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Executive Summary And Policy Recommendations

As a result of contemporary robotics trends and advancing unmanned systems, as well as the growing reliance on autonomy and artificial intelligence (AI), determining characteristics of warfare are drastically changing. Furthermore, humanity's centuries-long way of fighting, along with its perception of battle-spaces, is on the edge of a major transformation. This paradigm shift has been proceeding in a non-linear, swift, and unclear fashion in different corners of the world. The ongoing revolutionary techno-scientific leap is interdisciplinary, and driven by interactions between different fields in a broad spectrum. Although the coming change is still in its early phases, it is expected to cause major political, military, economic, social, infrastructural, and informational transformations.

A careful assessment of the top Turkish political-military decision-makers' understanding of, and the defense industries elites' approaches to, drones firmly suggest that Turkey sees the unmanned military systems and robotic warfare something more than 'simply' military modernization portfolio, **an opportunity of pioneering the next geopolitical breakthrough**. This ambitious calculus depends on the key assumption that, for various reasons, Ankara has not fulfilled the necessary accomplishments during the industrial age. Even a viable indigenous main battle tank project had to wait for the 2010s (with the forthcoming Altay line) to be completed. Yet, at the time being, the robotic warfare and unmanned autonomous systems revolution is leading to a paradigm shift which will change the determining parameters of the global power struggle. At such times, runner-ups could take advantage of the new conditions, and rise to the top. Gunpowder, for example, led to such a paradigm shift in the past and had a profound effect on the world order.

While Turkey is not a lead manufacturer of manned fighters or bomber aircraft, it has already become one of the most successful manufacturers and users of armed tactical unmanned aerial systems, and is also showing a good performance in producing related smart munitions. Bayraktar TB-2 armed tactical drone and its ROKETSAN-manufactured high-precision munitions are now game-changers in dealing with the nation's troublesome, hybridized battle-spaces in the Middle East. Operation Olive Branch could not have been carried out so flawlessly had Ankara not developed robust armed drone capabilities. In the absence of intensive unmanned systems use, the Turkish casualties would for instance have been much higher.

At the time being, all branches of the Turkish Armed Forces, along with the police and the intelligence, are users of indigenously designed and manufactured unmanned systems for different purposes. This marks a very critical advantage since it leads to a specific strategic culture on drone operations. Furthermore, many of the Turkish unmanned systems were tested under real warfighting conditions in hybrid battlegrounds during Operation Euphrates Shield and Operation Olive Branch, as well as in internal security and counterterrorism missions. Without a doubt, such a combat record and bottom-up communication channels, namely the defense sector's and top political-military echelons' inputs received from tactical and operational–level commanders, remain critical references for further advancements.

The new techno-scientific revolution and the next military paradigm are not limited to remote-controlled unmanned systems. Artificial intelligence, autonomy, and advanced robotic warfare will be the determining parameters of future wars. If Ankara is to really pioneer the next revolution in military affairs, it should capitalize on the success in unmanned systems design and production, and carry on with the emerging trends of the techno-scientific breakthrough. In this regard, swarming potential of the new systems, such as Alpagu, Kargu, and Wattozz, (the latter under the project phase), network-centric use of Bayraktar TB-2 with other manned platforms (such as T-129 ATAK gunship), as well as the Undersecretariat for Defense Industry's recent robotic warfare (literally, the robot-soldier) project remain promising avenues.

Research universities are vital in developing the required manpower and know-how, as well as sustaining/ attracting the necessary human resources for designing and producing high-end unmanned systems. If the Turkish defense sector is to seize the new paradigm shift in robotics, AI and autonomy, then the Turkish academia should also play an important role via research universities, which need beefing-up both in quantity and quality, with a particular focus on the key fields driving the ongoing techno-scientific revolution.

Designing and manufacturing robotic warfare platforms and autonomous systems center on an interdisciplinary research focus ranging from data science to aerospace engineering. In this regard, this report strongly recommends Turkish decision-makers to initiate a new **interdisciplinary research center**. The scope of the proposed interdisciplinary research center should incorporate War Studies and related sub-topics, along with techno-scientific fields relevant to the new breakthrough including, but not limited to, **computational neuroscience, evolutionary biology, behavioral biology, robotics, data science, artificial intelligence, and related engineering departments** for developing a thorough understanding of future unmanned military systems and robotic warfare issues. The newly established National Defense University could be hosting such an initiative.

Exact future state and impact of new technologies are becoming increasingly uncertain. Real world trial-and-error of every product is almost impossible, and also expensive. As a result, the proposed research center should also involve advanced simulation and wargaming efforts to boost the readiness levels of the Turkish military-industrial complex and the Turkish security forces. The proposed interdisciplinary center should also drive major research efforts to monitor, understand, predict, and adapt to ethical and legal implications of new technologies. Thus, establishing a legal and military ethics branch is strongly recommended.

Turkey's academia, business circles, strategic community, military, intelligence community, and government should actively contribute to the ongoing international debates on the trajectory, implications, and regulations of the new revolution in robotic warfare, autonomous and unmanned systems, and AI. Simply put, the technological competitive edge can produce tangible results only when coupled with adequate concept development capabilities. In this respect, the US, for example, is not only leading the technological improvements, but also shaping the literature and concepts of robotic warfare and lethal autonomous weapon systems. On the other hand, although Turkey produces combat-proven and effective tactical armed drones along with other categories, its think-tanks are not structured to influence, let alone shaping, global strategic affairs debates on unmanned and autonomous systems. This gap has to be closed if Turkey is to become a leading actor in robotic warfare. While Turkish defense industries is receiving sound military operational and tactical feed backs from the security forces, it is not getting world-class conceptual inputs from the Turkish strategic community.

To set a way-forward in robotic warfare capability development, Turkey needs two guiding frameworks. The first and broader one, as proposed by this report, remains a **National Artificial Intelligence Strategy and Roadmap**. Such a top-level strategy document should provide strategic guidance and commanding principles in a wide-array of issues ranging from promoting necessary human resources and know-how for translating AI-enabled technologies into key, tangible capabilities. Secondly, Turkey needs a **Robotic Warfare Strategy Document** to replace its existing Unmanned Aerial Systems Roadmap. In tandem with the global trends in unmanned systems, Turkish defense sector made its initial achievements in the unmanned aerial systems (UAS) segment. Yet, the unmanned revolution is also on its way in other domains with advancing unmanned ground vehicles (UGVs), as well as surface and underwater systems. Thus, Turkey needs to enhance its UAS-oriented focus, and adopt a more comprehensive approach to robotic warfare.

At the military-strategic and operational levels, this report recommends the Turkish military-industrial complex to focus on the **cross-domain integration** of various unmanned systems. Especially, the **UGV – UAS teaming** is well within the existing capabilities of Turkey's defense sector. As explained by this study, cross-domain teaming of different unmanned platforms and systems offers invaluable opportunities to militaries in contemporary complex and high-risk battle-spaces.

The final military-strategic and operational re-commendation is derived from the lessons-learned from **Azerbaijan's April 2016** clashes with the Armenian forces over Nagorno Karabakh. During the conflict, the Azerbaijani military effectively used **loitering weapon systems** (known as 'kamikaze drones') procured from Israel. Loitering munitions offer precision solutions against time-sensitive, relocatable targets. Especially in areas with high-risk of collateral damage, or when in need of minimizing the target identification – engagement cycles in dynamic battlegrounds, these assets are proven fairly effective. Furthermore, by providing a **fusion of surveillance and strike capabilities**, they are becoming more reliable as their technological enablers advance. Turkey made a promising initiation into the loitering weapon systems sector with Alpagu and Kargu. Yet, the Turkish defense industry has a long way to go before producing advanced systems with higher endurance, higher payload, and better capabilities overall. Thus, fostering loitering weapon systems research and development should be a priority for Turkey's unmanned systems modernization. At this point, Turkish defense planners should avoid reducing loitering weapon systems into a Special Forces capability. The Israeli inventory, as well as Azerbaijan's operational achievements in April 2016, showed that advanced loitering weapon systems could indeed play crucial roles in hybrid battlegrounds carrying the risk of inter-state conflict.

Introduction: Into A Human-Machine Revolution In Military Affairs

> Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make because they lead lit-tle by little to the truth.[1]

Unmanned military systems have already become the hotspot of contemporary War Studies and current political-military affairs. Starting from the US war on terror, these platforms have been getting smarter, more advanced in their mission portfolio, more lethal, and more accessible to many state and non-state actors. When the US Armed Forces waged the 2003 Iraq campaign, it had only a handful of drones in the skies, and few, if any, unmanned ground systems presence. In a few years from the outset of the war, the US Predators were hunting down their targets with high-end munitions, and unmanned ground vehicles (UGVs) were being used to defuse the problematic roadside bombs.[2]

However, what makes these systems probably the next revolution in military affairs (RMA) is not their silent kill capabilities or thousands of miles reaches. In fact, recent leaps in autonomous systems, artificial intelligence, swarming intelligence, and machine learning have been snowballing into a near future breakthrough. The avalanche noise is already out there, and the forthcoming decades are likely to bring about astonishing developments in robotic warfare.

This report will examine the next revolution in military affairs (RMA) with a specific focus on unmanned military systems. Subsequently, Turkey's achievements, its critical requirements, and possible options for an indigenous development of unmanned military systems will be analyzed. These sections will also assess why and how Ankara strives to improve its unmanned military systems capabilities, and explore the required next steps to capitalize on current accomplishments.

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1 Jules Verne, A Journey to the Center of the Earth.

2 Peter, W. Singer, Unmanned Systems and Robotic Warfare, Testimony before the US House of Representatives Committee on Oversight and Government Reform – Subcommittee on National Security and Foreign Affairs, Brookings, 2010.

The Ongoing Techno-Scientific Breakthrough And Unmanned Systems

Throughout the history, *homo sapiens*, as species, have not killed its own kind by solely relying on itself. For example, cavalry, resulting from the domestication and then 'weaponization' of horses, had been a game-changer until the 20th century. The Turkish Independence War, commanded by Mustafa Kemal Pasha (Ataturk), could not have accomplished victory had the Turkish Army lacked maneuver superiority through its formidable cavalry formations. Likewise, war elephants, pigeons, dogs, and many other 'peers' have accompanied the mankind in fighting its wars. The Turkish Armed Forces even officially awarded a mule, Reşo, due to its services in the counterterrorism efforts of the 1990s –the mule was famous with anticipating landmines–, and offered him a comfortable retirement at the Army Stables in Ankara.[3] During the Olive Branch, IED detector dogs were deployed in the area of operations for saving Turkish lives. Now, one can well think that unmanned systems would function as war animals, and would team up with *homo sapiens* in its wars without asking for water and food, or have a bad day due to emotional or hormonal factors. In fact, it is not that simple. **Mules do not plan logistics of a division during forward deployment, nor do detector dogs decide the strategy of a counter-IED operation in a hybrid battleground. Starting from the 21st century, and resulting from the rise of autonomy and the AI in military systems, human beings may not be the only decision-makers at times of war in the coming decades.** This is a major paradigm shift in warfighting, which might still look like sci-fi to the most, just like the Cold War nuclear weapons balance and ballistic missile proliferation look in the eyes of a WWI officer who lived in the very same century.

The ongoing revolutionary techno-scientific progress is interdisciplinary, driven by a constant interaction between scientific and technological fields in a broad spectrum. Regarding the recent military use of unmanned platforms, various technologies such as artificial intelligence, robotics, nanotechnology, satellite communications and others play key roles.[4] Moreover, a number of scientific fields have been gaining momentum in terms of relevant discoveries, as well as their interactions. For example, Professor Edward Osborne Wilson, one of the most influential biologists of the modern history, argues that the continuous communication between the fields of evolutionary biology, paleontology, scientific understanding of brain functions, robotics, and artificial intelligence not only drives the progress in each of these fields but also enables a greater understanding of "life".[5] More sensationally, Professor Yuval Noah Harari, a history scholar and the author of the international bestsellers Sapiens and Homo Deus, started his 2018 Davos speech by a bold statement, "*we are probably one of the last generations of homo sapiens. Within a century or two, (the) earth will be dominated by entities that are more different from us, then we are different from Neanderthals or chimpanzees*". In brief, an interdisciplinary research context is a significant pre-requisite to develop and employ the next-generation systems, and also to understand, predict, and adapt to the rapid evolution of how differently militaries and societies would function in the future.

Modern technologies including artificial intelligence and robotics resemble many characteristics of nature. Machine-learning, especially artificial neural networks, mimic the processes of the human brain. Advances in cognitive neuroscience and computational neuroscience continue to enable new technological breakthroughs such as human-machine teaming, coupled with increased levels of autonomy in military systems.[7] In daily lives of the general public, common technologies such as facial or voice recognition, and even smart predictions of Google search functions owe to artificial intelligence behaving similarly to the human brain in many ways. A notable example of similar, contemporary research is the increasing number of scientific studies looking into behaviors of ant colonies to improve metropolitan transportation systems.[8]

3 TRT Archives, http://www.trtarsiv.com/izle/127433/mayin-dedektoru-katir-reso-nun-emekliye-ayrilmasi, Accessed on: May 02, 2018.

4 Robert O. Work and Shawn Brimley, 20YY Preparing for War in the Robotic Age, Center for New American Security, 2014.

5 E.O. Wilson interview, YouTube, https://m.youtube.com/watch?v=lx26k8LTCdI , Accessed on April 29, 2018.

6 For the full speech, see: http://www.ynharari.com/wef2018/, Accessed on: May 02, 2018.

7 Emerging Cognitive Neuroscience and Related Technologies, National Research Council of the National Academies, 2008.

8 Rami Musa, Jean-Paul Arnaout, and Hosang Jung. "Ant colony optimization algorithm to solve for the transportation problem of cross-docking network." Computers & Industrial Engineering 59, no. 1 (2010): 85-92.

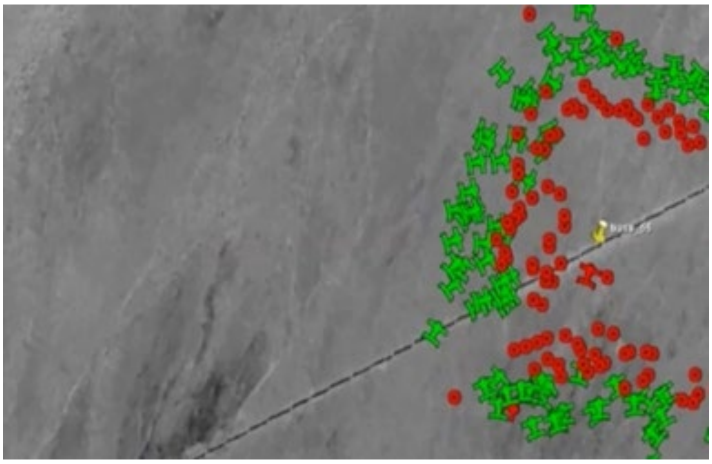
Robotic swarms remains another field to monitor closely to predict the next military breakthrough. Simply, it is based on the "*collective, cooperative dynamics of a large number of decentralized distributed robots through use of 'simple' local rules*".[9] At the very epicenter of swarm robotics, there lays self-organization, namely, "*the emergence of macro-level behavior from non-linear interactions among individual agents, and between systems components and their environment*".[10]

Now, who / what might conduct the best examples of swarming other than current – but mostly near future – robots? One, who wants to give a precise answer to this question, does not need to search too far, because the answer is around the very readers of this report. Bacteria colonies, bee colonies, bird flocks, termite colonies, and ant colonies all show very advanced swarming behavior.[11] In other words, any sci-fi fashion future warfare scene, in which killer robots fight each other in organized formations using networked tactical concepts, must have been inspired from the evolutionary biological roots of swarming living things in the nature. This is why inter-disciplinary research and development remains key to survive for any nation in the next decades.

Humans also used swarming when systematically killing each other to impose their will on the adversary for political purposes, which is called 'war' in the Clausewitzian definition at its best.

A 2005 RAND study carefully reviewed notable cases from military history and concluded that from the Scythian cavalry to the Turkish Mamluk horse archers of Saladin, and to modern warfare, there are many examples of swarming conducts. According to the study, the "ultimate swarm" were the Turkic-Mongol hordes of the steppes, because, starting from the rule of Genghis Khan, these formidable military formations swarmed at both tactical and operational levels.[12]

According to the abovementioned study, the most important variables for successful swarming are superior situational awareness, standoff capability, elusiveness, simultaneity, and encirclement.[13] Can robots gain those capabilities one day? More importantly, can they accomplish demanding tasks against manned formations?



Left: A bird flock, natural swarming behavior[14] Right: An excerpt from the video footage of a micro-drone swarm test conducted by The U.S. Department of Defense and Naval Air Systems Command. "The test consisted of 103 Perdix drones which demonstrated collective decision-making, adaptive formation flying, and self-healing."[15]

9 Andrew Ilachinski, AI, Robots, and Swarms, Center for Naval Analyses, 2017.

10 Ibid. p.106.

11 Ibid.p.107.

12 For a comprehensive study, see: Sean J.A. Edwards, Swarming and the Future of Warfare, RAND Pardee Graduate School, 2005.

13 Ibid. p.xvii.

14 Wikimedia Commons, https://commons.m.wikimedia.org/wiki/File:Auklet_flock_Shumagins_1986.jpg#mw-jump-to-license, Accessed on: April 25, 2018.

15 The Washington Post, https://www.washingtonpost.com/videonational/defense-dept-demos-one-of-the-worlds-largest-drone-swarms/2017/01/09/6971391c-d6ac-11e6-a0e6-d502d6751bc8_video.html?utm_term=.e9e9877f0be5, Accessed on: April 25, 2018.

Implications of the ongoing techno-scientific progress are unlikely to remain limited to task-specific applications. Rather, the ongoing breakthrough in the relevant scientific research and technology developments indicate large-scale transformations in geopolitical, military, social, economic, and informational spheres. Notably, the rapid growth of technology is non-linear. Thus, it is not feasible to make generalized predictions in a linear, additive fashion by extrapolating from the current pace of the progress. That being said, similar to Moore's Law predicting an annual doubling of transistors on computer chips and massive growth of computer power, a recent study by the Santa Fe Institute and MIT researchers predicts a rapid advancement for 62 different technologies.[16] Moreover, **the current progress is synergistic**. Discoveries in various technological fields enable the overall progress in an interconnected way.[17] For example, modern unmanned systems rely on robotics, sensors, nanotechnology, artificial intelligence, natural language processing, satellites, among many other technologies. Overall, the current techno-scientific dynamism and its potentially disruptive effects force policy-making processes to become increasingly agile, flexible, future-oriented, and adaptive.

The abovementioned synergistic techno-scientific progress provides new capabilities to address challenges posed by the overwhelming amount of information. Advancements in "*understanding and augmenting human cognition*" enable new applications for "*pervasive environmental sensing and situational awareness, open source intelligence, surveillance, and reconnaissance (ISR), smart logistics, distributed Command-Control-Communications-Computers (C4), education and training, improved human creativity and even strategic communications and humanitarian support*".[18] All the mentioned capabilities have already started transforming modern warfare, particularly by leading to increasing levels of autonomy in unmanned systems, cyber defense, intelligence analysis, along with decision-making efforts.

An illustration of modern transformative technologies mentioned by various reports published in the United States. The list in the center summarizes commonly emphasized technologies.[19]

16 Béla Nagy, J. Doyne Farmer, Quan M. Bui, and Jessika E. Trancik. "Statistical basis for predicting technological progress." PloS one 8, no. 2 (2013).

17 James Kadtke and I. I. Wells, Policy Challenges of Accelerating Technological Change: Security Policy and Strategy Im-plications of Parallel Scientific Revolutions. National Defense University Center for Technology and National Security Poli-cy, 2014.

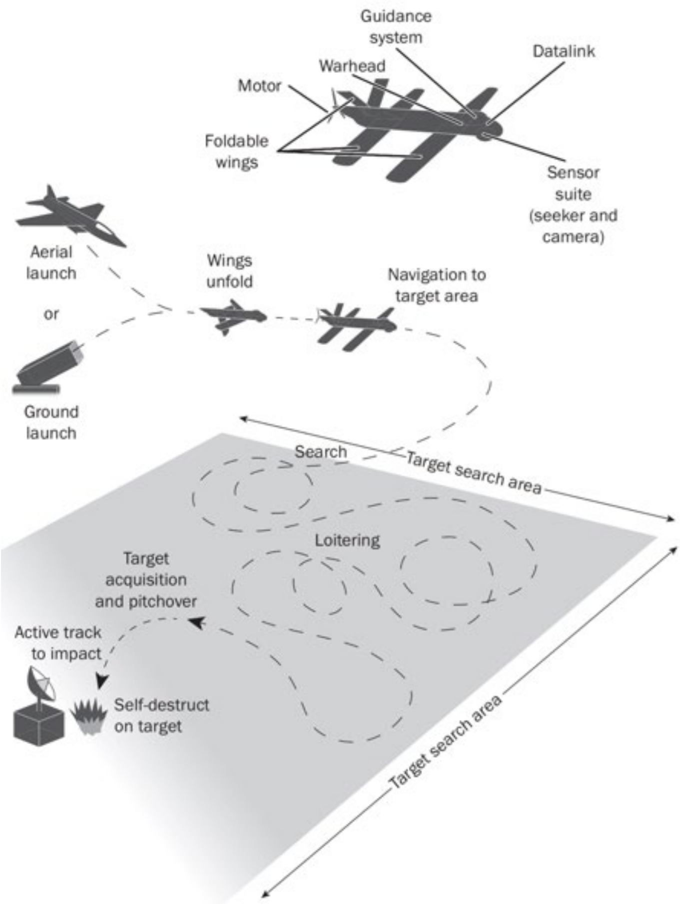
18 James Kadtke and I. I. Wells, 2014.

19 Andrew Ilachinski, 2017. For the reports the visual refers to: Emerging Science Technologies, Intelligence and National Security Alliance, Council on Technology and Innovation, 2013; S. Brimley, K. Sayler, and B. Fitzgerald Game Changers: Disruptive Technology and U.S. Defense Strategy, Center for a New American Security (CNAS), 2013; Envisioning 2030: US Strategy for the Coming Technology Revolution, Strategic Foresight Initiative, Brent Scowcroft Center on International Security, 2013; R. Work and S. Brimley, 20YY: Preparing for War in the Robotic Age, CNAS, 2014; Summer Study on Auton-omy, DoD, Defense Science Board (DSB), Task Force Report (TFR), Office of the Under SecDef for Acquisition, Technolo-gy and Logistics, 2016; The Role of Autonomy in DoD Systems, DoD, DSB, TFR, Office of the Under SecDef for Acquisi-tion, Technology and Logistics, 2012; The National Artificial Intelligence Research and Development Strategic Plan, Nation-al Science and Technology Council, Networking and Information Technology R&D Subcommittee, 2016; Robotics Collaborative Technology Alliance: FY 2012 Annual Program Plan, Army Research Laboratory, 2012; Unmanned Systems Integrated Roadmap: FY2013-2038, U.S. Department of Defense; Global Trends 2030, National Intelligence Council, NIC 2012-001, 2012; Technology and Innovation Enablers for Superiority in 2030, DoD, DSB, TFR, Office of the Under SecDef for Acquisition, Technology and Logistics, 2013; Zachary J. Lemnios, Testimony Before the United States Senate Committee on Armed Services, Subcommittee on Emerging Threats and Capabilities, 2012, https://www.armed-services.senate.gov/imo/media/doc/Lemnios%2004-17-12.pdf.

Looking into developmental and operational phases of military robotics systems, a recent US Army War College Strategic Studies Institute work compares modern unmanned systems with a few historical military inventions through the lens of "life cycles". Accordingly, military systems are categorized into "*experimental (entrepreneurial), institutionalized, ritualized, and satirized (or romanticized) phases*".[20] During the initial experimental (entrepreneurial) phase, a weapon system has promising strategic, operational, and tactical features that can alter the battlefield. However, states' defense apparatuses and armed forces need time before fully integrating the system into their way of warfighting. In the next phase of institutionalization, militaries and nations develop an understanding of the system and start using it regularly. Moreover, development, production, training, and other relevant processes then become standardized. In the ritualized phase, use and production of the weapon system start to have diminishing returns and higher costs, and the weapon system day by day fall short of addressing the transforming threat environments. Finally, in the satirized phase, the system is considered obsolete, and even suicidal to employ.[21]

Referring to the abovementioned conceptualization based on life cycles of weapons, use of robotic systems in modern warfare shows the characteristics of the initial experimental phase.[22] Developers and users of remotely controlled –and increasingly autonomous– systems bring about a feedback mechanism, using battlefield experiences to identify and update specific requirements for upcoming platforms and capabilities waiting next in the line.

As the leading actor in this field, the United States Armed Forces not only used unmanned systems to generate force-multiplier effects in Afghanistan and Iraq, but has also been pursuing dynamic trial-and-error processes with significant mutual top-down and innovative bottom-up mechanisms. Russian use of unmanned systems is another remarkable example of how experience, adaptation, and innovation interact. Learning from setbacks in Chechnya and Georgia, the Russian military-industrial complex has been able to integrate unmanned systems into its war-fighting capabilities, leading to their extensive use in Ukrainian and Syrian theaters. Technically speaking, the increasing level of integration between the Russian unmanned aerial systems and Russian artillery marked good achievements. All in all, as the weapon systems gain more autonomous characteristics, they will enjoy increased speed, agility, coordination, reach, and persistence. These improvements will tangibly pay-off in a broad array of military missions ranging from strikes in anti-access / area denial (A2/AD) environments to air defense, and to intelligence-surveillance-reconnaissance (ISR) tasks.[23] Altogether, these changes would mark a new era of warfare. Unmanned systems might be the principal combatants of the new warfighting regime.



Structure and mission-cycle of modern loitering munitions. Loitering munitions utilize high levels of autonomy.[24]

[20] Robert J. Bunker, Armed Robotic Systems Emergence: Weapons Systems Life Cycles Analysis and New Strategic Realities, U.S. Army War College Strategic Studies Institute, 2017.

[21] Ibid.

[22] Ibid.

[23] Vincent, Boulanin and Maaike Verbruggen, Mapping the Development of Autonomy in Weapon Systems, SIPRI, 2017.

[24] Ibid.

Unmanned Systems In Modern Warfare

When grasping a complex situation, probably the best way to anticipate an uptrend is to focus on the statistical data. In 2001, the Pentagon had some 170 unmanned aerial systems. By 2014, the number was over 11,000.[25] Probably only a few, if any, manned platform category was subject to such a beef-up within a decade. Besides, one should also look at the other end of the spectrum. 2018 studies reveal that more than 150 manufacturers in some 30 countries are producing and designing over 230 counter-drone systems.[26]

Unmanned aerial systems have been evolving to become one of the central components of aerial warfare, expanding from the air-ground operations of the recent decades, to complete the aerospace dimension in future warfare. Despite earlier examples and use for mainly ISR purposes, unmanned systems technology has become more prominent in the last two decades, mainly for kinetic roles in counterinsurgency and counterterrorism operations. Unmanned aircraft and their sensors have provided near-persistent intelligence, surveillance, and reconnaissance capabilities, proving particularly effective when used to support other military components. The US military and its allies have increasingly relied on medium and high altitude, long-endurance systems in Afghanistan and Iraq wars. Especially in counterinsurgency campaigns, networked use of unmanned aerial systems creates a force-multiplier effect.

In addition to two major theaters of military operations, unmanned armed systems have been used for counterterrorism operations in various countries, including, but not limited to Pakistan, Yemen, Somalia, and Libya. Furthermore, the reliance on armed unmanned aerial systems has particularly increased in the absence, or with the drawdown, of larger scale military operations. For example, referring to the US-led UAS strikes in Pakistan, then CIA head Leon Panetta boldly stated in 2009 that it was *"the only game in town"*.[27] **Moreover, according to an exclusive news report published by Reuters in 2016, the US Air Force data showed that the proportion of air strikes carried out by unmanned aerial systems exceeded those by manned aircraft for the first time since the outset of the conflict. In the totality of weapons used by the US Air Force, the ratio of unmanned strikes rose from 5 percent in 2011 to 56 percent in 2015, and 61 percent in the first quarter of 2016.**[28]

ANKA-S unmanned aerial systems, produced by Turkish Aerospace Industries, have SATCOM capability, significantly expanding their reach.[29]

25 Mark, A. Gunzinger and David A. Deptula, Toward a Balanced Combat Air Force, CSBA, 2014.

26 Arthur Holland, Michel. Counter-Drone Systems, the Center for the Study of the Drone, 2018.

27 CNN, http://edition.cnn.com/2009/POLITICS/05/18/cia.pakistan.airstrikes/, May 27, 2018.

28 Reuters, https://www.reuters.com/article/us-afghanistan-drones-exclusive/exclusive-afghan-drone-war-data-show-unmanned-flights-dominate-air-campaign-idUSKCN0X-H2UZ, Accessed on: April 29, 2018.

29 SSM Official Twitter Account, https://twitter.com/SavunmaSanayii/status/982876121581617152?s=20, Accessed on: April 28, 2018.

Apart from the proven strategic, operational, and tactical advantages in recent counterinsurgency and counterterrorism operations, the breakthrough is likely to be caused by next-generation, more autonomous, and more artificially intelligent unmanned systems. The mentioned features of sophisticated systems will enable better human-machine teaming in air operations. The primary result is expected to be the *"physical teaming between 'manned' and 'unmanned' vehicles, and cognitive teaming that blends automation and human decision-making"*.[30] As a multiplier to advantages of the existing systems, such as the exclusion of the human from the cockpit, reduction of size and costs, endurance and persistence, next-generation unmanned systems will enable even more significant affordability and networking capabilities. **In particular, use of unmanned systems is likely to be a vital component of air operations in anti-access/area-denial (A2/AD) environments, by enabling deeper penetration to zones that are too dangerous for manned aircraft.** The artificial intelligence technology is also likely to be a major driver in the mentioned evolution of air warfare. Notably, in recently reported simulation tests involving the US Air Force Research Lab, **an artificial intelligence system was able to defeat a veteran human fighter aircraft pilot "repeatedly and convincingly"**.[31] Further development and integration of the artificial intelligence technology are expected to enable decision-support for operations while increasing the autonomy of future unmanned aerial systems.[32] More autonomous systems will also reduce bandwidth requirements since they will not have to stay in contact with the human operator constantly. **Furthermore, next-generation unmanned aerial systems will be "the key to affordable power projection".**[33]

A quick glimpse into the US Navy's X47B Unmanned Combat Air System (UCAS) could give an idea about the scope of the unmanned systems breakthrough. In July 2013, this 'fancy, smart toy' successfully performed an arrested landing on board USS George H.W. Bush (CVN 77) Aircraft Carrier. This was a historic moment for the future of American naval aviation and power projection patterns around the world.[34] The X-47B did not only accomplish an impressive arrested landing on board an aircraft carrier. It also completed its catapult launch from the deck of an aircraft carrier, refueled in mid-air while flying.[35] At this point, it would worth reminding how the manned platforms of the Russian aviation, or their pilots, or the surface vessels' crew –but definitely somebody– made fatal mistakes during the Admiral Kuznetsov's deployment off the Syrian coasts, and how those mistakes led to the loss of at least one Mig-29K and one Su-33 Flanker.[36]

X47-B autonomous mid-air refueling.[37]

30 Paul Scharre, Yes, Unmanned Combat Aircraft Are the Future, War on the Rocks, 2015, https://warontherocks.com/2015/08/yes-unmanned-combat-aircraft-are-the-future/ , Accessed on: May 1, 2018.

31 Breaking Defense, https://breakingdefense.com/2016/08/artificial-intelligence-drone-defeats-fighter-pilot-the-future/ , Accessed on: May 1, 2018.

32 Ibid.

33 Paul Scharre, 2015.

34 The US Navy, http://www.navy.mil/submit/display.asp?story_id=75298, Accessed on: May 02, 2018.

35 Northrop Grumman, X47-B Unmanned Combat Air System, http://www.northropgrumman.com/Capabilities/X47BUCAS/Documents/UCAS-D_Data_Sheet.pdf, Accessed on: May 02, 2018.

36 The Aviationist, https://theaviationist.com/2016/12/05/russian-su-33-crashed-in-the-mediterranean-while-attempting-to-land-on-kuznetsov-aircraft-carrier/, Accessed on: May 02, 2018.

37 For the refueling video of X47-B, see: https://www.youtube.com/watch?v=O5m1CTO92kM, Accessed on: May 02, 2018

Unmanned systems add to non-linear, complex, and hybrid characteristics of modern warfare. Airspace in hybrid environments is often contested, either by the adversaries' disruptive capabilities at higher altitudes, or mobile and portable air defense systems at lower echelons, such as MANPADS and anti-aircraft guns. Moreover, anti-tank guided missiles (ATGM) have proliferated into many modern military theaters, and they are used by state and non-state actors alike, significantly threatening armor survivability. Assuming that modern battlefields will remain contested with "asymmetric" threats, autonomous systems will be essential to carry out military operations at greater distances. Furthermore, unmanned systems have become attractive operational options in hybrid warfare environments, primarily because of their ability to carry out so-called "dull, dirty, or dangerous" missions while minimizing the risk to humans, and decreasing workforce demand.

The low-cost, relatively small, commercially available unmanned systems bring a new set of challenges regarding detection, tracking, and elimination of airborne threats as well as disrupting the adversaries' ISR capabilities. Besides, the presence of enemy unmanned aerial systems create risks for both stationary and maneuvering troops on the ground, leading to new tactics, procedures and training requirements for operational security.

Contemporary and future autonomous systems would also fit into hybrid or non-linear warfare concepts with their greater stealth characteristics, swarm intelligence technology, and decreased risks to human operators. Their hard-to-detect and asymmetric character enable so-called "political warfare" operations, similar to Russia's infamous "little green men" in Ukraine.[38] While concepts like non-linearity, complexity, chaos, and unrestricted warfare have become essential parts of the modern operational art of major actors such as the US, Russia, and China, autonomous and unmanned systems enter inventories to explore and exploit adversaries' weaknesses. **Additionally, the use of certain types of unmanned systems has similar characteristics with cyber warfare, particularly due to its covert, stealthy and sometimes non-attributable use. For example, unmanned underwater vehicles (UUVs) have become a core element in the contested South China Sea.**[39]

Similar to the unmanned aerial systems, unmanned ground vehicles (UGV) diminish operational risks by *"achieving lower risk to humans"*, and enabling *"accessibility to areas not suitable for humans"*.[40] Current unmanned ground systems include various types of platforms for engineering missions, IED detection and disposal, search and rescue platforms, and several logistics vehicles. Armed reconnaissance and other lethal mission types are among potential applications.[41] Furthermore, as in other domains, one of the major requirements of unmanned ground vehicles' employment will be effective manned-unmanned, unmanned-unmanned, and human-machine teaming.

The US Army categorization of unmanned ground vehicles includes "*soldier transportable, vehicle transportable, self-transportable, and appliqué"* systems. Soldier transportable systems consist of relatively small and lighter vehicles (in the US classification, not exceeding 35 pounds), and have been mostly used for ISR missions and IED disposal. Vehicle transportable systems require a mover due to their increased weight. Systems in this category enable various mission types including lethal action, and they are expected to become more autonomous in the near future. Self-transportable systems, which are able to carry out autonomous or remotely controlled relocation, require sophisticated sensors and AI attachments. Finally, the US Army classification includes appliqué systems that *"can be used to convert fielded and future manned systems into unmanned systems"*.[42]

Several countries have UGV programs aiming to integrate future autonomous systems into their force structures. Currently, most of the unmanned ground vehicles that are employed by armed forces worldwide are lightweight. Development of the UGV technology is in its early phases

[38] Tobias J. Burgers and Scott N. Romaniuk, Hybrid Warfare in the South China Sea: The United States' 'Little Grey (Un)Men', The Diplomat, 2016, https://thediplomat.com/2016/12/hybrid-warfare-in-the-south-china-sea-the-united-states-little-grey-unmen/, Accessed on: April 24, 2018.

[39] Ibid.

[40] Jeffrey L. Caton, Autonomous Weapon Systems: A Brief Survey of Developmental, Operational, Legal, and Ethical Issues, U.S. Army War College Strategic Studies Institute, 2015.

[41] Ibid.

[42] Ibid.

and dependent on artificial intelligence, sensors, robotics, SATCOM, and swarm intelligence technologies as well as increased autonomy. Most of the existing larger platforms have modular designs with flexibility to address differing operational demands, fitted optionally with different sets of effectors.[43] The US Army develops concepts to integrate next-generation unmanned ground vehicles into its force structure in the mid-2020s. Reportedly, among the projects that are carried out by the US Army are experimenting inclusion of *"larger robotic combat vehicles (RCVs)"* including unmanned tanks into its ground formations; developing a concept work to *"explore how to use robotics and autonomous systems during combined arms breach missions"* -namely the *"Robotic Complex Breach Concept"*; and prototyping the *"Next-Generation Combat Vehicle"* with at least a similar capability to existing main battle tanks. One specific advantage of unmanned systems that has been referred to is that with no human on board, heavy unmanned ground vehicles may operate with lighter armor, decreasing the weight of platforms in a significant way. Notably, the US Department of Defense considers ways to shorten acquisition processes, mainly due to the rapid progress in relevant technologies.[44] Furthermore, Russia, China, and Israel develop unmanned ground vehicles, and are expected to be among the major players in future UGV markets.

Unmanned systems are also increasingly becoming relevant to delivering the weapons of mass destruction (WMD) agents. As mentioned in other sections of this report, with varied sophistication levels, unmanned systems technology proliferates rapidly. A growing number of actors, including rogue states and non-state armed groups gain access to, or develop, unmanned systems. Similar to the missile technology and IED threats, unmanned systems enable asymmetric remote-strike capabilities. Although in the last few decades there have been calls for *"strengthening export and arms controls, deterrence, and defense"* measures to prevent such scenarios,[45] current military, technological, and commercial trends indicate a growing risk of unmanned delivery of WMDs,[46] as well as a potential growth of intelligence and security efforts to detect and eliminate such threats. On the other hand, unmanned aerial systems also enable new ways to detect and identify biological and chemical threats.[47]

Unmanned systems play a variety of roles in modern naval operations by teaming up with manned platforms. For example, they are used for increasing the situational awareness and operational ranges of warships. They especially proved effective in intelligence, surveillance and reconnaissance missions. Platforms with larger decks can also employ long-endurance and long-range UAS for additional purposes thanks to their heavier payload capacities.[48] Unmanned surface vehicles have been used for various operation types including maritime security, and also for boosting situational awareness and survivability of naval assets. Unmanned underwater vehicles have become attractive due to their information gathering, stealth, autonomy, and non-attributable characteristics. Thus, these platforms' use is likely to increase in the forthcoming years. The proliferation of A2/AD capabilities and other features of emerging security environment demand an effective utilization of the complex set of tools, including not only the mentioned unmanned systems but also cyber, electromagnetic, air and missile defense systems in combination with more conventional elements.

In sum, unmanned systems, for some time already, have been in the process of integration into daily naval operations, became one of the central pillars of network-centric warfare concepts, and also became major components in "military systems".[49]

At this point, certain crucial questions may arise: How would a general or military analyst (re)calculate force-to-force ratio and acceptable casualties in case unmanned formations populate an important proportion of the battlefield? Would it make political-military decision-makers more courageous and willing to go to war, since they would not face the

43 Melanie Rovery, Robotic Recruits: The Adoption of UGVs in US Army Ground Formations, Jane's Defence Weekly, April 12, 2018.

44 Ibid.

45 Jeffrey N. Renehan, Unmanned Aerial Vehicles and Weapons of Mass Destruction: A Lethal Combination?, Air University, 1997.

46 The Telegraph, https://www.telegraph.co.uk/news/uknews/terrorism-in-the-uk/11177388/Terrorist-could-use-drones-for-chemical-and-biological-attacks.html , Accessed on: May 1, 2018.

47 Edgewood Chemical Biological Center, https://www.ecbc.army.mil/mobile/news/2016/ecbc-tests-chemical-biological-sensor-integration-utah-desert.html , Accessed on: May 1, 2018.

48 Krause, Joachim, and Sebastian Bruns, eds. Routledge Handbook of Naval Strategy and Security. Routledge, 2016.

49 For a broader discussion on naval force structures and network-centric warfare, Ibid.

burden of fallen troops and their sorrowful families at home? Most of the Western leaders preferred no-boots-on-the-ground policies in the face of the violent ISIS threat. Would they adopt the same cautious stance, say in the 2050s and beyond, should they become able to deploy a massive number of combat unmanned ground vehicles supported by highly autonomous unmanned aerial vehicles capable of swarming, as well as machine-machine and machine-human teaming? It should also be emphasized that in such a scenario, the bulk of the unmanned fighting force could be deployed from other unmanned naval surface platforms, and could refuel in the air from other unmanned tanker aircraft.

The unmanned systems and robotic warfare revolution, by nature, would not only play into the hands of state actors as mentioned above. Notably, we should ask some pessimistic questions such as: How would a radical extremist cell would plan a chemical or biological terrorist attack when cyber means will be more robust to target the SCADA (supervisory control and data acquisition) systems of very critical facilities, and when advanced mini-drones could be used to deliver genetically-engineered biological warfare agents effectively? What is worse, let's assume that the terrorist cell enjoys AI-driven modeling and simulation capabilities for predicting the dissemination efficiency rates of their delivery systems in any given large metropolis of the world, its drones have swarming skills, and its cyber information operations could manipulate millions of internet users around the world about the scope of the attack. All in all, robotic warfare, AI, and autonomous unmanned systems revolution could easily make the world a more dangerous place.

Conceptualization Of The Autonomy In Modern Military Systems

Amidst the 'bombardment' of fancy terms and titles, it would be wise to refine the readers' understanding of what 'autonomy' refers to, and how it could be assessed precisely. To start with, there is no black and white use of autonomy in modern warfare. Many systems are autonomous in different levels, depending on their tasks, their design philosophies, and techno-scientific capabilities of producer military-industrial complexes.

In theory, the degree of autonomy in modern robotic systems is often defined through a spectrum ranging from remotely operated vehicles to fully autonomous systems that require no human intervention. The US Department of Defense Unmanned Systems Integrated Roadmap categorizes *"self-directed"* and *"self-deciding"* systems based on their different autonomy features and design philosophies.[50] In the robotics terminology, remotely operated vehicles are sometimes named as teleoperated robots. Remotely-controlled (teleoperated) systems have varying degrees of autonomy, using in different tasks such as autonomous take-off and landing, and autonomous navigation. Most of the existing unmanned aerial systems, unmanned ground vehicles, unmanned surface vehicles, and unmanned underwater vehicles; as well as civilian deep sea exploration devices, planetary rovers, and medical devices used in surgery are considered as teleoperated or remotely-controlled robotic systems. Overall such systems include "*the operator interface*", *"the communications link"*, and the robot itself.[51]

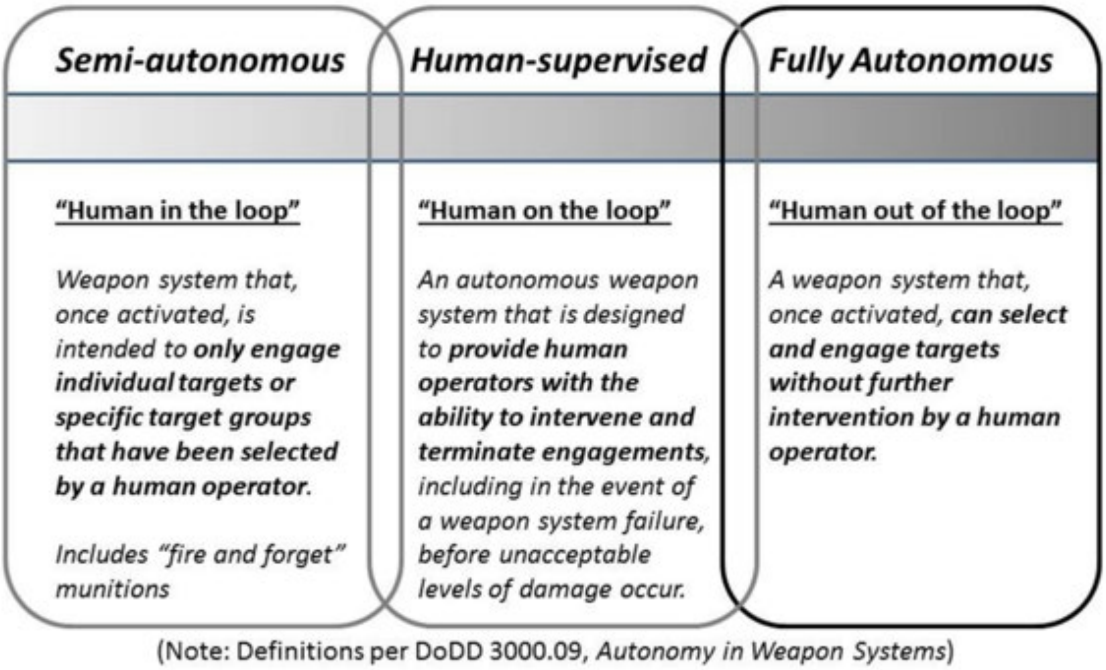
By definition, autonomy in military systems ranges from remotely-operated platforms and capabilities, which demand constant human control, to fully autonomous systems that are able to sense, analyze, interact with, and engage their environments without human intervention. To address the complexity of autonomy, a specific categorization is often used defining the human role in the operation of those systems and platforms.[52] *"Human-in-the-loop*" systems require constant, or frequent, control by the operator, especially for target selection and engagement. Most of the guided munitions, even though they have differing degrees of autonomy to carry out their missions, are controlled by human operators, and partly designed to give a boost to *"human control over warfare"*. Despite varying degrees of autonomy involved, a common requirement for guided munitions is a human operator

[50] Sloan Elinor, 2015.

[51] Winfield, Alan. Robotics: A Very Short Introduction. OUP Oxford, 2012.

[52] Paul Scharre and Michael C. Horowitz, "An Introduction to Autonomy in Military Systems", Center for New American Security, 2015.

selecting the target to be engaged. The systems with a *"human-on-the-loop"* address the demand of speed in the battlefield, detecting and engaging targets with predefined specifications. Air and missile defense systems and active protection systems fall under the *"unmanned supervised weapon systems"* within this category. On the far end of the autonomy spectrum, notably, *"human-out-of-the-loop"* systems can operate and decide to engage their targets with minimum human intervention. One specific type of systems within this category is loitering munitions that are able to detect and engage their targets. Israel's *"Harpy anti-radar system"* loitering munition is one of the few operational examples in this category.[53] The U.S. military used portable and small-size loitering munitions in counterinsurgency operations. Relevant studies also mention *"encapsulated torpedo mines"* with regards to their autonomy levels.[54]



The spectrum of "autonomy" and the U.S. Department of Defense definitions.[55]

Although previous military systems used limited and varying degrees of autonomy since at least mid-20th century, there is growing industrial and defense sector interest in acquiring more autonomous systems. First and foremost, the mentioned developments and progress in AI, robotics, and other technologies enable new systems that require much less and even no human intervention in operational cycles. Moreover, from military-strategic and operational standpoints, increasing autonomy in warfighting systems would mark significant opportunities. Although unmanned systems in all domains are getting increasingly sophisticated, still, most of these vehicles require "human-in-the-loop" procedures and demand a large number of personnel to carry out operations. Higher degrees of autonomy will decrease that demand by enabling unmanned systems to carry out operations relying on their own intelligence for learning, sensing, reacting, adapting to varying environmental aspects. Moreover, swarm intelligence will allow new tactical and operational tools that would include, but not limited to, *"wide-area, long-persistence, networked, adaptive electronic jamming, and coordinated attack"*.[56]

53 Ibid.

54 Ibid.

55 Jeffrey L. Caton, Autonomous Weapon Systems: A Brief Survey of Developmental, Operational, Legal, and Ethical Issues, U.S. Army War College Strategic Studies Institute, 2015. For the U.S. Department of Defense definitions: Under Secretary of Defense for Policy, Department of Defense Directive (DoDD) 3000.09, Autonomy in Weapon Systems, The U.S. Department of Defense, 2012.

56 Andrew Ilachinski, 2017.

Various factors drive the ongoing shift to more autonomous military systems, particularly increasing the availability of robotics and other relevant technologies, geostrategic competition, limitations in workforce and defense budgets, technical hurdles in the constant remote operation of unmanned systems, and the speed element which has been becoming a vital component of modern warfare. The mostly used unmanned systems require a significant amount of bandwidth and an often reliable satellite connection to be remotely operated. Increasing autonomy and artificial intelligence are likely to decrease such challenges.

Moreover, the operation of remotely-controlled systems requires significant manpower. Reportedly, for example, the operation of the US Air Force MQ-9 Reaper medium-altitude long-endurance unmanned aerial system requires 180 personnel, while the Global Hawk high-altitude long-endurance system requires 300. As quoted by Sloan Elinor in a recent study, a US military official names unmanned platforms as *"the number one manning problem"* in the US Air Force. Higher degrees of autonomy and better human-machine teaming enabled by artificial intelligence may diminish workforce requirements.[57]

Artificial Intelligence Revolution And Military Systems

A number of recent developments in the AI technology have already hinted at impressive progress in this promising and rising field. Both expert views and tangible achievements show that artificial intelligence already exceeds human capabilities in certain functions. In several cases, AI defeated the world champion of the Go game, well mimicked human brain to learn how to navigate complex structures such as the London Underground, developed unique encryption algorithms –although it is not taught to do so–, invented a unique "translation algorithm" to better carry out specific "interlingua" tasks, and even successfully performed diagnostic roles in healthcare by reviewing and learning "millions of mammograms" much faster than humans.[58] Taken together, the remarkable progress in the artificial intelligence field indicates significant implications for security and defense fields. These changes are not sci-fi, nor predicted for the next century or at the time when the humanity colonizes other planets. The expected impact is most probably to come in the 2020s and the 2030s.

An increasing number of defense firms now develop new systems powered by artificial intelligence, enabling human operators to interact with multiple unmanned systems in novel ways. From an operational perspective, this very trend may lead to less demanding workforce requirements, and faster, as well as more "intelligent" decision-support by modern systems. Notably, such military applications of the AI technology also rely on recent progress in natural-language processing, facial recognition, and other capabilities to enable greater human-machine collaboration.

This skyrocketing AI breakthrough will probably cause "disruptive" and immense effects both in military and civilian domains. Among the drivers of the current trends, significant uptrends in computing capabilities, availability of data, and progress in machine learning techniques deserve attention.[59] In this regard, a recent report by the Belfer Center highlights expected major changes in military, informational, and economic domains as potential outcomes of the future progress in artificial intelligence and robotics. The findings suggest increasing availability of AI-powered drone technology *"to a broader range of actors"*, boosted autonomy and automation in the cyber domain, more sophisticated use of AI in information operations, and significant shifts in the global economy –particularly in the job market–.[60] Furthermore, the cited Belfer Center study offers some thought-provoking scenarios as potential trajectories for the AI trends. The likely scenarios include **autonomous weapons** becoming the core element of modern armed forces – something that will render some of the prominent military systems obsolete–, broader use of **swarm intelligence**, and even widespread application of **robotic assassination tactics** that are *"difficult to attribute"*. Other scenarios would include broader use of AI in cyber warfare.[61] In sum, the AI technology is expected to cause fundamental changes in defense, security, and intelligence environments.

57 Sloan Elinor, 2015.

58 Andrew Ilachniski, 2017.

59 Allen Greg and Taniel Chan. Artificial Intelligence and National Security, Belfer Center for Science and International Affairs, 2017.

60 Ibid.

61 Ibid.

Artificial intelligence technology is expected to alter the decision-making processes in the modern battlefields. In particular, updates in the *"observe, orient, decide, act (OODA) loop"* are to address emergent hybrid or non-linear security challenges, partly due to the proliferation of the AI technology and autonomous systems. A recent Jane's briefing quoted NATO advisers urging the Alliance to develop and integrate AI-enabled systems into the existing capabilities: *"AI's distributed autonomy and scale mean that the classic decision loop in the battlefield is going to collapse. The machines will have to have more autonomous decision-making because more humans you put in the loop, the more latency [delay] you will add and the less efficiency in decision-making you get"*. Jane's quoted another figure stating that *"NATO's entire C4I [command, control, communications, computers and intelligence] profile has to be reorganized to deal with AI and hyper warfare"*.[62]

Integration of artificial intelligence technology into operations emanates from, and accelerates, the ongoing transformation of modern warfare since **speed and operational tempo** become increasingly important. Concepts such as hybrid warfare, non-linear warfare, and fifth-generation warfare identify the characteristics of changing defense and security environment, emphasizing the blurring military and non-military dimensions of war. Presence of combatants and non-combatants in *"indistinguishable"* ways in modern battlefields exceeds natural human capabilities to identify and react to events promptly.[63] The progress in artificial intelligence leads to increasing levels of autonomy to address such challenges. *"Information processing"*, *"cyber attacks"*, *"unmanned aerial swarms"*, *"autonomous weapon systems"*, and *"surveillance and social engineering"* are major types of operations that have been enabled by artificial intelligence.[64] The pace of progress in the AI and other relevant technologies will be able to expand the abovementioned set of missions significantly in the near-term. Recent announcements already reveal the expansion of swarming technology, human-machine teaming, and machine-machine teaming capabilities into littoral and undersea environments.[65] Moreover, the artificial intelligence, robotics, and swarming technologies evolve in a way that enables cross-domain operations of swarming robotic systems, such as the launch of unmanned aerial platforms from the unmanned surface or underwater platforms.

Expansion of machine-learning techniques is a major driver leading to the recent growth of the artificial intelligence technology. Machine-learning designs allow artificial intelligence systems to use prior knowledge, training data, and experience to foster decision-making capabilities. Three specific functions to develop such systems are supervised learning, unsupervised learning, and reinforcement learning methods. Although most of the previous research in the field have relied on supervised learning techniques, which require the human developer "supervising" the system with large amounts of data, notably, systems with other two forms of algorithms are increasing in number. Applications of machine-learning techniques are already used in defense and security domains. It is believed that intelligence organizations worldwide use machine-learning techniques to address analytical challenges emanating from large amounts of data. Furthermore, the technology is likely to enable more sophisticated human-machine and machine-machine teaming efforts. Two specific outcomes are the use of autonomous systems to increase the speed of ISTAR (intelligence-surveillance-target acquisition, and reconnaissance) operations and decision-making processes by militaries, as well as predictive analyses by intelligence organizations.[66]

The scientific community is increasingly able to solve the mysteries of the human brain by acquiring more detailed models. Although the autonomous systems in defense and security do not necessarily need a complete cognitive model, the scientific progress is highly likely to affect the momentum of development of new systems as well as the foundation of operational concepts.[67] For instance, the human-machine collaboration will have a significant impact in applications of future robotics and artificial intelligence technologies in the battlefield, partly relying on the mentioned techno-scientific interaction that enables robotic systems and AI to assist human operators, decision-makers, and analysts. A study by the National Research

62 Brooks Tiger, NATO Urged to Rapidly Absorb AI into its Command and Control, Jane's Defence Weekly, October 20, 2017.

63 Tate Nurkin, China and US Compete for AI Dominance, Jane's Intelligence Review, March 14, 2018.

64 Ibid.

65 C4ISRNET, https://www.c4isrnet.com/video/2018/04/12/heres-where-underwater-drone-technology-is/ , Accessed on: April 24, 2018.

66 Hussein Abbass, Artificial Intelligence Begins to Transform Security Landscape, Jane's Intelligence Review, November 15, 2017.

67 Emerging Cognitive Neuroscience and Related Technologies, National Research Council of the National Academies, 2008.

Council of the National Academies in the US highlights the abovementioned correlations as follows:

"Robotic assistants respond to the growing use of unmanned systems in the military, whereby large numbers of heterogeneous unmanned ground, air, underwater, and surface vehicles work together, coordinated by a smaller number of human operators.[68] *A key requirement for such systems is real-time cooperation with people and with other autonomous systems.*[69] *While these heterogeneous cooperating platforms may operate at different levels of sophistication and with dynamically varying degrees of autonomy, they will require some common means of representing and appropriately participating in joint tasks. Just as important, devel¬opers of such systems will need tools and methodologies to assure that the systems work together reliably and safely even when they are designed independently."*[70]

Transformative characteristics of new technologies have profound effects on the global geopolitical and geostrategic competition. Remarkably, China has emerged as a major investor in artificial intelligence technology and autonomous military systems. Beijing coordinates a nation-wide concentrated effort to create a $150 billion industry and become a global leader in the AI technology by 2030.[71] In the military domain, China's official conceptualization of this transformation centers on the shift from modern *"informatized"* warfare to future *"intellegentized"* warfare.[72] Among the expected future capabilities of Chinese military are *"intelligent and autonomous unmanned systems; AI-enabled data fusion, information processing, and intelligence analysis; war-gaming, simulation, and training; defense, offense, and command in information warfare; and intelligent support to command decision making"*.[73] The Chinese government announced multiple strategy documents highlighting its ambitious objectives.

Although the overall conditions noted hitherto seem promising, still, there remain various interconnected challenges for future development of autonomous systems. Firstly, there are significant time-consuming technical difficulties in generating systems that *"sense, perceive, detect, identify, classify, plan for, decide on, and respond to a diverse set of threats in complex and uncertain environments"*.[74] Secondly, the uncertainty of complex operational environments has major impacts on the criteria for trusting autonomous systems, especially at times of war. Thirdly, as autonomous systems use artificial intelligence to carry out their missions, they have *"emergent behaviors"* that are sometimes unforeseeable. The risk of potential undesirable behaviors may create additional cautionary approaches in development and acquisition of such capabilities. Furthermore, designing and planning *"human-machine interactions"* become an important challenge as autonomous systems do not rely on continuous "teleoperation" by humans. Finally, as achievements of artificial intelligence technology and autonomous systems rely on keeping the human out-of-the-loop, controlling and predicting behaviors of such assets emerges as a likely challenge in the development of future systems.[75]

The most common expectation from emerging new technologies is the simplification of tasks and operations for humans. However, new weapon systems and resulting concepts, procedures, and doctrines often add to the complexity of war, rather than simplifying it. In the realm of navies, for example, use of a variety of advanced platforms such as aircraft carriers and high-end surface vessels, aerial assets, underwater vehicles, and electromagnetic capabilities in several naval environments requires to manage interconnected and very complex operational demands, despite these weapon systems develop game-changer capabilities, thereby introduce a new set of policy, strategic, operational, and tactical options. Similarly, use of autonomous systems offers new *"context-dependent"* capabilities. All in all, *"autonomy itself does not reductively 'fix' any existing problems, rather, it redefines, extends and potentially opens up entirely new mission spaces. And its value can only be assessed in the context of specific mission requirements, the operating environment, and its coupling with human operators"*.[76]

[68] D.C. Summey, R.R. Rodrigues, D.P. DeMartino, H.H. Portmann Jr., and E. Moritz, Shaping the Future of Naval Warfare with Unmanned Systems, Naval Surface Warfare Center, 2001.

[69] Michael A. Goodrich and Alan C. Schultz, "Human-Robot Interaction: A Survey", Foundations and Trends in Human-Computer Interaction 1, no. 3 (2007): 203-275.

[70] Emerging Cognitive Neuroscience and Related Technologies, 2008.

[71] Elsa Kania, China's AI Agenda Advances, The Diplomat, 2018, https://thediplomat.com/2018/02/chinas-ai-agenda-advances/ , Accessed on: April 25, 2018.

[72] Elsa B. Kania, Battlefield Singularity: Artificial Intelligence, Military Revolution, and China's Future Military Power, Center For a New American Security, 2017.

[73] Ibid.

[74] Andrew Ilachinski, 2017.

[75] Ibid.

[76] Ibid.

Another important angle of AI is its interaction with information technologies and functions.

Considering information overflow challenges in modern warfare, separating meaningful and actionable information from the noise has become increasingly time-consuming and workforce demanding. Artificial intelligence technology has already started to be used to support analysis and management of large amounts of data. In particular, the combination of machine-learning techniques with cloud computing enables autonomous and network-wide situational awareness. Remarkably, artificial intelligence has already been used to support analysis of video footage and high-resolution imagery acquired by air platforms and satellites.[77] In a specific project called "Project Maven", the US Department of Defense utilized Google's TensorFlow artificial intelligence system to analyze video footage from unmanned aircraft.[78] Through deep learning neural networks, the system achieved high-accuracy rates in the classification of "objects of interest". Furthermore, capabilities related to the Project Maven were also combined with *"a correlation and geo-registration system"* called "Minotaur" *"to flag classified objects on a map"* for wider network-based use of acquired information.[79] The US military has already used capabilities developed with Project Maven against ISIS targets in Syria and Iraq.[80]

Project Quantum, a separate and larger scale project of the US Air Force, aims to develop a system *"to make sense of all the real-time sensor data from machines that flow across the enterprise and assess problems before they happen"*.[81] The project, utilizing a system called Cyber Physical Software (CPS), aims to add artificial intelligence to the decision-support toolkit and support analysis cycle regarding the components of armed forces, as well as external dynamics.[82]

Major challenges and vulnerabilities of AI based systems include cyber defense, security of training data, and prevention of potential adversarial manipulation.[83] A common security concern regarding artificial intelligence, and also other systems connected to communication networks, is *"hacking"*. In particular, developers of AI systems need to consider the security of the algorithms and data flow in and out of the systems. Furthermore, as artificial intelligence systems are trained, security of *"the training data"* is another potential concern. Once the system is trained, the primary threat would be *"input manipulation"*, aiming to alter the AI behavior. One specific concern which was referred to by a recent RAND study regarding the impact of AI on nuclear security is "*generative adversarial networks"*, which is *"a technique in which a generator neural network interacts with a classifier neural network to create increasingly fake examples"*.[84]

On a final note, various ethical and legal concerns continue to dominate the international debate regarding the use of lethal autonomous weapon systems. International humanitarian law is cited as applicable to the lethal use of autonomous systems. Moreover, a multi-faceted international conversation on the applicability and implications of a potential ban on lethal autonomous weapons systems continues. Notably, recent events in Syria, Iraq, Yemen, and some other parts of the Middle East suggest that extremist armed groups and "rogue" actors show a strong willingness to use these new technologies for their asymmetrical advantages. Increasing availability of the modern technologies, their dual-use nature, and relatively cheaper costs are major enablers. Even in case of an international agreement on a limited or total ban on lethal autonomous systems, preventing their development, export, and use will emerge as a major security challenge.[85]

[77] Military.com, https://www.military.com/defensetech/2018/04/10/air-force-looks-artificial-intelligence-fight-future-wars.html, Accessed on: April 29, 2018.

[78] Independent, https://www.independent.co.uk/life-style/gadgets-and-tech/news/google-artificial-intelligence-ai-pentagon-drones-us-military-air-force-surveillance-employees-a8245516.html , Accessed on: April 24, 2018.

[79] Defense One, https://www.defenseone.com/technology/2017/12/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/, Accessed on: April 24, 2018.

[80] Jack Shanahan, Project Maven Brings AI to the Fight Against ISIS, Bulletin of the Atomic Scientists, 2017, https://thebulletin.org/project-maven-brings-ai-fight-against-isis11374 , Accessed on: April 24, 2018.

[81] Forbes, https://www.forbes.com/sites/jenniferhicks/2017/08/22/united-states-air-force-starts-artificial-intelligence-project-to-analyze-flow-of-information/#59541ddf1534 , Accessed on: April 24, 2018.

[82] Ibid.

[83] Edward Geist and Andrew J. Lohn, How Artificial Intelligence Affect the Risk of Nuclear War, RAND Corporation, 2018.

[84] Ibid.

[85] Sean Welsh, Autonomous Systems Raise Legal Questions, Jane's Intelligence Review, January 18, 2018.

Geopolitical, Military-Strategic, Operational, And Political Reasons Of Turkey's Strong Interest In Unmanned Military Systems

A careful assessment of the top Turkish political-military decision-makers' and the defense industries elites' approaches to drones suggest that Turkey sees the unmanned military systems and robotic warfare issues more than, 'simply', military modernization portfolio, but a true geopolitical breakthrough opportunity. Ankara has been late in adapting to the pace of technological transformation in military industries. It could manage to produce its main battle tank, Altay, somewhat belatedly in the 2010s. Yet, the robotic warfare and unmanned systems revolution is drastically leading to a paradigm shift which could alter the major parameters of the global power struggle. At such times, second tier players of the previous era could take advantage of the emerging new conditions and improve their global standing. While Turkey is not in the lead in terms of manufacturer of manned fighters or bomber aircraft, it has already become one of the successful players for tactical armed unmanned aerial systems and related smart munitions.

From Ankara's standpoint, investing in unmanned military systems development marks certain strategic leaps. The first and foremost benefit remains the advanced warfighting capabilities brought about by unmanned systems, along with the goal of minimizing casualties in very dangerous hybrid battlegrounds. Secondly, taking advantage of the paradigm shift in global defense industries, Ankara and Turkish defense firms seek to foster export capabilities to the growing markets, especially at a time when Turkey offers combat-tested systems which is a key parameter in arms exports. Thirdly, Turkish strategic community wants no acquisition reliance, even on the allies, for capability development in high-end military technologies. Lessons-learned from the counterterrorism efforts of the 1990s, and some of Turkey's allies' reluctances to sell tactical game-changer weapons, are crucial facts in this respect.

Warfighting In Hybrid Battle-Spaces: Turkey's Drones Getting The Job Done

As discussed in previous sections, autonomous systems and unmanned platforms will be at the core of future warfighting concepts with a growing reliance in the forthcoming years. Thus, being active in these rising military trends would be tantamount to securing Turkey's competitive edge in the 2020s, the 2030s, and beyond. Looking into the recent Efes 2018 Exercises, at the time of writing, it is observed that the Turkish Armed Forces displayed advanced unmanned aerial systems capabilities equipped with smart munitions, along with real-time situational awareness boosting kits for ground troops[86]. This effort alone hints at the rising drone understanding of the Turkish military.

Having digested the lessons learned from Operation Euphrates Shield and Operation Olive Branch, Turkish political-military decision-makers saw the very reality that hybrid battle-spaces bring about extremely dangerous situations for military personnel. Advancing anti-tank guided missiles (ATGM) and improvised explosive devices (IEDs) pose menacing threats to armor survivability, while man-portable air defense systems (MANPADS) make altitudes below 10,000 – 15,000 feet risky for aerial platforms, especially for rotary-wing assets and low-flying attack aircraft. Besides, hybrid adversaries, including terrorist organizations, insidiously use information warfare. Thus, protecting soldiers from captivity in high-risk operational environments has become more crucial than ever to sustain the public support to military campaigns.

UAVs have already become game changers in Turkey's counterterrorism efforts. They enabled effective area control with advanced ISTAR capabilities, and produced results that could be achieved by the efforts of multiple battalions in the 1990s. At present, the Turkish Army and the Gendarmerie enjoy boosted tactical and operational awareness in the mountainous and rugged terrain of eastern Anatolia. Such an improvement enabled better security for military outposts which offered frequent targets for the PKK terrorist activity in the past decades. All in all, drones are providing the Turkish Armed Forces with beefed-up survivability.

A milestone for Turkey's unmanned systems capability development remains the production of indigenous armed unmanned aerial vehicles (SİHA in the Turkish acronym). Apart from the Bayraktar TB-2, Anka MALE UAV's armed variant has also started conducting active duties –with 200kg

[86] https://www.youtube.com/watch?v=O3H70DSd2bE&feature=youtu.be, Accessed on: May 23, 2018.

payload capacity and 24hours endurance– in counterterrorism operations in July 2017[87]. (New modernization efforts are likely to increase the payload capacity, and enable new mission attachments)

The Anka-S SATCOM-controlled UAV[88] variant is of significant importance. According to the Turkish Aerospace Industries, the satellite-control feature, which equips the drone with beyond the line of sight functions, already made Anka-S a more capable platform. From its command and control station, the system can operate up to 6 vehicles simultaneously. Besides, in case of a loss in communications, Anka-S is able to conduct autonomous landing to the pre-set fields[89].

Armed drones of Turkey, first and foremost Bayraktar TB-2 tactical UAV, have become game-changers in high-risk operational environments. Especially, pinpoint targeting performance throughout Operation Olive Branch was a strong indicator of what this newly developed capability could achieve.

Hybrid warfare challenges at Turkey's doorstep urge Turkish defense planners to invest more in the armed drone capacity. According to Turkey's official news agency, the latest batch of armed Bayraktar TB-2 platforms (8) were delivered to the Turkish Land Forces in March 2018. With the delivery, the current number of total Bayraktar TB2 aircraft in Turkish security forces' inventories was reported 46, of which at least 23 are armed with ROKETSAN-made smart munitions (at the time of writing, Baykar Makina delivered 6 additional Bayraktar TB-2 armed tactical UAVs to the Gendarmerie).[90] Turkish security forces have been using the systems since the first delivery in 2015. Turkish news outlets also reported that Bayraktar TB-2 platforms flew more than 4,000 operational hours during the Olive Branch campaign.[91] Apart from conducting precision strikes, the systems designated targets for other air force and army aviation platforms. Given the weather conditions, Bayraktar TB-2s were at times used in extremely high or low altitudes. Operation Olive Branch witnessed increased payload of the system (4 Roketsan-manufactured MAM-L munitions at a time), as well as a rich variety of the MAM-L line including thermobaric, anti-armor, and airburst variants.[92] More importantly, of total 3,391YPG / PKK militants eliminated by the Turkish Armed Forces and the indigenous components of the cross-border campaign, 449 were directly killed by these tactical armed drones. Besides, Bayraktar TB-2s also performed target acquisition for other platforms leading to further 680 kills. In total, the platform was used in 1,129 eliminations.[93]

On February 22, 2018, Turkish artillery –probably the 122mm class multiple-launch rocket systems (MLRS)– targeted a convoy, carrying arms and ammunition to the PKK/YPG militants in the outskirts of Afrin, Syria.[94] The Turkish Armed Forces later released the video footage of the strike, showing the successful discrimination of the highly time-sensitive military targets from nearby civilian vehicles, as well as from the adjacent populated areas. Apparently, Turkey's unmanned systems, which have been intensively deployed over the area of operations, had played a major role in this engagement through pinpoint ISTAR inputs, enabling quick reaction and precision strike opportunities.

Bayraktar TB2 unmanned aerial systems were also used in adverse weather conditions during the Operation Olive Branch. The platform is fitted with ROKETSAN's smart munitions.[95]

87 The Turkish Ministry of Defense, https://twitter.com/tcsavunma, Accessed on: April 21, 2018.

88 Jane's 360, http://www.janes.com/article/75160/turkey-to-start-testing-satcom-control-of-anka-s-uav, Accessed on: April 21, 2018.

89 Airforce-Technology, https://www.airforce-technology.com/news/tai-delivers-first-satellite-controlled-anka-s-system-turkey/, Accessed on: April 21, 2018.

90 Anadolu Agency, https://aa.com.tr/tr/turkiye/tskya-8-yeni-siha/1096099 , Accessed on: April 29, 2018.

91 Anadolu Agency, https://aa.com.tr/tr/turkiye/bayraktar-tb2-zeytin-dali-harekatinda-4-bin-saat-uctu/1097076, Accessed on: May 01, 2018.

92 Anadolu Agency, https://aa.com.tr/tr/turkiye/bayraktar-tb2-zeytin-dali-harekatinda-4-bin-saat-uctu/1097076, Accessed on: April 24, 2018.

93 Necdet Özçelik, "Askeri Harekatların Kuvvet Çarpanı: İnsansız Hava Araçları", Anadolu Ajansı, April 2018, https://aa.com.tr/tr/analiz-haber/askeri-harek%C3%A2tlarin-kuvvet-carpani-insansiz-hava-araclari/1122660, Accessed on: May 01, 2018.

94 Anadolu Agency, https://aa.com.tr/tr/dunya/tsk-muhimmat-konvoyunu-sivillerden-ayirip-vurdu/1071318, Accessed on: April 24, 2018.

95 Baykar Makina Official Twitter Account, https://twitter.com/Slck_byrktr/status/986695898817277952?s=20, Accessed on: April 25, 2018.

Apart from kinetic roles, Turkey also utilized its unmanned aerial systems to support information operations during the Olive Branch. Video footage obtained by drones were particularly circulated in social media.

In February 2018, media outlets reported video footage of the YPG militants firing mortars towards the Turkish territory from urban areas. The footage also included a subsequent air strike targeting the building sheltering the group.[96] On March 12, 2018, another footage appeared on Turkish media outlets, showing the YPG militants using force against the civilian population trying to escape the danger zone.[97] As a result of these and some additional cases, overall, unmanned aerial systems became an important asset to counter the YPG-led disinformation campaign.

Open-source pieces of evidence show that the Turkish forces also used micro unmanned aerial vehicles during Operation Olive Branch.[98] Micro UAS offer specific advantages in urban environments, especially due to the challenges posed by densely built areas. Considering the recent examples of how battlefield lessons-learned drive Turkey's unmanned systems development, Turkish security forces are highly-likely to increase their use of micro unmanned aerial vehicles in future. In fact, at the time of writing, the Undersecretariat for Defense Industries was running a tender for acquiring rotary-wing, micro UAS[99].

Rolling Wheels and Tracks: The Upcoming UGV Breakthrough

Turkey's warfighting concepts and plans about unmanned systems are not limited to the skies. In fact, the rise of non-linear threats necessitates a firm response through indigenous unmanned ground vehicles (UGV) production.

During the Olive Branch campaign, President Recep Tayyip Erdogan hinted at Ankara's plans to launch an 'unmanned tank' program, and set such an achievement as an imminent goal for the country's burgeoning defense industry. Moreover, President Erdogan highlighted two points when praising Turkey's unmanned military systems successes. Firstly, he drew attention to the importance of producing key weapon systems nationally, and reminded the hardships of procuring high-end arms –even from Turkey's close allies– in the past. When explaining how Turkey decided to foster its indigenous drone programs, President Erdogan voiced an old Turkish proverb, *"bad neighbor makes one own a house"*. Secondly, he set forth the casualty minimization objectives to explain the need for unmanned ground combat vehicles[100]. Notably, the President referred to an early incident that took place in Sheikh Haruz in early February 2018 when five Turkish soldiers lost their lives in their armor due to ATGM fire by the PKK / YPG militants. He also reminded the loss of a T-129 ATAK helicopter with its two crew[101].

Following the President's comments, the Turkish defense industry responded swiftly. On February 24, 2018, Ismail Demir, the Undersecretary for Defense Industries, tweeted that the armored combat vehicle Ejder Yalcin was being tested successfully for unmanned use in near future. Undersecretary Demir underlined that Turkey would be a nation to shape future technologies in robotic systems[102]. Besides, on February 25, 2018, the Undersecretariat for Defense Industries' official Twitter account released the pictures of some unmanned ground vehicles and explained that 43 armored platforms were currently active in the inventory for military engineering missions at home and abroad. Besides, on February 22, 2018, the Undersecretariat told that it was readying some 20 UGVs swiftly for the Olive Branch[103].

Ejder Yalcin "optionally unmanned" armored combat vehicle has been tested.[104]

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96 Hurriyet, http://www.hurriyet.com.tr/gundem/turkiyeye-roket-atan-teroristler-ilk-kez-bu-kadar-net-goruntulendi-40740503, Accessed on: April 24, 2018.

97 Anadolu Agency, https://aa.com.tr/tr/dunya/afrinden-cikmak-isteyen-sivilleri-tehditle-durdurdular/1086593 , Accessed on: April 24, 2018.

98 Anadolu Agency, https://aa.com.tr/tr/turkiye/yerli-sistemler-tsknin-gucune-guc-katiyor/1087243 , Accessed on: April 24, 2018.

99 The Undersecretariat for Defense Industries, https://www.ssm.gov.tr/Images/Uploads/MyContents/V_20180521170802880124.pdf, Accessed on: May 23, 2018.

100 Sabah, https://www.sabah.com.tr/ekonomi/2018/02/22/insansiz-tank-yapacagiz, Accessed on: April 22, 2018.

101 Ibid.

102 Undersecretary for Defense Industries Official Twitter Account, https://mobile.twitter.com/savunmasanayii?lang=en, Accessed on: April 22, 2018.

103 Ibid.

104 Ibid.

In February 2018, Turkey's Undersecretariat for Defense Industries (SSM) announced a new unmanned ground vehicle, UKAP (Uzaktan Kumandali Atis Platformu) UGV, while stating that the platforms would be delivered to the Turkish Armed Forces in the following months. UKAP UGV was initially designed to be fitted with ASELSAN's remote-controlled stabilized weapon system SARP for armed reconnaissance missions.[105] It is a modular platform and can be used for a broad array of missions, such as minesweeping as well as search and rescue operations.[106] The system can also utilize SATCOM technology to increase its operational range. Furthermore, future variants may be able to be networked with unmanned aerial systems.[107] The UKAP UGV can be employed to diminish risks to the troops on the ground in hybrid warfare environments. Apart from the Turkish Armed Forces, Katmerciler, the producer of the UKAP UGV, offers the system's variants to international defense markets.[108] The firm recently signed a cooperation deal with Malaysia's DefTech for the promotion of the system for potential buyers in Asia.[109] At the time of writing, a Turkish defense consortium – including Katmerciler, Delta, and Savronik – signed a deal with the British Horiba Mira to develop a new version of the company's Viking UGV for Turkey[110].

Throughout Operation Olive Branch, the Turkish Armed Forces also employed TOSUN "engineering" unmanned ground vehicles.[111] In February 2018, Turkish authorities stated that engineering UGVs were actively used in military operations in Syria.[112] TOSUN UGV has an operational range of 5 kilometers, and it is primarily used for clearing roadblocks and trenches. The requirement for such systems emerged particularly after 2015, during counterterrorism operations against the PKK's urban terrorism campaign, and subsequent cross-border military campaigns in urban and sub-urban battlegrounds. Facing increasingly urban and hybridized threats, fast integration of the TOSUN UGV into Turkey's military operations highlight a strong awareness and willingness to utilize advantages of modern unmanned systems technology.

Last but not least, Turkey's armor survivability projects deserve attention. Currently, Turkish defense firms involve in a few programs to develop active protection systems (APS) for ground vehicles. Recently, the PULAT system (later named Pulat-AKKOR, based on the Zaslon-L) was announced ready to fit Turkish armored platforms in cooperation with the Ukrainian defense industries.[113] The system is able to detect, track, and engage multiple projectiles simultaneously, and it is designed to eliminate its targets in short distances. ASELSAN also develops the AKKOR APS, a more sophisticated system with both hard-kill and soft-kill capabilities, to engage multiple

TOSUN engineering UGV played an important role during Operation Olive Branch.[114]

targets in a range of 100 meters. Considering the speed element, active protection systems require a greater level of autonomy than remotely controlled systems. They are able to detect, classify, track, and engage their targets with a speed which often exceeds natural human limitations. Therefore, the development and active use of indigenous active protection systems would be a major milestone for the Turkish defense industry, particularly regarding "human-on-the-loop" autonomy. Highlighting the fact, Turkey's Defense Minister Nurettin Canikli recently stated that the PULAT system is a major turning point for the future of Turkish defense sector.[115]

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105 Anadolu Agency, https://aa.com.tr/tr/turkiye/tskya-insansiz-kara-araci-takviyesi/1071403, Accessed on: April 24, 2018.

106 Anadolu Agency, https://aa.com.tr/tr/ekonomi/insansiz-kara-aracinda-ihracat-basarisi-/1010835, Accessed on: April 24, 2018.

107 Ibid.

108 Ibid.

109 HaberTurk, http://www.haberturk.com/alpagu-ile-kargu-dunyanin-ilgisini-cekiyor-1827948-ekonomi/13 , Accessed on: May 1, 2018.

110 Jane's Defence Industry,"Horiba Mira Signs Turkish UGV Agreement", May 24, 2018.

111 TRT Haber, http://www.trthaber.com/m/?news=insansiz-kara-araclari-goreve-hazir&news_id=352696&category_id=10 , Accessed on: April 21, 2018.

112 Anadolu Agency, https://aa.com.tr/tr/turkiye/milli-savunma-bakani-canikli-afrinde-insansiz-is-makinelerini-daha-fazla-kullanacagiz/1074952, Accessed on: April 24, 2018.

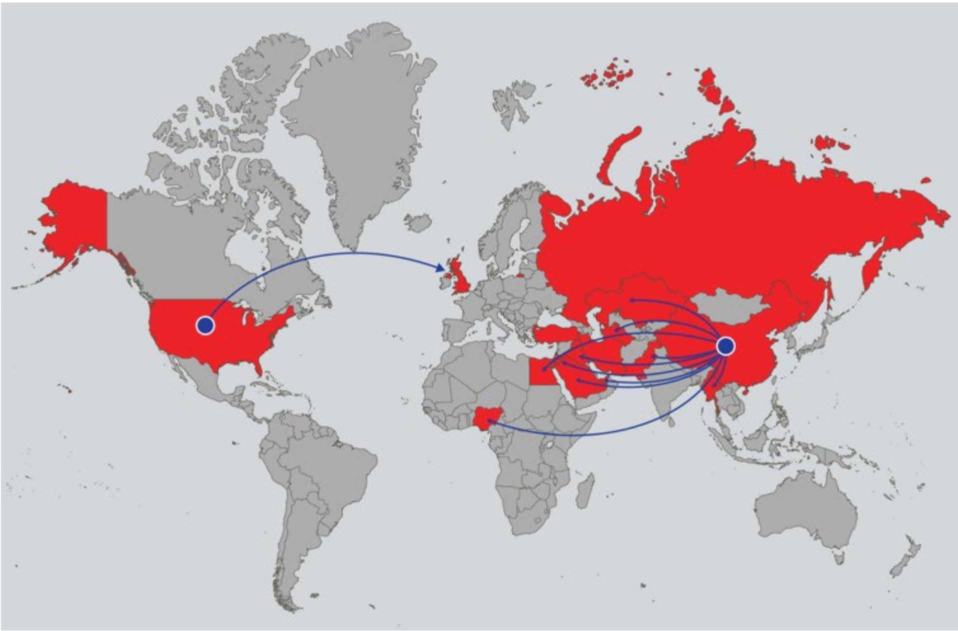
113 Aksam, https://www.aksam.com.tr/foto-galeri/guncel/-afrin-merkeze-once-tosun-girecek/41859/, Accessed on: May 01, 2018

114 Anadolu Agency, https://aa.com.tr/tr/turkiye/bakan-canikliden-pulat-aciklamasi/1081899 , Accessed on: April 29, 2018.

115 Ibid.

Defense Exports

There are two major clusters of themes in the international debate regarding the exports of unmanned military systems. The first theme approaches the subject as a **proliferation issue,** while also consists of an emphasis on technological diffusion and transformation of defense and security affairs. As mentioned in other sections of this report, relatively low-costs, commercially-driven market features, accessibility, and a number of attracting capabilities are key factors for unmanned systems' worldwide spread. At least 90 countries and non-state actors possess unmanned aerial systems, although with varying degrees of size and sophistication.[116] The proliferation of armed drones is slower, with at least 16 countries either indigenously developed or imported these types of systems with a defense industry focus, although technological diffusion increasingly enables new development programs as well as fitting initially commercial or military ISR systems with lethal capabilities.[117]



Countries with armed unmanned aerial systems, and exporting nations.
According to the CNAS report (2017), pending exports are not included in the map.[118]

The second theme is **the growth of market size and international competition.** Israel, the United States, and China are major players in the field. The abovementioned trends enlarge market opportunities for other developers too. Two major complications affecting the market movements are the Missile Technology Control Regime (MTCR) and the United States' declared policies regarding the export of unmanned systems. Currently, MTCR categorizes unmanned aerial systems similar to the missile technology rather than aircraft, discouraging exports of unmanned platforms with "*a payload of at least 500 kg to a range of at least 300 km*",[119] and their components. The United States is leading an initiative to ease the MTCR regulations by proposing an update to the categorization of the regime.[120] Recently, the Trump Administration also released a memorandum on arms sales which aims to ease regulations for unmanned aerial systems exports.[121] Notably, China has emerged as a major drone exporter in recent years, attracting buyers particularly in the Middle East, Central Asia, and Africa.[122] In addition, Israel remains a prominent exporter of unmanned aircraft, mainly for ISR purposes. Besides, the global market for unmanned surface vehicles, unmanned underwater vehicles, and unmanned ground vehicles is also growing.

116 Elisa Catalano Ewers, Lauren Fish, Michael C. Horowitz, Alexandra Sander, and Paul Scharre, Drone Proliferation Policy Choices for the Trump Administration, Center for a New American Security (CNAS), 2017.

117 Ibid.

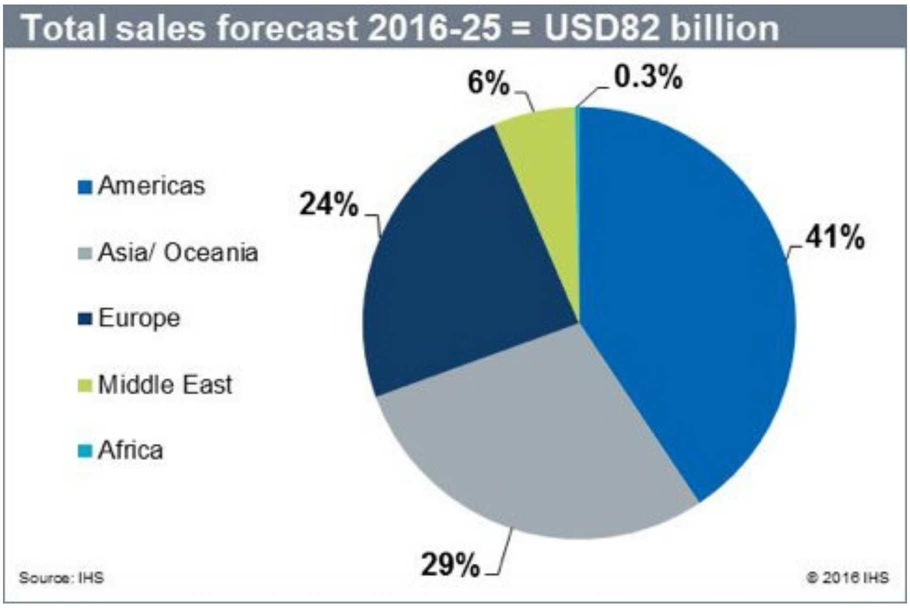
118 Ibid. Data sources: Matt Fuhrmann and Michael C. Horowitz, "Droning On: Explaining the Proliferation of Unmanned Aerial Vehicles," International Organization, 71 no. 2 (Spring 2017), 397-418; and Stockholm International Peace Research Institute (SIPRI) Arms Transfers Database, https://www.sipri.org/databases/armstransfers.

119 Fact Sheet Bureau of International Security and Nonproliferation, the U.S. Department of State, https://www.state.gov/t/isn/rls/fs/2017/266847.htm, Accessed on: April 29, 2018.

120 Defense News, https://www.defensenews.com/air/2017/12/19/heres-how-the-trump-administration-could-make-it-easier-to-sell-military-drones/, Accessed on: April 22, 2018.

121 National Security Presidential Memorandum Regarding U.S. Conventional Arms Transfer Policy, The White House, https://www.whitehouse.gov/presidential-actions/national-security-presidential-memorandum-regarding-u-s-conventional-arms-transfer-policy/, Accessed on: April 25, 2018.

122 Reuters, https://www.reuters.com/article/us-singapore-airshow-drones/u-s-israeli-drone-makers-keep-wary-eye-on-rising-chinese-idUSKBN1FS1E7, Accessed on: April 25, 2018.



A briefing by IHS Jane's (2016) forecasts global military unmanned aerial system sales totaling 82 billion US Dollars between 2016 and 2025. The graph shows the portions of region-based projections.[123]

The Turkish defense industry's efforts in developing drones have already paid off in lucrative deals. Since robotic warfare, autonomy, and unmanned systems are becoming the very reality of future warfare, Ankara sees an invaluable opportunity to step up Turkey's arms exports in the forthcoming years through more advanced – and more importantly, combat-tested – unmanned systems.

Especially in recent years, several export deals, both finalized and prospective, have already marked the merits and benefits of Turkey's unmanned systems exports policy. Turkey's Anadolu Agency reported that during the DSA 2018 Exhibition, Turkish defense authorities have been in talks with Malaysia for finalizing an important sale package of Anka MALE UAVs, following the initial understanding reached in the last year's IDEF 2017[124]. Jane's 360 also confirmed the prospects of such a deal, hinting at a further collaboration between the Malaysian defense contractor DRB-HICOM DefTech and Turkish Aerospace Industries (TAI)[125]. Furthermore, Turkey aims to hit a larger market share in Southeast Asia. In this regard, bilateral defense cooperation between Turkey's TAI and PT Dirgantara Indonesia could lead to the production of a MALE unmanned aerial system (based on the ANKA line) for the Indonesian Air Force.[126] In January 2018, Jane's Defence Weekly quoted Indonesian officials stating that the deal would include "*joint development and localized manufacturing*".[127] Besides, at the time of writing, Turkey and Kazakhstan agreed on a cooperation deal including the ANKA UAS and the trainer aircraft Hürkuş.

Along with TAI, Turkey's ASELSAN is also exploring new markets. This important Turkish defense actor develops a variant of its Stabilized Advanced Remote Weapon Platform (SARP) with its Malaysian partners. ASELSAN teams up with the National Defence University of Malaysia (UPNM), and Malaysian Industry-Government Group for High Technology (MIGHT) in the ongoing program. Moreover, Malaysia's DefTech, Turkey's Katmerciler, and ASELSAN currently collaborate to develop "*the SARP-UGV unmanned ground vehicle*".[128]

Apart from the abovementioned programs and expansions, ASELSAN already has a significant presence in Malaysia. ASELSAN Malaysia, a new local subsidiary, has been active since 2017. The company collaborates with Gentin Etika (GESB) to produce the SMASH naval gun for the Malaysian Navy.[129]

123 Unmanned Systems: The Reign of the Persistent Warriors, IHS Jane's Intelligence Briefings, November 11, 2016.
124 Anadolu Agency, https://aa.com.tr/tr/turkiye/ankalar-malezya-yolunda-/1119748, Accessed on: May 01, 2018.
125 Jane's 360, http://www.janes.com/article/79345/dsa-2018-tai-offers-anka-male-uav-to-southeast-asian-countries, Accessed on: May 01, 2018.
126 Gabriel Dominguez, DSA 2018: TAI offers Anka MALE UAV to Southeast Asian Countries, Jane's Defence Weekly, April 17, 2018.
127 Jon Grevatt, Indonesia, Turkey Set to Co-Develop MALE UAV, Jane's Defence Weekly, January 18, 2018.
128 Jon Grevatt, DSA 2018: Aselsan Commits to Malaysian Expansion, Jane's Defence Industry, April 17, 2018.
129 Ibid.
130 Embassy of Pakistan, http://www.pakembassyankara.com/sdetay.asp?did=456 , Accessed on: April 29, 2018.

Turkey also enjoys strong and growing defense cooperation with Pakistan. Previously, Turkish defense industry played an active role in the modernization of Pakistan's F-16 fighter arsenal. The Pakistani Navy is expected to procure Turkish MILGEM corvettes. Recently, Turkey signed a deal with Pakistan's PAC Kamra to procure 52 MFI-17 Super Mushshak trainer aircraft. Ankara and Islamabad have a "High-Level Military Dialogue Group"[130] to foster bilateral defense cooperation. Notably, Ankara has been in talks with Islamabad for the sale of some 30 T-129 ATAK gunships. Pakistani authorities, including Prime Minister Shahid Khaqan Abbasi, repeatedly expressed their interest in procuring the TAI and AgustaWestland (AW) manufactured T-129 ATAK gunships to replace aging platforms of the Pakistani military.[131] In March 2018, 3 T-129 ATAK attack helicopters of the Turkish military joined the Independence Day military parade in Islamabad, highlighting the level of bilateral defense relations, and importance of the ongoing talks on the procurement of these high-end army aviation platforms. Especially, if the T-129 ATAK deal realizes, Turkey's defense partnership with Pakistan will gain a significant boost.

Capitalizing on the momentum, incorporation of unmanned systems more intensively into the Pakistani – Turkish defense projects remains a strong possibility.

Along with Pakistan, Turkey also builds on its strategic relations with the wealthy Gulf nation Qatar. In March 2018, during the DIMDEX 2018 Exhibition, Turkish defense firms signed multiple agreements with a total worth exceeding 700 million US dollars, such as Baykar Makina securing a deal for the armed variant of Bayraktar TB-2. According to the official press release, Baykar Makina will deliver six platforms, three ground command stations, a UAS training simulator, and a command and control system to the Qatari Armed Forces.[132] Previously, achieving Turkey's first-time drone export, the firm also delivered Bayraktar Mini unmanned aerial systems to Doha.[133] Bayraktar Mini is a portable system designed for the use by ground troops for tactical ISR purpose.[134] The recent deal for Bayraktar TB-2 systems will potentially lead to future export of Turkish precision smart munitions too.

Self Reliance For Turkey's Military-Industrial Complex At A Time Of Paradigm Shift Towards Robotic Warfare

On various occasions, Ankara saw the very necessity of producing key weapon systems and platforms predominantly by its national industrial complex, since dependence on foreign supplies can be easily subject to political conditions. Thus, investing in unmanned military systems, and equipping the Turkish Armed Forces with indigenous weaponry in general, is seen as a guarantor of Turkey's geostrategic *marge de manoeuvre*.

Turkey's indigenous motivations stem from two particular set of requirements : the ongoing need for counterterrorism operations, and some NATO allies' reluctances to sell arms to be used in the those efforts. The constraints on the supply of of tactical game-changers, most notably armed drones, is another problematic area.

The Gendarmerie, under the Ministry of Interior, is one of the principal pillars of Turkey's counterterrorism capacity. The Turkish Gendarmerie is expected to boost its close-air support and ISTAR capabilities with a combination of new unmanned aerial systems and also T-129 ATAK gunships. The Undersecretariat for the Defense Industries (SSM) recently announced the delivery of 3 ATAK helicopters to this branch.[135]

Turkish military-industrial complex has used nationalist symbols during the T-129 deliveries to the Gendarmerie Command. The choppers were designated as J-1071 Alparslan *(with 'J' stands for Jandarma –the Gendarmerie in the Turkish language– Alparslan was named after the famous Seljuk Sultan that commanded the critical battle of Malazgirt in 1071 to push into Anatolia),* J-1299 Osman Gazi *(named after the first Ottoman Sultan and the foundation year of the Empire),* and J-1453 Fatih *(named after Sultan Mehmed II the Conqueror –Fatih– and the Conquest of Istanbul in 1453)*[136].

131 Hurriyet, http://www.hurriyet.com.tr/gundem/1-5-milyar-dolarlik-atak-40779075 , Accessed on: April 29, 2018.

132 TRT Haber, http://www.trthaber.com/m/?news=yerli-uretim-sihalarin-ihracat-basarisi&news_id=355173&category_id=7 , Accessed on: April 24, 2018.

133 Hurriyet Daily News, http://www.hurriyetdailynews.com/turkey-sells-mini-drones-to-qatar-15862, Accessed on: April 25, 2018.

134 SSM Official Twitter Account, https://twitter.com/SavunmaSanayii/status/973843733585317888?s=20 , Accessed on: April 25, 2018.

135 Undersecretary for Defense Industries Official Twitter Account https://twitter.com/IsmailDemirSSM/status/986890931734503424?s=20, Accessed on: April 22, 2018.

136 Ibid.

T-129 ATAK delivery to the Gendarmerie, J-1453 Fatih (Commemorating the conquest of Istanbul in 1453 and Sultan Mehmed II the Conqueror – Fatih – is visible on the tail)[137]

According to previous announcements, at least 6 Bayraktar TB2 platforms, of which 2 were the armed variants,[138] and 2 ANKA platforms were delivered to the Turkish Gendarmerie in 2017 (at the time of writing, Baykar Makina delivered 6 additional Bayraktar TB-2 armed tactical UAVs to the Gendarmerie). The Gendarmerie is expected to receive some 40 armed ANKA platforms in total.[139] Apart from other small-size UAVs that are used for internal security operations, ATAK attack helicopters, ANKA and Bayraktar TB-2 unmanned aerial systems are particularly significant for their growing network-centric capabilities.

The Turkish Gendarmerie's acquisition of Bayraktar TB-2 UAS and T-129 ATAK gunships is of even more critical importance due to a recent deal brokered by the Undersecretariat for Defense Industries. According to the deal, Baykar and TAI, producers of these two platforms, agreed to share real-time data transfer between Bayraktar TB-2 tactical drone and T-129 ATAK attack helicopter[140]. Indeed, network-centric approaches and advanced platforms (and of course, smart munitions manufactured by ROKETSAN) would transform the Turkish Gendarmerie into a capable hybrid warfare actor.

Apart from the tactical and MALE segments discussed earlier, new smaller UAVs could mark very critical achievements for Turkey's robotic warfare capabilities in the future.

In terms of autonomy, ALPAGU and KARGU tactical loitering and attack unmanned aerial systems, and TOGAN micro ISR unmanned aerial vehicle could offer significant capabilities. ALPAGU is a fixed-wing, tube-launched, and portable system initially designed for the use of elite ground forces in asymmetrical warfare environments. The initial variant of the system, consisting of a launcher, the platform, and a control station, has a of range 5km and 10 minutes of duration. KARGU is a quadcopter sister system, also designed for tactical loitering. Although they are remotely controlled with a fire-and-forget function to engage their targets, both systems have significant autonomy. They utilize "*computer imaging for targeting*", and they are fitted with machine-learning algorithms "*to optimize target classification, tracking, and attack capabilities without the requirement for a GPS connection*".[141] Reportedly, ALPAGU and KARGU systems entered into the serial production phase, and first deliveries to the Turkish Special Forces were made in the last quarter of 2017.[142] Recently, ALPAGU Block II was unveiled. The system consists of an upgraded platform, a multi-launcher, and a new warhead. ALPAGU Block II will be able to fit on ground and naval platforms, and could also be used from stationary ground troop contingents and military bases. TOGAN micro UAV uses similar "deep-learning" algorithms for ISR purposes. Notably, ALPAGU and KARGU systems might be expected to acquire initial swarming capabilities by 2019.[143]

137 Takvim, https://www.takvim.com.tr/guncel/2018/02/24/jandarmaya-ilk-atak-teslim-edildi, Accessed on: April 22, 2018.

138 Yeni Safak, https://www.yenisafak.com/ekonomi/bayraktar-tb2-ihalar-jandarmaya-teslim-edildi-2623628 , Accessed on: April 25, 2018.

139 Update: Turkish Gendarmerie Receives T-129 Attack Helicopters, Jane's Defence Weekly, April 24, 2018.

140 Hurriyet, http://www.hurriyet.com.tr/gundem/iha-gosterecek-atak-vuracak-40814994, Accessed on: May 02, 2018.

141 James Bingham, Turkish Special Forces Receive Loitering Munitions, Jane's Defence Weekly, December 12, 2017.

142 Ibid.

143 HaberTurk, http://www.haberturk.com/alpagu-ile-kargu-dunyanin-ilgisini-cekiyor-1827948-ekonomi/9 , Accessed on: April 28, 2018.

Flying To New Horizons

Turkey's top procurement body, the Undersecretariat for Defense Industries recently released its 2018 – 2022 Sectoral Strategy Document. According to the detailed white paper, Turkey adopts three main objectives in the autonomous and unmanned systems segment as follows[144]:

- **Obtaining the required sub-systems and technologies to support a sustainable unmanned and autonomous systems sector** (especially due to import limitations, as well as for gaining strategic independence),

- **Boosting the national unmanned aerial systems'* capabilities** *(*the document prefers using the Turkish acronym –İHA–, which refers to unmanned aerial systems, instead of a broader unmanned military systems emphasis),*

- **Preparing the unmanned systems sector for the future.**

Although the document prioritizes unmanned aerial systems, it also addresses other emerging unmanned military platforms, such as UGVs and unmanned maritime capabilities. This is a promising input showing the signs of a holistic approach. More crucially, the strategy document also highlights key breakthroughs, such as swarming intelligence, and refers to the autonomous weapons systems as the "third revolution in battlegrounds" after the gunpowder and nuclear weapons. However, the Undersecretariat did not openly mention other cutting-edge leaps, such as cross-domain drone operations, within its four-year scope[145].

At this point, some projects deserve attention for predicting Turkey's future drone capabilities:

- Recently an unmanned underwater vehicle, "a *mobile naval mine*", was unveiled by Albayraklar Savunma Teknolojileri Sanayi, a Turkish defense firm.[146] The company will officially launch its new project, called Wattozz, in June 2018.[147] As far as the initial reports suggest, the Wattozz systems include multiple unmanned underwater vehicles with skills such as stealth and encrypted remote control. The system can be used for kinetic strike as well as ISR missions. Wattozz will be able to detect, classify, track, and engage enemy naval platforms with explosive strike capabilities.[148] This project is of specific importance because the early indicators of the system hint at the prospects of swarm use. In case the producers could indeed succeed to develop an advanced level of swarming, then the Turkish Navy's deterrence capacity would be augmented by a force-multiplier asset.

- Baykar Makina is set to develop a heavy unmanned aerial system for the Turkish military. In February 2018, Turkey's National Defense Minister Nurettin Canikli announced that the new system would be named as Akinci, 'the raider', referring to the unconventional elite Turkish warriors in the medieval age. The platform will have 3,5 tons of maximum take-off weight, SATCOM capability, and will be fitted with four smart munitions, heavier than currently used precision weapons on Bayraktar TB-2 and ANKA platforms. In total, the platform will have around 1,000 kilograms of payload capacity. The first delivery is expected to be completed in 2021. Notably, Defense Minister Canikli also stated that Turkey's next-generation unmanned combat aerial system would be based on the Akinci line, and it is expected to be procured by 2027.[149] Strategic systems is a still awaiting level for the Turkish unmanned systems production.

This study forecasts –and strongly recommends– three major and achievable goals for Turkish defense industry in coming years.

The first goal is to be driven by an enhanced operational concepts vision. While Turkish defense sector has scored important points in several UAS segments, and recently showed a growing interest in the UGV production, it should adopt a cross-domain understanding. Given the

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144 The Undersecretariat for Defense Industries, 2018 – 2022 Savunma Sanayii Sektörel Strateji Dokümanı, 2018, pp.50-53.

145 Ibid.

146 Defense News, https://www.defensenews.com/unmanned/2018/04/16/this-remote-controlled-naval-mine-attaches-to-ships-explodes-on-command/, Accessed on: April 24, 2018.

147 Albayraklar Savunma Teknolojileri Sanayi, http://www.albayraklar.com/ , Accessed on: April 24, 2018.

148 Defense News, https://www.defensenews.com/unmanned/2018/04/16/this-remote-controlled-naval-mine-attaches-to-ships-explodes-on-command/, Accessed on: April 24, 2018.

149 Yeni Safak, https://www.yenisafak.com/gundem/akinci-geliyor-3163615 , Accessed on: April 25, 2018.

technological trends and contemporary battle-space parameters, UGV – UAV teaming seems the most imminent and most feasible opportunity for defense ventures.

The developments in the UGV – UAV teaming projects now produce more realistic results. For example, the Estonian defense firm MILREM has developed relevant concepts of operations for its THeMIS (Tracked Hybrid Modular Infantry System) unmanned ground vehicle. As reported by IHS Jane's, MILREM cooperates with another Estonian firm, Eli, to fit the THeMIS UGV with UAV launch and recovery capabilities, utilizing an unmanned quadcopter[150], and Eli's Drone Nest System.[151] In addition, at least one variant of the UGV can tether a multi-rotor unmanned aerial system developed by Threod Systems.[152] Originally, the THeMIS platform was unveiled in 2015. The system is able to be fitted with a wide range of payloads, with a guaranteed capacity of 750 kilograms. (In 2017, the platform was displayed carrying ASELSAN's Stabilized Advanced Remote Weapon Station during the IDEX 2017 defense show in Abu Dhabi).[153]

Another notable example of UGV-UAV teaming efforts, which this time the UAV platform carries the UGV, centers on the Squad Mission Support System (SMSS), developed by Lockheed Martin. The UGV is designed to carry out multiple types of missions including logistics, fire-support, and armed reconnaissance. It is one of the heavier platforms among other systems built for similar missions, weighing some 1955 kilograms, and utilizes various degrees of autonomy. In several occasions, the platform was dropped by an unmanned aerial system, the K-Max helicopter, into a simulated area of operations to carry out its missions such as logistical support or surveillance, "*returning high-definition imagery via satellite*".[154] On a different note, as one of the most remarkable examples of cross-domain unmanned systems teaming, the US Navy experimented with unmanned ground vehicles launching unmanned aerial vehicles "*after exiting an autonomous assault amphibious vehicle*" during an amphibious exercise.[155]

Secondly, lessons-learned from Azerbaijan's April 2016 clashes with the Armenian forces over Nagorno Karabakh suggest that loitering weapon systems (known as 'kamikaze drones') would play crucial roles in future complex battlegrounds. During the conflict, Baku took advantage of its military cooperation with Israel, one of the most important drone manufacturers and exporters of the world, and extensively used Israeli-made loitering munitions to target Armenian military formations with high precision[156]. During the clashes, the Washington Post reported that the Azerbaijani Armed Forces used Israeli Harop "suicide drones"[157]. The Israeli Aerospace Industries' Harop is an advanced loitering weapon system with 6 hours endurance, 185km cruising speed, and could strike from any direction at any attack angle[158]. Loitering munitions offer precision solutions against time-sensitive, relocatable targets. Especially in areas with high-risk of collateral damage, or when in need of minimizing the identification – engagement cycle, these assets are fairly effective. Furthermore, by providing a fusion of surveillance and strike capabilities, loitering munitions are becoming more reliable as their technological enablers advance[159].

IAI's Harop Loitering Weapon System.[160] This ISR/Strike asset reportedly played a key role for the Azerbaijani Armed Forces during the April 2016 clashes.

150 UMEX 2016: THeMIS set for load-carrying role in upcoming trials, Jane's International Defence Review, March 07, 2016.

151 Update: MILREM eyes fourth- and fifth-gen THeMIS UGVs, Jane's International Defence Review, October 10, 2017.

152 Ibid.

153 THeMIS, Jane's Land Warfare Platforms: Logistics, Support & Unmanned, 2018.

154 Squad Mission Support System (SMSS), Jane's Land Warfare Platforms: Logistics, Support & Unmanned, 2018.

155 Ibid.

156 For an in-depth analysis of the 2016 conflict, see: Laurence, Broers. The Nagorny Karabakh Conflict: Defaulting to War, Chatham House, 2016.

157 The Washington Post, https://www.washingtonpost.com/news/checkpoint/wp/2016/04/05/israeli-made-kamikaze-drone-spotted-in-nagorno-karabakh-conflict/?utm_term=.75752e409cd3, Accessed on: May 23, 2018.

158 Jane's IHS Markit, IAI Harop, April 2018.

159 Jane's IHS Markit, Loitering with Intent, November 2015.

160 http://www.iai.co.il/2013/36694-46079-en/Business_Areas_Land.aspx, Accessed on: May 23, 2018.

As noted earlier, Turkey made a promising initiation into the loitering weapon systems sector with Alpagu and Kargu. Yet, Turkish defense industry still has way to go before producing more advanced systems with more endurance, higher payload, and better capabilities overall. At this point, the most important thing is to avoid reducing loitering munitions into a Special Forces capability. The Israeli inventory, as well as Azerbaijan's operational achievements in April 2016, showed that advanced loitering weapon systems could play crucial roles in hybrid battlegrounds carrying the risk of inter-state conflict.

The third and final goal that this report recommends is about developing a thorough understanding of what the next Revolution of Military Affairs is about. As discussed earlier, the next RMA will center on robotic warfare, and will be underpinned by artificial intelligence enabled technological features.

Optimistically, given the open-source indicators, it is evident that Turkey has already started to review its options in robotic warfare and autonomy-related fields.

In 2017, the Undersecretariat for Defense Industries organized the Unmanned and Autonomous Land Platforms Design Competition, the ROBOIK, to boost Turkey's research & development capacity in this segment. The most promising achievement of the project was its success in mobilizing Turkey's innovative minds from all corners of the country. ROBOIK managed to attract hundreds of unmanned autonomous land platform projects[161]. In early 2018, the Undersecretariat announced a new endeavor, called the "Robot Soldier Project", with an invitation for academic participation.[162] The project, at first, is designed to attract all interested persons and institutions which could contribute to Turkey's robotic systems development in a wide-array of sub-systems. By doing so, the Undersecretariat aims to grasp the national capacity to foster robotic research and development opportunities[163].

However, if Ankara's strategic calculus is to be on the winning side of the coming paradigm shift, then solely designing and producing weapon systems would not be sufficient. A pioneer nation should also take the lead in concept development and shaping the global debate. In doing so, Turkey's academia, business circles, strategic community, military, intelligence community, and government should actively involve in the ongoing international debates on the trajectory, implications, and regulations of the new technological breakthrough in robotic warfare and AI. Simply put, the technological competitive edge would only produce tangible results when coupled with concept development capabilities. In this respect, the US, for example, is not only leading the technological improvements but also shaping the literature and concepts of robotic warfare and lethal autonomous weapon systems.

Turkey could potentially rely on its newly established National Defense University as a hub of concept development. In doing so, the Defense University should be equipped with an **interdisciplinary research center**. The scope of the proposed interdisciplinary research center should incorporate War Studies and related sub-topics with techno-scientific fields relevant to the new breakthrough including, but not limited to, computational neuroscience, evolutionary biology, behavioral biology, robotics, data science, artificial intelligence, and related engineering departments for developing a thorough understanding of future unmanned military systems and robotic warfare issues. Furthermore, exact future state and impact of new technologies are becoming increasingly uncertain. Real world trial-and-error of every product is almost impossible, and also expensive. As a result, the proposed research center should also involve in advanced simulation and war-gaming efforts to boost the readiness levels of the Turkish military-industrial complex and the Turkish security forces. The proposed interdisciplinary center should also drive a major research effort to monitor, understand, predict, and adapt to ethical and legal implications of new technologies. Thus, establishing a legal and military ethics branch is strongly recommended.

Along with the recommendations for the National Defense University, Turkey needs to boost its research universities to augment its techno-scientific capacity. At this point, the most important requisite is to attract and encourage Turkey's homegrown elite workforce, as well as the best brains of the world, to contribute to the national unmanned and autonomous systems endeavors.

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161 The Undersecretariat for Defense Industries, https://www.ssm.gov.tr/website/ContentList.aspx?PageID=1088, Accessed on: May 22, 2018.

162 HaberTurk, http://www.haberturk.com/turk-silahli-kuvvetleri-icin-robot-asker-projesi-gelistirilecek-1865958-ekonomi, Accessed on: April 28, 2018.

163 For the full text of the Undersecretariat's call for applications, see: https://www.ssm.gov.tr/Images/Uploads/MyContents/V_20180209101549041041.pdf, Accessed on: May 22, 2018.

Conclusion

Warfare is "*a messy, self-organized ecology of living fluids consisting of many nonlinearly interacting parts constantly adapting to changing conditions*".[164] It is extremely complex. In addition, modern techno-scientific progress causes profound changes in political, military, economic, social, and informational processes. Notably, the ongoing transformation in itself is highly dynamic, nonlinear, and interconnected. Thus, the exact impact of the current breakthrough on warfighting remains uncertain, especially in the long-term. On the other hand, modern warfare has already been changing, and in not so distant future, it will be fought by humans teaming up with artificially intelligent, autonomous, and frequently swarming robotic systems.

Because of the given characteristics, the ongoing transformation urges policy-making efforts to become more adaptive and future-oriented. Adaptation to the change is not only the key aspect of national security, but also an enabler for gaining significant geopolitical, geostrategic, and economic returns.

Turkey is now a major drone producer, even though its defense industry's performance in more strategic segments remains to be seen. Ankara has gained impactful experience in drone operations under real conflict conditions, and proved to be able to integrate unmanned systems into the existing operational concepts and doctrines, suggesting a significant adaptation.

Turkey's unmanned military systems, particularly in the tactical UAS segment, are combat proven. Turkish security apparatus, defense industry, and decision-makers employ an effective feedback mechanism that leads to greater benefits for further advancement. Moreover, Turkey's defense firms proved able to collaborate with war-fighters on the battleground in developing high-end systems.

Yet, the next revolution in military affairs is not only about drones. It is a combination of several emerging technologies discussed in the first part of this report. For carrying on its momentum, Turkey needs to establish and support a larger, cooperative strategic community including defense firms, think-tanks, academia, business circles, inter-disciplinary research institutions, and military experts. Even more importantly, **Ankara has to encourage the brightest minds of the nation to pursue their careers in Turkey, and should also find ways to attract the qualified global workforce.**

This report emphasizes the significance of a multi-sectoral and interdisciplinary effort for Turkey to effectively capitalize on its recent momentum. New horizons in emerging technologies, especially machine-learning algorithms and swarming by unmanned combat platforms, could indeed offer game-changer opportunities for Turkey. In order to be among the winners of the new paradigm shift, Ankara needs to enhance its UAS-driven scope, and add new dimensions – such as the cross-domain UAS–UGV teaming – by fostering a **robotic warfare roadmap.** Furthermore, the Turkish government should promote a **national AI strategy** to coordinate and synchronize the country's capabilities in this segment, and to direct them into higher ambitions. These reforms would certainly allow Turkey to graduate to a new level in unmanned military systems design, production, and use.

[164] Andrew Ilachinski,. Artificial war: Multiagent-Based Simulation of Combat. World Scientific, 2004.

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The Rising Drone Power: Turkey On The Eve Of Its Military Breakthrough

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