors will use armed drones in contested environments, or that drone-technology spreads to non-state actors, increases with proliferation too. As discussed above, the US-led Joint Declaration is currently inadequate to address these issues properly. The 2017 UNIDIR study clearly showed that states should work together, through multilateral channels in an inclusive, comprehensive and ambitious way to develop common standards for oversight, transparency, and accountability regarding the use and export of armed drones. The findings in this report add urgency to this call. The growing number of new and emerging drone producing states poses a serious problem as many of these states are not part of existing arms export agreements such as the MTCR, the Wassenaar Arrangement or the Arms Trade Treaty. The proliferation of dual-use technology, limited categories that should cover armed drones in existing export controls, and novel technological developments will present a critical challenge to risk assessment and export control mechanisms. The world is now in dire need of a pro-active international community that acts towards finding solutions that ensure the protection of civilians in armed conflict, uphold human rights principles and striking a balance with the legitimate security needs of states. If it fails to do so, technology will further outpace policy. ♦

7. Drone Developments on the Horizon

Military and commercial use of drones will likely continue to show substantial growth. According to a recent report, the global market for drones is anticipated to reach US$21 billion by 2025.[196] Other sources suggest that by 2021, drones will be used along major highways to provide ubiquitous wireless coverage using a combination of LTE, 5G, and satellite communications.[197] While these forecasts may be somewhat optimistic, there is little doubt that drone technology is likely to proliferate widely and we will see a multitude of new applications in the near future. Most development horizons are projected for 5-10 years. Militaries rarely forecast their equipment programs more than 20 years in advance, as changes in government often have a considerable impact on research and development priorities. The website Air Drone Craze has identified seven generations of the technology's development phases and currently places the systems in use in generation six, with higher end professional grade drones already moving into the seventh generation of development.[198] The overlap between commercial and military drone technologies is likely to become more profuse and substantial. As one sector develops new innovations, the other is likely to adopt advances quickly, accelerating the technological development overall in turn. At present, industry-driven research and development programmes remain as important and effective as government-driven programmes in generating and incorporating new advancement. For example, the US company Skidio is selling the R1 'self-flying camera' which uses artificial intelligence to follow and record its users.[199] This technology is likely to be adopted by military and governmental users in the near future.

7.1 A broader range of applications

A growing demand for new drone technologies drives the expansion of new uses and applications. Once an innovative technological development becomes more ubiquitous, affordable and accessible it will likely easily find its way into the more mundane aspects of civilian life, such as sports activities. Target tracking technology, for example, allows a drone-mounted camera to track and film an individual while skiing. For the energy sector, for example, drone technology has become more weather-resistant, with longer flight times and increased

payload capacity. This has allowed companies such as the Chinese MMC to manufacture drones that are able to assist in stringing power lines, a task that was significantly more difficult in the previous years, resulting in a 200% growth of their business.[200]

GROWING SERVICE INDUSTRY

As the range of drone applications expands and the technology becomes more complex, the need for specialisation grows as well. Any given individual will no longer be able to switch their skills instantaneously between devices (e.g. engineering, piloting, or programming) and the need for service support will manifest itself. This will range from training, pilot contracting, after-sales support, optimisation, customisation, repairs and upgrades, to specialist services such as flight planning and complex operations management. One such example is the growing market for drone simulators, which is predicted to have a compound annual growth rate of 15% between 2017 and 2022. Because an expensive drone might be damaged during real life training, virtual training allows armed forces and companies to pay for the drone training only, while the provider of the simulator carries the cost of the necessary equipment.[201]

SOCIETAL ACCEPTANCE

At present, drones are still met with a certain scepticism by the wider public, not least because their military use is often shrouded in secrecy. This is illustrated, for example, by a recent Freedom of Information request made by Drone Wars UK, which asked for information from the UK government about its plans to allow the RAF's upgraded version of the US Predator drone to be flown within the UK.[202] Nonetheless, whether it is related to privacy, autonomy, safety, or security concerns, the public is likely to become more trusting of the technology once suitable reassurances have been put in place. Such assurances might manifest through advancements in design, improvements in safety features or the creation of regulations that match the requirements and expectations of the public. Moreover, the public is likely to also become desensitisated to drones as they become more ubiquitous over time. Lower cost and easier accessibility of drone technology is likely to be a key factor here[203] and states will need to develop cross-governmental communications strategies when engaging with military combat drones.[204]

GOVERNMENT REGULATION

Although countries have been making significant progress in developing legislation, the extent to which drones can be operated is still limited. As technological advancements accelerate governing bodies will be required to develop and enforce an array of new legislations. Ranging from air traffic management to drone use regulation in urban areas, additional technologies may be required for better and safer navigation, such as detect-and-avoid systems, data linking, or geofencing. What influence the military, industry, academia, and civil society may have on this area of legislation remains to be seen.[205] Other options tabled, by the EU for example, include the requirement to obtain licences for the use of certain drones[206], while the Federal Aviation Administration (FAA) in the US also requires Transport Security Administration (TSA) background checks for non-hobbyist drone users.[207]

AUTONOMY

Autonomous sub-systems are becoming notably more commonplace, not only in unmanned military systems, but also in civilian systems, such as self-driving cars. Automated defence systems are already able to identify, track and fire upon an incoming missile long before an operator can react, and cutting-edge surveillance assets are capable of charting their own

course and adjust it when necessary without further human commands. The international community is currently engaged in a fervent debate over the requirement to have a 'human in the loop' or 'on the loop' for autonomous technologies capable of exerting lethal force. However, the development of autonomous system is outpacing any such discussions. [208]

MANNED-UNMANNED TEAMING

Another trend is that of manned-unmanned teaming. In 2016, the US paired Apache attack helicopters and Textron Shadow drones for joint missions in Iraq. During the teaming the Texon drones served to support the Apache crews with additional real-time electro-optical and infrared images, allowing the pilots to locate and pursue moving targets more quickly and from farther ranges.[209] In contrast, Optionally Piloted Vehicles (OPV), such as the Firebird manufactured by US company Northrop Grumman, offer an integrated version of manned-unmanned teaming. This Firebird MALE drone can optionally be controlled from a ground control station or by an on-board pilot. This added versatility is designed to provide additional capability and a greater range of options when gathering data.[210]

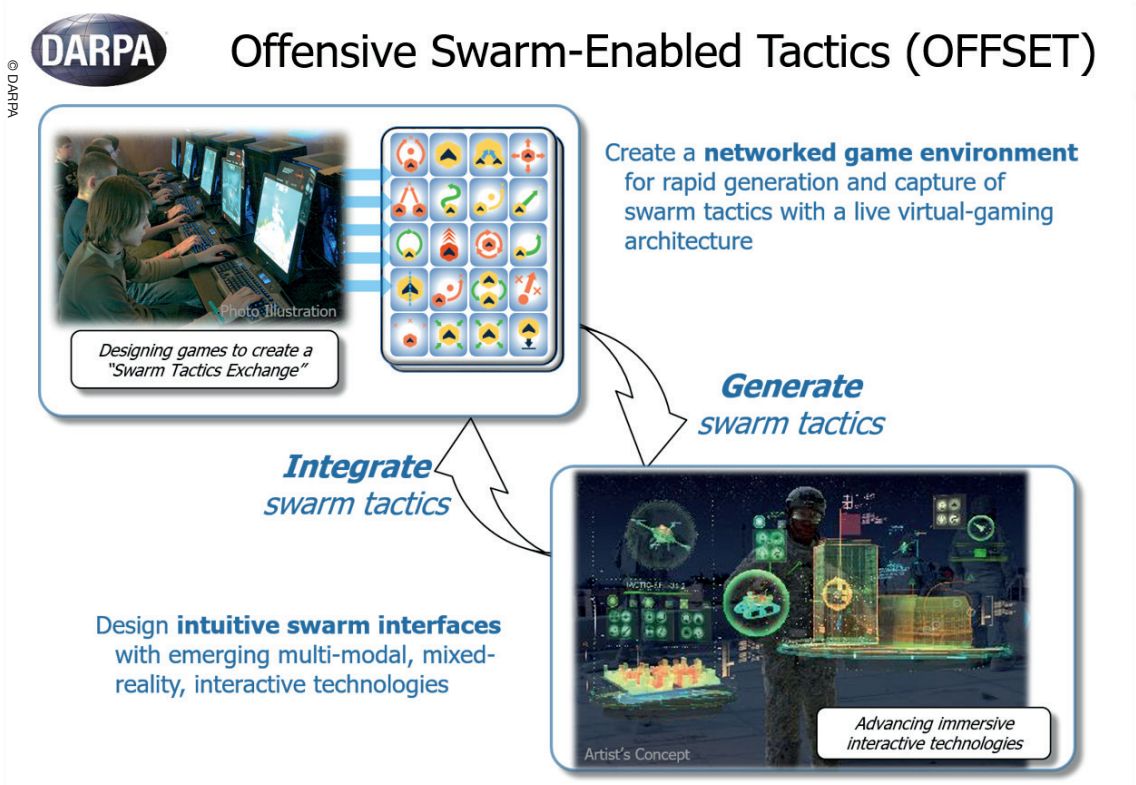
AIR-TO-AIR DRONE COMBAT

The overwhelming majority of military drone combat engagements are currently air-to-surface in nature, but as drones become more advanced, in hardware as well as software, they will become more capable of air-to-air manoeuvres and attacks. These developments are likely to run in parallel with increases in achievable speeds for fast-moving drones, such as the hypersonic X-51 Waverider, improved targeting at range, and the adoption of stand-off range munitions. Some unmanned aircrafts are already capable of engaging manned aircrafts, however the current disparity between different classes of weapons is likely to be reduced over time.

SWARMING

As autonomy increases, so does the ability for multiple drones to remain in contact with one another during missions. With sophisticated swarm technology, one single operator would be able to control multiple drones as easily as they control one and, utilising sensor fusion, be able to react according to the aggregated information. The use of intelligent swarms is already in development and the intention is currently for multiple smaller drones to move in concert, avoiding collisions and intelligently selecting targets. With increased autonomy this would allow for scenarios in which drones could make an ever-greater number of decisions themselves, including how many and what type of munitions would be required to destroy a given target. The swarm could, for example, determine that an armoured vehicle would require more drones to target, while soft-skin vehicles would require fewer. Any 'excess drones' not required for the attack would 'know' to return to a safe location for recovery or initiate self-destruction.

The US, Russia, China, and Israel each have programmes exploring the utility of drone swarms in the modern battle space and developments are already underway. As far back as October 2016, three US Boeing F/A-18 Hornets deployed a swarm of 103 Perdix micro drones, and on 11th June 2017, China launched a test flight of 119 micro-drones.[211] This was followed up by China in December 2017 with a swarm of approximately two dozen small fixed-wing aircrafts, testing against a simulated reconnaissance mission performed as a single entity and with portions of the flight conducted autonomously.[212]



DARPA's OFFensive Swarm-Enabled Tactics (OFFSET) program envisions future small-unit infantry forces using small drones in swarms of 250 robots or more to accomplish diverse missions in complex urban environments.

STEALTH TECHNOLOGY

The drive toward stealth technology has a long history. Militaries have sought to build aircrafts that are able to conceal their presence from radar, infrared, visible light, RF, and audio detection systems since World War I, and this trend continues today. Increasingly, the desire for stealth operation also applies to drones. The larger unmanned aircrafts, such as the US Air Force Sentinel, the British Taranis, and the Chinese Sharp Sword are relatively well established (although not all are in service yet), however, advances are underway to apply stealth technologies also to smaller drones, increasing the potential number of stealth combatants in any given theatre. BAE's MAGMA drone, for example, has no-control surfaces, which has the ability to enhance stealth properties.[213]

POWER

Size, weight, and power are critical to any technological system and advances in these fields are inevitable. Recent developments in wireless power transfers are already reaching greater distances; alternative fuel options are explored by a number of companies. Boeing, for example, is investing in the development of hydrogen engines, whereas others have turned to integrating solar energy sources into their systems, like the Solar Eagle and Zephyr (both by QinetiQ, UK). There are also plans to produce a solar powered Vulture drone, which would, in theory, be able to operate for a period of five years without interruption. Conventional mid-air refuelling as practiced by manned aircraft are now also executed by prototype drones, as intended for the MQ-25 Stingray, for which Boeing, General Atomics, and Lockheed Martin have each put forward different designs as part of the US Navy competition for the drone.[214]

MATERIALS SCIENCE DEVELOPMENTS

Current manufacturing practices exploit new, modern materials, such as graphene, carbon nanotubes, molecular glue, metal foam and aerogel. These are all likely to impact future developments in drone manufacturing as well. Capitalising on cutting edge materials science, drones are likely to become lighter, yet stronger, and will benefit from meta-materials that facilitate subwavelength imaging, for example, for greater stealth capabilities. Additionally, as 3D printing becomes more affordable, the materials for the manufacture of components will become more varied, allowing for a greater range of components to be built to higher specifications.

OPEN SOURCE DEVELOPMENT

As highlighted earlier in this report, amateur manufacturers have developed and built makeshift drones for use in conflict hot spots. There are already a considerable number of open source software and hardware tools available on the Internet for this purpose, including autonomous flight technologies (Paparazzi drone), autopilot software with advanced data-logging, analysis and simulation tools (ArduPilot), multicopter stabilisation technologies (LibrePilot), imagery mapping (OpenDroneMap), and smartphone integration software (Flone). While militaries and big commercial producers will expectedly maintain a tight hold on the most advanced and capable software and hardware technologies, it is likely that amateur users will continue to build viable combat drones and develop alternative methods to solve military problems.

7.2 Security İmplications

The rise of new drone industries will not only provide their home country with a greater range of drone capacities, but it will also likely contribute to the global proliferation of this technology in a number of ways. States have an incentive to export their indigenous drone technologies to others, as this strengthens alliances, provides financial income and stimulates the development of better and improved drone technologies. Moreover, as cheaper technologies come on the market, rivalling states might be motivated to also acquire drones in order to not fall behind with their military technology. So why does this proliferation matter?

ILLEGAL TARGETED KILLINGS

Drones have been used in ways that violate both international human rights law and international humanitarian law. The use of drones by the US' CIA to execute individuals outside of official theatres of war with little to no accountability or transparency is a worrying practice. The US' claim to the justified use of lethal force anywhere in the world, without adequate explanation of who is targeted and why, sets a dangerous precedent which may well be mirrored by other states ready to use their newly acquired drone fleet. An increased proliferation of drone technology may thus likely contribute to an increase in violations of the appropriate use of force, supported by vague notions of self-defence, therefore continually undermining principles of international law.

ESCALATION POTENTIAL

As more and more countries integrate drones into their military forces, tensions have mounted in relation to border transgressions and disputes. An early example is the downing of a Georgian reconnaissance drone by Russia in April 2008, escalating tensions between both countries and

eventually sparking a brief armed conflict.[215] In 2015, Pakistan shot down a commercial Indian quad-copter drone flown by the Indian military, accusing the Indian military for spying on their border.[216] In 2017, above the Aegean Sea, Greek fighter jets twice intercepted a Turkish Anka drone, this subsequently led to skirmishes between Greek and Turkish jets.[217] That same year, an Indian drone crashed in Chinese territory, leading to heavy protests from Beijing, accusing India of having invaded Chinese airspace.[218] Also in 2017, Pakistan shot down an Iranian drone, which had flown into its airspace[219], moreover, a Pakistani commander also threatened to shoot down US drones in its airspace.[220] In 2011, a US RQ-170 Sentinel drone crashed in Iran [221]; an Israeli drone flying from Azerbaijan in 2014 reportedly met the same fate.[222] Iran itself has been accused of flying an armed drone into Israeli airspace, and although this claim is disputed, as geo-location data seem to put the drone firmly in Jordanian air space, it didn't stop Israel from escalating both its rhetoric and the military response.[223] Israel too lost an armed drone in Lebanon, which crashed after a technical malfunction in March 2018.[224]

Wargame exercises and simulations have shown that actors are likely to use drones in a cheaper, expendable way, which had previously come at too great a political cost when the lives of pilots were at stake. Drones offer a low-cost means of asserting considerable airpower, however, militaries are also much less hesitant to take adversarial drones down with force. As a consequence the threshold to use force is lowered on both sides of a conflict. In other words, drones essentially "offer a more gradual escalatory action compared to the use of other military assets."[225] Complicating this development is the fact that countries are able to use plausible deniability as a way to deny any intentional transgression, claiming malfunctioning of the drone, loss of communication or other technical reasons beyond their control. It is evident that with an increased number of countries in possession of and using drones, the risks for escalation and the potential for the more widespread use of force also increases, as narratives of the right to self-defence as a just cause for the use of force are more easily deployed. A case in point is Israel's reaction to an Iranian drone, which had crossed into its airspace in February 2018. Not only did Israel shoot down the armed drone, it also launched an attack on the Syrian base from which the drone was allegedly launched, escalating forceful action considerably and further weakening regional stability.

NON-STATE ACTORS

As drone technology proliferates, the danger that military-grade drones might fall into the hands of hostile non-state actors or rogue states becomes ever-greater. As indicated earlier in the report, so-called Islamic State is already known to have used drones to target enemies, attack the enemy with explosives, and even disrupt the ability of troops to call in airstrikes.[226] As is to be expected, the technology they are using is becoming more and more sophisticated, and their eagerness to employ drones more widely in aid of their goals shows no signs of abating.

The realisation that drones might be used for nefarious, violent purposes has sparked several panicked responses already. In both Iran and in Saudi Arabia, government forces have opened fire at commercial drones flying near the office of Ayatollah Khamenei[227], and the palace of King Salman bin Abdulaziz al Saud, respectively.[228] There are also growing fears that drones might be used to bomb crowded places, such as sports stadiums during the Olympics or other popular events for which crowds gather. The spectre of a drone being used to deploy chemical, radioactive, biological or nuclear weapons has also already been raised: In 2015, a drone with a

tiny amount of radiation landed on top of the offices of Japanese Prime-minister Shinzo Abe.[229] As drone technology becomes more sophisticated, cheaper and more widespread, the chances that a non-state actor will gain access to it, and use it with increasingly devastating results become increasingly probable. Access do drone technology provides militant non-state actors with additional ways to spread propaganda material; drones provide such actors with ways to more easily scout enemy positions and movements for a stronger military advantage; they are used for target acquisition and engagement, attacking the enemy with bomblets, in self-destruct mode, single or in swarms – the ways in which new drone technologies are able to be exploited by unsavoury actors are many, and growing. This already puts an increased constraint on armed forces as additional defence capabilities are required, while movement becomes more limited, as outlined by US and Iraqi forces during their campaign against IS.[230] ♦

A rebel fighter walks near what purportedly are the remains of a Syrian regime drone that was shot down by Israel the day before, in a field near Barqah, a few dozen kilometres from the Israeli-occupied Golan Heights on July 12, 2018.

© AFP PHOTO / OMAR HAJ KADOUR

A Turkish-backed Syrian rebel fighter uses a drone at a monitoring point near the Syrian village of Qilah, in the southwestern edge of the Afrin region close to the border with Turkey, on January 22, 2018.

8. Conclusion

Drones are a game-changer for the ways armed forces and armed non-state groups conduct their operations in conflict. From the smallest eye-in-the-sky drones to heavily armed long endurance drones, to DİY commercial ones weaponised with small explosive charges, used in swarms, or solo, remotely piloted vehicles have brought a new power dynamic to armed conflicts. The absence of risk to the pilot, their low cost of production, combined with unprecedented loitering capabilities, precision weapons capacities and a wide range of high-tech sensor equipment have made drones ostensibly indispensable for military commanders and politicians worldwide. The expanding uses to which drones are put and their rapid global proliferation requires a vigorous assessment to ensure they are used within existing legal frameworks and in accord with the principles stipulated by international norms regarding the use of lethal force. Neglecting to give this development the attention it deserves, risks overlooking potential threats to international and regional stability and security.

This report has outlined the impending growth in the global market for drones. Government and commercial investments in developing drone technologies is at a high and shows no sign of abating. Of the currently 450 drone manufacturers globally, two thirds are working on military drones, in the hopes of gaining a substantial slice of the projected market value of US$21 billion by 2021. Civilian users make up the largest segment of this market, with hobbyist use ranking at the top, followed by drone use for infrastructure and agricultural projects. However, the lines between commercial, hobbyist drones and military-grade drone technology have become increasingly blurry as military non-state actors find ways to militarise simple, off-the shelf drone technologies, as evidenced in a number of conflicts around the world.

To date, only a handful of international actors have dominated the global drone market. The US, China and Israel each have the financial means, political will and know-how to develop sophisticated drone platforms and payloads, giving them not only a leading advantage in the use of drones, but also an influential position for the export of drone technology. But times are changing. As shown in this report, there is a growing group of emerging developers and manufacturers, gradually establishing their own expertise to tap into the global market for drones and build a strong domestic drone industry. Their aim is not merely to be self-sufficient in equipping their armed forces with a range of drones technologies, but also to seek a more prominent role on the global stage for drone exports. Countries like Iran, Turkey, Ukraine, Pakistan and South Africa each aim to capture a specific segment of the military drone market, focusing on relatively cheap, small and medium-sized weapons-capable drones which can be operated without a complex, high-tech satellite infrastructure. Increasingly, these systems are also combat-tested, giving a further incentive for interested buyers. A quick survey of drone-focused expos and arms fairs reveals the rapid progress made in this segment.

The growing proliferation poses new challenges to existing export regulations and restrictions. Limited defence budgets and current international export legislation provide structural barriers for a more rapid spread and use of mid-segment military drones, however, the emergence of new producers, determined to take a slice of the market, signals that existing rules guiding the production and use of drones may soon be outpaced by the realities of modern warfare. A strong multi-lateral approach to set appropriate guidelines for the safeguarding of peace and stability is required. Both the 2016 US-led Joint Declaration and the 2017 UNIDIR framework stress that a constructive approach is required for states to set boundaries for the 'responsible use' of drones and address the various concerns raised.

Where existing export control agreements lay the foundation for a more comprehensive discussion on military and dual-use drones technologies, the debate should now turn to the unique features that make drones such an enticing technology for the use of force, and the security implications that arise therefrom. Recent incidents where drones were seen to transgress borders and sovereign airspace, and consequently shot down, illustrate the potential for the escalation of force and hostile tensions with the introduction of drones.

Further exacerbating this growing precarity is the fact that militant non-state actors are quick to realise the benefits of drones as a militarily advantageous tool. Reports highlighting how hostile groups harness the potential of cheap, over-the-counter technology to build their own systems, capable of reconnaissance as well as armed attacks in Iraq, Syria, Yemen, Israel and the Ukraine indicate that this trend is likely to continue with greater frequency. New developments on the horizon for swarm technologies, micro-drones, greater levels of autonomy and stealth capacities will further compound the attractiveness of drones, offering a range of novel ways to use them. This, in turn, is likely to have a detrimental impact on civilian lives – inside and outside of traditional theatres of war – and jeopardise international stability and security.

It is our mission at PAX to work with committed citizens and partners to protect civilian lives against the perils of war and conflict, to contribute to the end of armed violence, and to work toward a stable and just peace. This task includes being critically reflective about the use of weapons systems and the challenges they pose to peace and stability, through the lens of political, military, legal and ethical analyses. We further aim to hold states accountable for their efforts to uphold international legal principles and norms regarding the use of armed force in and outside official battlefields.

This report offers a snapshot of the most recent technological developments in the area of drones used for military purposes to illustrate the rapid pace with which new drone technologies and capacities develop and are likely to proliferate. This should give us cause for great concern and should motivate a more focused investigation into how access to a greater range of cheaper systems will produce new risks to security and stability. Moreover, it should give enough evidence to prompt states to work on improving export controls for drones and related technologies within the context of a wider multi-lateral debate on the responsible use of new technologies. This report focuses on drone technologies; however, similar issues arise with other emerging technologies for military purposes, including cyber technologies, nanotechnologies and Artificial Intelligence. ♦

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A member of the Iraqi forces carries a grenade carrying feathers, which is to be fired from a drone in the fight against Islamic State (IS) group jihadists in the northern Iraqi city of Mosul on March 14, 2017. IS have used small drones to drop explosives on advancing Iraqi forces since they launched the battle to retake the whole of Iraq's second city in October. But now, Iraqi forces have adopted the terrifying tactic, equipping their own remote-controlled devices with 40-mm grenades.

9. Recommendations

Addressing the concerns over increased proliferation and use of dual-use and military drone technology requires a joint, multi-lateral effort by states, industry and civil society to strengthen export controls and prevent misuse. PAX therefore submits the following recommendation for states, international organisations and civil society working toward an effective framework:

- Develop a comprehensive overview of the current challenges and risks associated with emerging drone technologies in conflict environments. This entails outlining existing uses of all types of drones and the risks associated with misuse, including dual-use and civilian systems. Such an overview should include an analysis of force escalation potential and the impact on regional security balances and stability. Such an overview could by drafted by a group of selected military, and international relations experts, diplomats and civil society groups and would provide a useful baseline for further discussions on the regulation of drone export and use.

- Update control list and improve risk assessments in existing export control regimes. States should cast a wider net on what types of drones or related technologies might be misused or diverted to unwanted end-users, and assess the potential for exported drones to be put toward misuse within the regional security context of the importing state. A broader discussion on the opportunities and limitations for civilian drone technology and export controls should also be encouraged. As a whole, and at a minimum, these measures and discussions serve as an educational tool for participating states dealing with export limitations for drones.

- Establish a normative and/or regulatory framework for drone use and exports. Existing export control regimes are either limited in terms of participation and scope, or are based on loose, voluntary commitments. There is a clear need for a global platform where states have the opportunity to exchange information regarding the development of new military applications for drones and associated risks, and are able to discuss the implications this has for the export of drones and related technologies. Such a framework could also function as an explorative mechanism for future military technologies.

- Support comprehensive and inclusive multilateral discussions on the use and proliferation of dual-use and military drones. Unmanned systems might have added value for civilian and military environments, yet emerging technologies with a set of unique features also pose novel risks that could undermine peace and stability. Moreover, current practices of illegal targeted killings risk further undermining existing legal principles for the use of lethal force in and outside the battlefield. These issues should be subject to ongoing discussions at a multi-lateral level.

- Strengthen the debate by expressing concerns over both the use of armed drones and increased proliferation in the UN General Assembly. Participant states to export control mechanisms such as the Arms Trade Treaty, the Wassenaar Arrangement, the Missile Technology Control Regime, should raise these issues in appropriate forums.

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