Sustaining the U.S. Lead in Unmanned Systems

Military and Homeland Considerations through 2025

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

AUTHOR
Samuel J. Brannen

PROJECT TEAM
Samuel J. Brannen
Colonel Ethan Griffin (USAF)
Rhys McCormick

A Report of the CSIS International Security Program

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In November and December 2013, the CSIS study team (Samuel Brannen, Ethan Griffin, and Rhys McCormick) convened four working group discussions on unmanned systems, and conducted dozens of individual interviews and smaller group discussions that captured a broad variety of perspectives and stress-tested policy recommendations. Discussants were drawn from across the executive and legislative branches of government, from the defense industry, and from the broader national security policy community. They will see their insights reflected here per the terms of the nonattribution discussion.

The study team owes a particular debt to Colonel Bill "Sweet" Tart (USAF), who in his role as director of the U.S. Air Force's Remotely Piloted Aircraft Division has endeavored to educate by sharing his vast knowledge of this emerging technology. This is knowledge he and his fellow airmen have earned the hard way.

The author is particularly indebted to his fellow study team members and to his colleagues Kathleen Hicks, David Berteau, Clark Murdock, Maren Leed, James Lewis, Andrew Metrick, and Mark Massey for their intellectual contributions, practical guidance, and unyielding support.

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This report does not represent a consensus view, and its text was not previewed or shared in whole or in part outside of CSIS prior to publication. The policy recommendations are offered from the standpoint of advancing U.S. national interests.

Center for Strategic & International Studies
1616 Rhode Island Avenue, NW | Washington, DC 20036
202-887-0200 | www.csis.org

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Over the past decade, the United States has relied heavily on and set the global standard in the use of unmanned systems technology in theater wars in Iraq and Afghanistan, a global campaign to disrupt Al Qaeda and its affiliates from Somalia to Pakistan, a contingency operation in Libya, and support to French efforts in Mali. As of July 1, 2013, the Department of Defense (DoD) possessed nearly 11,000 unmanned aerial systems (UAS)[1] of many different types and capabilities, thousands of small unmanned ground vehicles (UGVs), and an assortment of experimental unmanned surface vessels (USVs) and unmanned underwater vehicles (UUVs). While the public has focused on kinetic strike missions by UAS, the primary use of unmanned systems to date has been UAS to provide battlefield intelligence for U.S. ground forces, along with the use of UGVs to counter the threat of improvised explosive devices. Unmanned systems have saved American lives, saved noncombatant lives, and imposed cost on the enemy.

In the decades ahead unmanned systems have significant potential to continue to increase U.S. military effectiveness across a range of priority missions, including enabling new U.S. concepts of operation (CONOPs). This will require relatively modest financial commitment, but more pronounced strategic commitment, particularly to encourage experimentation that will uncover the most promising areas for investment and emphasis. Importantly, additional capability could be relatively quickly and affordably leveraged from the existing unmanned force structure through networking across the air, ground, and maritime domains with other unmanned and manned platforms (including existing platforms). It would be a profound mistake to dismiss current systems as a leftover capability from "last war" requirements (counterinsurgency and global counterterrorism).

Unfortunately, it is increasingly uncertain if the United States will realize this potential. Despite its commanding head start in the acquisition and use of unmanned systems, the U.S. lead is at risk in the decades ahead. U.S. strategists and policymakers have not taken sufficient steps to continue to exploit the military-technical revolution underway.[2] With the effective 2014 end of the Afghanistan War, commitment within DoD to explore the broader possibilities of unmanned systems is retreating.

Underscoring strong anecdotal evidence presented throughout this report, DoD will enact a third consecutive year of decreased research, development, testing, and evaluation (RDT&E) spending on unmanned systems (a 33.4 percent decrease from FY13 to the likely FY14 level,[3] compared to an 8 percent decrease in overall RDT&E).[4] Unmanned systems strategy across DoD remains divorced from formal strategic guidance and resource processes that drive program and budget decisions in the Pentagon. Unmanned systems acquisition, operations, and maintenance have been largely funded as a wartime requirement through the overseas contingency operations (OCO) account and not the base defense budget, putting them at heightened risk of further, rapid, and nonstrategic cuts. In announcing the FY15 president's budget request, Secretary of Defense Chuck Hagel stated, "The Air Force will slow the growth in its arsenal of armed unmanned systems that, while effective against insurgents and terrorists, cannot operate in the face of enemy aircraft and modern air defenses."[5]

Moreover, no military department has plans for major next-generation unmanned platforms with committed budget.[6] The history of military innovation teaches that it is often not the first country to innovate technologically that ultimately realizes the greatest operational advantages of a new military capability, but the military that best imagines the potential of a new technology and reorders bureaucracies and conventions to exploit latent advantages.[7] Vision, resourcing, and adaptive institutional cultures determine success, and it is not clear the United States has committed these to unmanned systems.

While Pentagon interest in the technology appears to be waning, the rest of the world is rapidly increasing attention and investment in unmanned systems[8] (detailed in the "Arms Control and Export Considerations" section below). In the midst of this growing global interest, the United States has chosen to indefinitely put on hold sales of its most capable UAS to many of its allies and partners, which has led these countries to seek other suppliers or to begin efforts to indigenously produce the systems. Foreign adoption of unmanned systems by U.S. allies and adversaries alike will play out in an effectively multipolar, regionally complex, rapidly proliferated environment. The barriers to entry for basic unmanned systems capability are already low and will continue to drop, raising the real potential that lesser powers and nonstate actors will also field systems in growing numbers. Regardless of U.S. export policies, unmanned systems are therefore likely to further complicate the international security environment and U.S. interests worldwide across the spectrum of operations. This challenge set will require increased intellectual attention and resourcing to manage risk.

Unmanned systems will also have new domestic prominence and importance for the United States as they are increasingly adopted for homeland and law enforcement missions, for private commercial use, and by individuals. While plans are moving ahead on U.S. domestic technical and safety issues through the Federal Aviation Administration (FAA), the federal government has not publicly articulated a vision for what the development and spread of this technology means in strategic terms for our nation (both risk and opportunity). Tactical and operational expertise in this new technology is so far outpacing strategy and policy.

All is not bleak, though, and the window of opportunity remains open for the United States to lead the world in unmanned systems, maximizing opportunity and addressing risk where it exists. The United States unquestionably maintains its lead in unmanned system in the near term, including the critical human dimension: a remarkable engineering, expert operator, and tactician community from the past decade of war. The United States has an existing unmanned force structure that is magnitudes larger than any other nation, and even in the midst of a procurement holiday, significant capability can be gained from the aforementioned potential of experimentation, integration, and continued upgrading of existing platforms. But maintaining this lead over the next decade and beyond will require policy decisions and strategy development.

Over the past year, the National Security Council staff has convened an interagency conversation on unmanned systems policy in a broader context. This effort was a follow-up to President Barack Obama's May 23, 2013, speech on counterterrorism policy at the National Defense University,[9] but it wisely steered the conversation more generally to consider the future of the technology in the United States and internationally. The process has yet to result in any publicly articulated outcomes, but it is a positive step forward. As the leader in unmanned systems operational use, what the United States says and does in coming months and years will shape the international environment.

The U.S. domestic conversation on unmanned systems also has shifted recently in tone and sophistication. Rapid growth of the technology in the U.S. civilian commercial sphere and trade industry advocacy is driving that change. The announcement in late 2013 by the Federal Aviation Administration of six test sites for National Airspace System integration of UAS by the FAA, and chief executive officer of Amazon Jeff Bezos's announcement of testing of UAS for package delivery, are among a series of events spurring the public's imagination in a new direction.[10] An informed congressional constituency is also coalescing around what could become a significant U.S. industry over the next decade.[11] Despite increasing local and state legislative efforts to control and restrict unmanned systems due to privacy and other concerns, the overall trend line points to the continued domestic growth in unmanned systems.

This report does not seek to offer comprehensive answers on the many larger issues that intersect with unmanned systems today—in particular counterterrorism and privacy—but to contribute objectively to a broader policy and strategy-level conversation on this technology. The discussion in this paper is focused primarily on UAS because they have progressed the most technologically, and will continue to vastly outnumber unmanned systems in the ground and maritime domains out to 2025 (the timeframe of this paper). This is a scoping effort to highlight the most urgent policy issues while framing an enduring research agenda. The views in this report, and in particular the recommendations, reflect only those of the CSIS scholars whose names appear on this publication (hereafter "CSIS study team"). The CSIS study team owes a great debt to many experts on this issue from government, defense industry, and across the broader defense and technology policy community. In November and December 2013, the CSIS study team convened four working group discussions on unmanned systems, and conducted dozens of individual interviews and smaller group discussions that captured a broad variety of perspectives and stress-tested policy recommendations. Working group participants were drawn from across the executive

and legislative branches of government, from the defense industry, and from the broader national security policy community. Participants will see their insights reflected here on the terms of the nonattribution discussion. So, too, this report benefited tremendously from an informal and growing network of operators and thinkers interested in understanding the implications of unmanned systems technology for the United States and the world in the years ahead.[12] The CSIS study team is particularly grateful to colleagues Kathleen Hicks, David Berteau, Clark Murdock, Maren Leed, James Lewis, Andrew Metrick, and Mark Massey for their intellectual contributions, practical guidance, and unyielding support.

This report is divided into six sections. The first assesses the public conversation to date on unmanned systems. The next four sections reflect the topics and discussion at the four CSIS working groups, and generally outline the findings in those conversations, augmented with additional research from other expert interviews and relevant literature. The final section offers specific policy recommendations that the study team believes are realistic, executable within the next year, and would best contribute to sustaining the U.S. lead in unmanned systems in the coming decade.

The “Drone” Narrative

Much of the public and private discussion surrounding “drones” has been misleading and narrowly focused. As a starting point, it is important to use accurate terminology. The platforms discussed in this paper are properly referred to as “unmanned systems.”[13] Even the most basic current-generation unmanned systems require not only a platform (be it an aircraft, ground vehicle, or maritime surface or subsurface vessel), but sensors, a ground-control station, and human maintainers, operators, and specialists to exploit the information collected. They do not operate independently (autonomously) and decisions to use lethal force adhere to the same criteria as they would for any manned platform. Technology will someday allow further reduced human control and involvement in the operations of these systems, but not for some time, and subject to policy considerations detailed in the technology section below.

Media and the public have often overstated the capabilities and numbers of the current-generation technology of UAS[14] and conflated ethical discomfort regarding U.S. global counterterrorism strategy and covert use of force decisions with UAS, the iconic platforms carrying out those missions. While unmanned systems have undeniably played a revolutionary role in U.S. counterterrorism operations over the past decade, they have not set counterterrorism policy. Of DoD’s nearly 11,000 UAS only a small number (fewer than 450) are physically capable of carrying armaments in known configurations, and among that group a much smaller number actually carry weapons and are operational at any given time (perhaps 70 to 80 that could be operational at the highest state of readiness).

Critics of U.S. counterterrorism policy have unduly focused on tactical and operational matters—and not the policy guiding them—with particular interest in covert UAS operations. The challenge in effectively addressing these concerns has been the lack of publicly available data that would either prove or disprove the frequent contention from administration officials and uniformed military involved in current operations that UAS result in significantly lower rates of civilian casualties than other operational approaches (e.g., manned fixed-wing airstrike alone or direct

action by ground forces). UAS critics also worry about the “sanitary” ease of unmanned systems technology. These critics believe that the fact that UAS lessen operational risk may influence U.S. decisionmakers to use force more often than they otherwise might. No objective analysis to support or deny that claim has emerged to date, and it deserves further study.

UAS proponents often introduce additional confusion into the debate. The CSIS study team heard many proponents (particularly of UAS export) highlight the limitations of UAS compared to current-generation manned aircraft, often diminishing what is novel and different about UAS (for example, they do not put a pilot in harm’s way and do bring new capabilities to warfare in their endurance if not speed and range). While it is true that, for example, an F-16 tactical fighter aircraft has greater speed, maneuverability, survivability, and kinetic strike capabilities than any current UAS, its operating characteristics and inclusion of a pilot also make it very different, and more capable for some missions and less for others. Without question, unmanned systems are different. Having a rational debate about what that difference really means requires objective understanding of the evolving technology as well as an understanding of overall U.S. military requirements to achieve national security objectives.

Unmanned Systems Technology to 2025

Looking out to 2025, consensus is that technology advances are most likely in autonomy, software and integration of existing systems, better sensors of all types, and solutions related to the increasingly contested and congested electromagnetic spectrum. Over this timeframe, unmanned systems technology may evolve more rapidly than currently anticipated, or may simply become lower cost due to the growing commercial sector. Affordability will also be a strong limiting factor due to budget constraints.

The most significant advance in unmanned systems over the next decade is likely to be the incorporation of autonomy. Autonomy has competing and broad definitions. Used here, autonomy refers to a specific action that a machine can take independently, without human intervention, confined to the limits and scope explained below. There are notable ethical considerations surrounding what may be technically possible but culturally unacceptable in implementation of autonomy, such as lethal autonomy and the decision to use force.[15]

Autonomy will be enabled by continued progress in efficiency and miniaturization of computer processing and power sources, and advances in machine learning (also referred to as artificial intelligence) and processing power. In an undersea environment, autonomy is essential for unmanned vehicles due to complexity in and operational vulnerabilities caused by sustained communications without physically tethered data links. Autonomy may also be increasingly necessary on the ocean’s surface, in the air, and on the ground due to anti-access and area-denial (A2/AD) technologies fielded by adversaries that will compromise communications through the electromagnetic spectrum that currently allow for remote-piloting and near-real-time exchange of information.

An autonomous system performing with anywhere near the proficiency of a human operator in complex operations (such as opposed combat missions) is very unlikely in the near term. However, the successful recent autonomous carrier landing of the X-47B Unmanned Combat Air System Carrier Demonstration (UCAS-D) program experimental aircraft demonstrated that some discrete tasks that are considered extremely difficult when performed by humans can be mastered by machines with relative ease. Autonomy will come first to functions where it will save communications bandwidth (i.e., onboard processing, exploitation, and dissemination of sensor data), lessen current difficulties of remote piloting (e.g., landing and takeoff; repetitive tasks), and improve flight safety (sense and avoid for integration into civilian airspace). Limited autonomy already exists in UAS in the form of waypoint navigation, and what could be categorized as more advanced autonomy already exists in a range of decades-old U.S. weapons systems, including air and missile defense systems, and as incorporated into manned aircraft and other ground and maritime platforms for targeting and countermeasures. The adoption of flash-trading on Wall Street illustrates in another context the edge that machine autonomy can provide to enable split-second decisions humans would be incapable of. Advances in machine learning and processing and human-machine interfaces will further expose where machine autonomy may be advantageous and where humans maintain an advantage. It will also be important to understand how to combine machine and human intelligence to best advantage.[16]

Related to autonomy, software will be a more rapid area of development than hardware over the next decade. Software can be more quickly upgraded and reconfigured and will play a critical role in integrating existing manned and unmanned systems in ways that could significantly improve the effectiveness of existing capabilities at lower cost. Unmanned systems will also see significant advances in the sensors that allow them to function and add capability.[17] Integrated "systems of systems" could allow for entirely new CONOPs, where sensors and kinetic weapons systems ("shooters") are seamlessly combined across multiple platforms through networked application. Going forward, integration of systems across domains and of the most sophisticated existing U.S. platforms could enable multiple platforms to be used as a truly joint weapons system across what some have called a "combat cloud."[18] Boundaries between what is an attack platform, what is defensive, and what is intelligence, surveillance, and reconnaissance (ISR) will continue to blur. Reductions in personnel end strength, significantly reduced final purchases of fifth-generation aircraft, and a likely procurement holiday in UAS over the next decade are incentive to drive software and data-link integration among existing systems. It will therefore be important for the Office of the Secretary of Defense for Acquisition, Technology and Logistics to continue to advocate and help create open architectures for control systems and data links. Though difficult to standardize and implement, open architectures foster greater innovation through a freer market for software and hardware solutions and allow smaller companies to compete. Open design will also allow control and integration potentially of multiple platforms simultaneously, including across domains. Augmented with autonomy, a single human controller could potentially control a distributed system of multiple platforms and sensors to achieve new types of effects and operations.

The electromagnetic spectrum upon which current-generation UAS rely—including links into cyberspace—has become an increasingly contested battleground in which

dominance or the ability to overcome enemy attacks could provide a decisive military advantage. Assured communications as well as "stealthy" communications will be areas of significant research, with consequence for the future viability of unmanned systems absent significant advances in and willingness to rely on autonomy for a broad range of functions.

The powerful intersection of UAS with the military technology of global satellite communications and precision-guided munitions has been made clear. Unmanned systems also intersect with a number of key emerging commercial technologies, from additive manufacturing (three-dimensional printing) that could enable rapid global proliferation of unmanned systems, to "big data" collection and processing that can make sense of the massive amounts of intelligence sensors can collect. Of course, advances in robotics—driven mainly by the commercial and nondefense research sectors—will also have significant implications for unmanned systems across domains.

As previously mentioned, unmanned systems are set to grow dramatically in the commercial sector, which already leads the military in use of the technology for logistics and supply chain applications. The military could reap significant benefit from leveraging this ongoing growth in privately funded research and development. However, DoD has at best a mixed record in its ability to harness private-sector innovation. The Defense Advanced Research Projects Agency (DARPA) has a more than five-decade history of tapping into this broader community for cutting-edge defense-relevant research, and it is in fact DARPA's past and ongoing projects that have provided much of the technology base for the U.S. lead in UAS. However, DARPA is charged with looking at the leading edge, and generally not incremental improvements or cost-reducing options that could come from the broader science and technology research community. DARPA's budget is also only a tiny fraction of the overall RDT&E budget. DARPA's funding amounted in FY2014 to 23 percent of the total DoD science and technology (S&T) budget ($2.79 billion of $11.98 billion DoD total S&T of the overall RDT&E budget of $67.5 billion). The perception from many outside government is that DoD has to date failed to communicate to commercial and defense industry its research and development priorities for unmanned systems, leaving them to guess where to most effectively invest any independent research and development funds (IRAD). DoD will need to find more effective ways to communicate and interact with the commercial sector if it is to capitalize on innovation that is applicable in the near term, let alone to encourage next-generation research.

Military Use from Today to 2025

Unmanned systems technology has been and increasingly will be transformative on the battlefield. The fusion of robotics, global satellite communications networks, advanced sensors, information technology, and human operators has created a new mode of data collection, awareness, and interaction across the planet that, paired with forward-deployed forces, allows for a truly new way of combat. While U.S. investment in UAS surged after the attacks of September 11, 2001, the current generation of UAS was in fact the result of a response to the experiences and investments linked to U.S. combat experience and requirements during the 1990s in the Balkans.[19] Military investment and operational use to date have focused on UAS for intelligence, surveillance, and reconnaissance (ISR) and limited precision strike. In these missions,

unmanned systems have allowed for up to 24-hour-per-day and 7-day-per-week persistence and near-real-time operational fidelity through full-motion video and other image and signals intelligence data. The vast majority of unmanned systems fielded to date, however, have been relatively simple, small, and focused on providing sensors (including ground-based) to identify individual targets across terrain types and counter the threat of improvised explosive devices (IEDs) in Iraq and Afghanistan. To repeat, the vast majority of these aircraft are not the larger and more capable high-altitude long-endurance (HALE) RQ-4 Global Hawk and RQ-170 Sentinel and medium-altitude long-endurance (MALE) MQ-1 Predator and MQ-9 Reaper that so captivate public attention. In these roles, UAS have logged millions of flight hours (including two million flight hours by the MQ-1 Predator and MQ-9 Reaper alone as of October 2013).

In the view of the military professionals who operate them, unmanned systems are conducive to a way of warfare that emphasizes the greatest possible reduction of risk to U.S. forces with the greatest possible care to protect civilians on the battlefield while achieving mission objectives. This is of particular importance in an age of warfare against irregular adversaries that operate among civilian populations. In a September 2013 report, UN special rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism, Ben Emmerson, wrote, “If used in strict compliance with the principles of international humanitarian law, remotely piloted aircraft [UAS] are capable of reducing the risk of civilian casualties in armed conflict by significantly improving the situational awareness of military commanders.”[20]

Unmanned systems also allow for persistent operation limited exclusively by energy supply and mechanical endurance. Flight crews can be swapped in and out indefinitely, even from across different parts of the globe dependent only on access to any interoperable control system. So, too, the unique expendability of unmanned systems is an important attribute. The downing of a manned aircraft is a major event requiring the commitment of additional manned assets or personnel on the ground to conduct search and rescue. So, too, it means the potential capture of pilot and flight crew, and most important, potential loss of American life. To date, the United States has not enacted CONOPs to treat UAS as expendable. (Ground forces veterans of Iraq and Afghanistan recall with some irony the risk they incurred to recover UAS that crashed for one reason or another, lest the aircraft and sensors fall into the hands of the enemy—the very UAS that were supposed to provide standoff and warning to keep them safe from enemy attacks.) The real opportunity in the expendability of UAS may come in a very different form that would allow the introduction of tactics, techniques, and procedures to overwhelm A2/AD defenses. In the deeper future, that may include techniques such as swarming with low-cost unmanned systems; in the near term, it could simply mean increased integration of manned and unmanned assets, with unmanned assets taking on greater risk in initial operations such as suppression of enemy air defenses.

The often-repeated argument that the military services are resisting UAS because they simply resist new ways of doing business is a straw man, distracting from a much more complex explanation steeped in general bureaucratic behavior and incentives within DoD. The biggest challenge for UAS adoption and funding is that they are viewed by many in the Pentagon as a “last war” capability or simply unimportant in

the current budget environment compared with personnel end-strength, major acquisition programs such as Joint Strike Fighter, or major platforms such as aircraft carriers. They are also lumped in with ISR more broadly, which has long been a capability area in which supply does not meet combatant commander demand, and which is conventionally understood by many in the Pentagon as an area where demand is simply insatiable. There are a host of bureaucratic reasons for this, including the unclear and largely unattractive career path offered[21] and thus lack of a coherent officer constituency.[22]

Responding to what he felt was strong institutional resistance to meet theater commander demand and the needs of ground forces, in 2008 Secretary of Defense Robert Gates created an ISR Task Force that mandated that the U.S. Air Force acquire sufficient aircraft and support infrastructure, crews, and maintenance to support 65 "orbits" or "combat air patrols" (CAPs) of the most capable electro-optical and infrared full-motion video aircraft to support ongoing operations in Iraq and Afghanistan. The Air Force has continued through the present to build toward that force structure (it is currently at 61 CAPs), but over the past year its senior leaders successfully argued to reduce the requirement after the drawdown of U.S. combat forces from Afghanistan by the end of 2014 to 55 CAPs. UAS are often described publicly and privately by senior Air Force leaders as a key part of wars fought in a virtually uncontested airspace, but not a solution to the challenges the military faces against A2/AD capabilities of potential adversaries that hold at risk U.S. conventional dominance and freedom of operations.[23] That language was echoed in the cuts announced on February 24, 2014, by Secretary of Defense Hagel, who said that the reduction to 55 CAPs was warranted on the basis of UAS vulnerability against "enemy aircraft and modern air defenses."[24] Notably, settling a multiyear argument including significant disagreement between Congress and DoD, Secretary Hagel also announced that the manned U-2 spy plane would be retired in favor of the Global Hawk RQ-4 UAS, stating, "With its greater range and endurance, the Global Hawk makes a better high-altitude reconnaissance platform for the future."[25]

After a major review process and significant pressure from Secretary Gates and other top officials, the Air Force decided to pursue an optionally manned (rather than manned-only) next generation long-range bomber. The Air Force has no current plans for any next-generation UAS for combat or air-to-air missions (i.e., an unmanned combat aerial vehicle such as the Navy is experimenting with).

The U.S. Army seldom discusses UAS in public, despite numerically owning the most of them and many of its senior leaders' direct experience with the systems in Iraq and Afghanistan. Behind the scenes, the Army is experimenting broadly with the technology and thinking through ways to further integrate the unique capabilities of unmanned systems with manned force elements. Amid broad cuts and a restructure of its aviation assets, the Army has preserved funding for datalink integration of its AH-64 Apache attack helicopters with RQ-7B Shadow UAS that will enable new tactics, techniques, and procedures to compensate in part for the retirement of the AH-58 Kiowa Warrior reconnaissance and armed reconnaissance helicopters.

In contrast to the Air Force and Army—and perhaps because it has the smallest current unmanned systems force structure and most ongoing procurement and experimentation—the U.S. Navy's leadership frequently discusses its commitment to

next-generation unmanned platforms, including its successful experimentation in 2013 with a carrier-based next-generation UAS known as X-47B Unmanned Combat Air System Carrier Demonstration (UCAS-D) program and plans for additional carrier-based trials alongside manned F-18 aircraft in 2014. However, as with all the other services, there is no money in the Navy's current future years defense program (FYDP) to produce and field such a next-generation system.[26] Rumor suggests that the Navy is looking at acquisition of the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) UCAS sometime after 2030, at which point UCAS based on current experimental models such as the British Taranis, French Neuron, and Chinese Sharp Sword could also be fielded by foreign nations.[27] Over the next several years the Navy will procure 68 MQ-4C Triton HALE UAS as part of its Broad Area Maritime Surveillance (BAMS) program, which will network other manned ISR platforms (particularly the P8-A Poseidon) and sensors together, with an initial operating capability in 2017.

The U.S. Marine Corps has a significantly smaller UAS force structure than the Army (including a lack of any MALE platforms) and self-admittedly the least budget space for future acquisition. However, its aviation community has demonstrated serious interest in the future potential for manned-unmanned teaming, including in electronic warfare, and has partnered with industry on recent experimentation. As with the other military services, the majority of funding for UAS acquisition and operations for the Marine Corps has been in the OCO budget and not the base defense budget. As the remaining OCO budget is reduced with drawdown in Afghanistan, unmanned funding is decreasing. However, the Marine Corps is experimenting with the RQ-21A Black Jack, which brings increasingly sophisticated capabilities to a smaller platform, and the Marine Corps has been aggressive in pursuing common control systems that could allow control of multiple air and ground platforms simultaneously.

A serious argument can also be made that UAS do not have an institutional champion tied to all-important resource decisions in the Pentagon. While the Joint Strike Fighter Program Office has a three-star officer permanently assigned to it, and cyberspace is now a technological domain with a four-star combatant commander (the dual-hatted director of the National Security Agency), unmanned systems strategy and acquisition is run by colonels and captains, tucked into broader aviation or other capability portfolios. Joint coordination in acquisition and use of unmanned systems to date has been based primarily on personal relationships and individual leadership (or absence thereof), not enduring organizational arrangements. DoD briefly explored designating the Air Force as the executive agent for UAS, but ultimately decided against any lead.[28]

Within the Office of the Secretary of Defense, the director for unmanned warfare & intelligence, surveillance, and reconnaissance—a Senior Executive Service (SES) career civil servant who reports to the assistant secretary of defense for acquisition—is responsible for strategy regarding unmanned systems across the Department of Defense. Since 2003, a congressionally mandated report known as the "Unmanned Systems Roadmap" has sought to order DoD joint thinking on unmanned systems.[29] Last updated in December 2013, the document seeks to provide an integrated look at DoD's approach to unmanned systems, but is not tied to formal DoD strategic guidance or the Planning, Programming, Budgeting and Execution (PPBE) processes that determine how resources are allocated and military capabilities fielded. The U.S. Air

Force periodically issues a "Remotely Piloted Aircraft Vector," due for an updated release in 2014, which also is not linked to PPBE but will aim to provide a technology roadmap to communicate independent research and development (IRAD) priorities to industry.

Finally, there is the all-important issue of senior-most DoD leadership's commitment to unmanned systems. Consensus among experts who have studied the history of the development of UAS is that the United States would not have had capable UAS for the current wars if not for the work of the Defense Aerial Reconnaissance Office (DARO) in the 1990s[30] and if not for the single-minded advocacy for the program by former Chief of Staff of the Air Force Ronald Fogelman and former Secretary of Defense William Perry. That high-level attention existed under Secretary Gates but has lost emphasis since his departure.

Unmanned Systems Military Use in the Ground and Maritime Domains

The most significant advances or changes to existing force structure involving substitution of unmanned systems in the near term will likely come on the ground, at sea, and undersea. In particular, budget and personnel reductions in the Army and Marine Corps are likely to drive the adoption of UGVs, which to date have been relegated to the "dull, dirty, and dangerous" tasks such as explosive ordnance disposal. Military logistics and supply chain management have yet to effectively harness robotics and information technology breakthroughs that are transforming commercial industry at the warehouse/depot level by allowing increased productivity at significantly reduced manning levels. A significant proportion of casualties sustained by U.S. forces in the wars in Iraq and Afghanistan occurred during convoy logistics operations because of improvised explosive device (IED) attacks, other roadside attacks, and road accidents. Reducing manning or eliminating it altogether in logistics supply convoys would save American lives in the future. Experimentation in Afghanistan with the commercially available remotely piloted K-Max helicopter proved the advantages of one approach to using unmanned technology in this role in tough terrain. Following it with ground vehicles is logical.

The Army's failed Future Combat System (FCS) had mapped out a sophisticated approach to UGS-UAS integration, and its cancellation certainly set back fielding of unmanned systems technology in the Army. Despite that failure, a relatively successful robotics program did emerge from FCS that could be leveraged for new platforms if the ground forces recommitted to them. In the current budgetary environment, such next-generation capabilities are not foremost on the minds of Army or Marine Corps senior leaders; use of unmanned systems for cost savings is.

The Navy has moved slowly in the development of unmanned surface vehicles (USVs), but is clearly committed to exploring the capabilities of unmanned underwater vehicles (UUVs), including its ongoing experimentation with the large-displacement UUV. The technology is potentially transformative in undersea warfare, including as a disruptive technology that could erode the United States' asymmetric advantage in the domain. Chief of Naval Operations Adm. Jonathan Greenert recently said that among his top priorities for the year is to lay out a roadmap with milestones to advance the

technology.[31] While USVs may benefit from commercial-sector investment, UUVs are likely to remain overwhelmingly driven by military investment.

Arms Control and Export Considerations

The U.S. military's greatest concern with regard to UAS policy in the future may be countering other countries' use of them. The relatively low cost of UAS, the broad potential for their future operational use, and the increasingly global availability of the technology all raise the need to consider whether existing countermeasures are sufficient. This has also led to questions about whether the United States should support nascent arms-control initiatives related to UAS.

The global supply-demand dynamic is shifting rapidly. Today, only the United States, United Kingdom, Israel, and China operate armed UAS[32]; but at least 18 countries are developing their own indigenous production capacity[33] and dozens more are seeking to acquire them, leveraging second-mover advantage in what they have learned from observing U.S. systems and operations over the past decade. Not only have others learned through U.S. operations but also through cyber espionage[34] and examination of wreckage, including the stealth RQ-170 Sentinel UAS that crashed in Iran in 2011, along with a host of other recovered UAS. This coincides with general trends in the availability of military-applicable technologies now increasingly originating from the global commercial sector, including the ability to precisely design and produce components using additive manufacturing (three-dimensional scanners and printers) and open-source information technologies and sensors.

U.S. decisions to date on the export of UAS are based in part on the U.S. Conventional Arms Transfer Process,[35] the Arms Export Control Act (AECA), the International Traffic in Arms Regulations (ITAR), and the Missile Technology Control Regime (MTCR). However, the United States has placed constraints on its decisions to export at least partly based upon policy disagreements within the executive and legislative branches as to whether the United States should widely share its most advanced UAS (particularly armed variants). To date, the United States has only exported armed UAS to the United Kingdom.

The current generation of UAS is not especially difficult to export from an AECA or ITAR perspective. Exports are most constrained by the MTCR, a voluntary regime of 34 nations committed to limit potential delivery vehicles for chemical, biological, and nuclear weapons, excluding manned aircraft.[36] Established in 1987, the regime hardly could have predicted the future of UAS, but did include them as they existed at the time ("target drones and reconnaissance drones"[37]) and did not differentiate between armed and unarmed variants. The regime applies "greatest restraint" to UAS that have a range exceeding 300 km and a payload exceeding 500 kg, which includes MQ-1 Predator, MQ-9 Reaper, and RQ-4 Global Hawk. Efforts over the past decade to update the MTCR to reflect current platforms have met resistance among member nations. It is notable that the MTCR misses entirely UAS-cruise missile hybrids such as so-called loitering munitions (the Israeli-made Harop is an early example). These weapons systems are already pushing the boundaries in lethal autonomy, with the ability to simply be flown in an orbit over an area and launch themselves against radiating targets they detect (air defenses, etc.).

MTCR supporters feel that the regime has been largely successful in preventing proliferation of a variety of potential delivery vehicles for weapons of mass destruction (WMD), particularly in the constraints it has placed on its member-state Russia, and caution that the United States not imperil the regime by proceeding with Category 1 UAS transfers. MTCR critics counter that ballistic and cruise missiles are proliferating rapidly among the countries of greatest concern—particularly North Korea and Iran—despite the regime. Notably, China is not a member of the MTCR, and despite claiming to adhere to its principles, is a known proliferator of many Category 1 systems into some of the most volatile regions in the world. Other detractors claim that the United States has been weak in enforcing the MTCR through diplomatic channels and that related arms control frameworks and treaties including the Intermediate-Range Nuclear Forces Treaty are also eroding—issues of far greater concern.

Unmanned systems have potential to be both regionally stabilizing and regionally destabilizing in the coming decades—particularly as they are operated in the contexts of hot borders or territorial disputes. On the one hand, unmanned systems could potentially reduce misunderstandings and miscalculation by providing real-time situational awareness that provides time and space for diplomacy and de-escalation. Unmanned systems could also strengthen border security against transnational threats. On the other hand, it is not clear how existing escalatory ladders and scenarios might play out with the introduction of this new and unique military capability. Any exchange of hostilities between manned with unmanned systems could be viewed in potentially dissonant ways by military and civilian leaders in different countries. A country may feel more entitled to destroy an unmanned system because there is no loss of life, while the country whose unmanned system was destroyed may view the attack as equally escalatory as an attack on a manned system. Thus, escalation dynamics could become unpredictable. To date, there has been no known engagement between two unmanned systems, but that is increasingly likely as more countries acquire UAS and air-to-air capabilities are developed.

It is so early in the development of UAS that thinking about how to control these systems in a way that promotes global and regional security without disadvantaging the United States or its allies is a difficult question, particularly in light of rapidly changing supply dynamics. It is, simply, an issue set that the United States should consider carefully. In that context, the United States must also consider the cost to future interoperability and its ability to affect global use and norms regarding unmanned systems if it chooses not to export the more capable UAS that allies and partners desire, and which it could influence through end-use monitoring, training and exercises, and other political-military discussion. If the United States truly believes it is a responsible user of unmanned systems technology and that the technology can allow more precise and discriminatory use of force, it is perplexing why it would not share it with allies and partners.

Homeland Security and Federal Law Enforcement Use

The Department of Homeland Security's use of unmanned systems focuses on nonlethal systems focused on border security. Within the Department of Homeland Security (DHS), the Customs and Border Protection (CBP) Office of Air and Marine is the lead for unmanned aerial systems and has the most sophisticated capability with

its fleet of MQ-1B Guardian aircraft.[38] Its UAS squadron totals nine: five in the Southwest Border Region,[39] two assigned to the Northern Border, and two to Cape Canaveral Air Station. The U.S. Coast Guard jointly operates CBP Guardian UAS and is experimenting with a cutter-based ScanEagle UAS. DHS has experimented with other UAS as well as UGS, particularly related to tunnel detection on the border.

CBP routinely approves requests by other DHS components and other U.S. agencies to operate its UAS in support of others' mission requirements. DHS headquarters is not involved in these decisions; they are made internal to the CBP Office of Air and Marine. DoD provides unmanned systems support to DHS, other domestic agencies, and state governments under a tasking process that applies the highest degree of oversight. Any domestic tasking of DoD UAS requires the personal decision of the secretary of defense.

DHS and DoD frequently discuss best practices and lessons learned regarding unmanned systems, encouraged in part by the presence of former DoD military officers throughout DHS and in key UAS positions in CBP. However, many constraints and differences exist between DoD use and DHS use of UAS and associated ISR capabilities, not least of which concern the rights of U.S. citizens in the homeland. Therefore, knowledge transfer from DoD to DHS is not viewed as a substitute for DHS's own internal development of knowledge on its unique mission set. In this regard, DHS is at the very early stages of understanding how the unique attributes of unmanned systems may meet homeland requirements.

Integration of UAS into the National Airspace System has begun with the announcement of the UAS test sites. If successful over the next few years, this will accelerate federal, state, and local use, as well as private commercial use, raising new policy issues.

Going forward, there is a need for DHS to develop and articulate its own understanding of unmanned systems at the headquarters (enterprise-wide strategy and policy) level. Unmanned systems have particular potential for border security missions. If DHS intends to continue to task UAS with domestic missions beyond border operations, it should articulate its principles for such use, given the extreme domestic sensitivity regarding these systems. This will require DHS to overcome its natural instinct to maintain silence on its use of systems due to law enforcement sensitivity. In particular, the lack of mention of unmanned systems in any form in the Quadrennial Homeland Security Review would be a missed opportunity to communicate principles of UAS use with Congress and the American public. DHS also must increasingly consider the threat posed to the homeland by proliferating UAS technology.

Recommendations

The following recommendations are considered by the CSIS study team to be highest impact in sustaining the U.S. lead in unmanned systems but also the most realistic in the expectation they can be executed with relative ease by senior decisionmakers. These recommendations do not require legislative changes and do not require additional resources (though, in some cases, could lead to reprioritization of existing resources).

- *The president should declassify and release civilian casualty figures from UAS strikes, and provide comparison between strikes using UAS and those using traditional manned air assets.* The success of UAS in helping to address the first significant threat of the 21st century endangers the future of the technology because of U.S. inability to effectively engage in public communications regarding the advantages of UAS in target discrimination. The U.S. military and intelligence community deserve credit for the professionalism they demonstrate each day in their use of this new technology as they prosecute a war to defend our nation from a determined enemy. So, too, Americans deserve objective facts at a time of growing mistrust of government programs related to counterterrorism. What was meant to be a covert program has become global front-page news, and the lack of transparency by the United States has allowed others to shape the narrative, damaging U.S. international reputation and ability to lead in setting standards for responsible use of unmanned systems (norms). The burden of proof now rests on the United States to factually demonstrate the care it has taken to prevent civilian casualties in operations against an enemy that intentionally hides among a civilian population while at war with the United States. In his May 23, 2013, speech, President Barack Obama created demand for greater transparency on the program that has become deeply associated with his administration.[40]

- *The secretary of defense should establish within the Office of the Secretary of Defense (OSD) a Defense Unmanned Systems Office (DUSO) to report directly to the deputy secretary of defense.* This office would be led by a two-star general or flag officer and would monitor and advise the deputy secretary regarding the cross-DoD research, development, testing and evaluation (RDT&E) budget as it relates to unmanned systems. The director for DUSO would have a civilian SES deputy and be staffed by a mix of civilian and military officers with technical and operational expertise in unmanned systems and related technologies. This office would ensure high-level focus within the department, create an effective coordinating function between military departments on investment decisions, and tie the compelling vision and strategy outlined in the OSD Unmanned Systems Integrated Roadmap to the PPBE process. A primary mission of the new office would be—in coordination with OSD Acquisition, Technology, and Logistics (AT&L) and DARPA—to closely collaborate with the defense industry, national research laboratories, and broader commercial sector to understand relevant ongoing RDT&E and appropriately identify priority research areas and direct resources, including through publication of a classified technology annex to the Unmanned Systems Integrated Roadmap. In its first year, the office should conduct a review across existing DoD roles and missions to determine potential areas where unmanned systems technology could create military advantage and where cost-benefit (and cost imposition on adversaries) could be greatest. This would energize the use and development of unmanned systems beyond an ISR-only or niche counterterrorism role. This office would also collaborate with Joint Staff J7 and relevant military components to inform experimentation with new concepts of operation to fully explore the potential of unmanned systems.

- *The DoD comptroller should compel standardization of budget data regarding UAS, and the director of OSD Cost Assessment and Program Evaluation (CAPE) should conduct comprehensive cost-benefit analysis between manned, unmanned, and "optionally manned" systems.* Current metrics available to understand the cost of

unmanned systems (including associated manpower) are at best confusing, and at worst misleading. Except in a handful of cases where specific cost studies were mandated (for instance, the next-generation long-range bomber), realistic cost estimates have not been available for defense decisionmakers to compare metrics such as cost-per-flight-hours on an "apples to apples" basis. Unmanned systems are not a silver bullet, but they are a new and important technology, and decisionmakers should better understand what tradeoffs and savings may be available to implement in the context of fiscal austerity, not to mention the ability to consider multiple platforms at multiple cost levels to achieve the same battlefield effects.

- *The United States should export armed UAS (including those classified under the Missile Technology Control Regime (MTCR) as Category 1 systems) to treaty allies and should continue to export unarmed MTCR Category 2 UAS to all trusted allies and partners.* The inability to date by the executive and legislative branches to develop coherent policy with regard to the export of UAS has negatively affected trust, hurt U.S. defense industry, and withheld capabilities vital to future coalition operations and burden sharing. In the next five years, armed and increasingly sophisticated unarmed UAS will be available from a growing number of supplier countries. Continued indecision by the United States regarding export of this technology will not prevent the spread of these systems; but it will deny the ability of the United States to ensure interoperability and encourage responsible use among allies and partners (including through end-use monitoring of systems). The United States should not self-restrict exports based on the largely unintended "capture" of UAS in the MTCR, which does not outweigh these more strategic considerations. U.S. export is unlikely to undermine the MTCR, which faces a larger set of challenges in preventing the proliferation of ballistic and cruise missiles, as well as addressing more problematic UAS-cruise missile hybrids such as so-called loitering munitions (e.g., the Israeli-made Harop).

- *The director for national intelligence should make a first-tier priority the collection of intelligence on the development of unmanned systems technologies by other countries (including in the commercial sector) and their development of new roles and missions, and concepts of operation for the technology, particularly regarding potential use as a delivery system for nuclear, chemical, or biological weapons.* Other nations will seek to exploit unmanned systems in ways that increase their military edge against U.S. conventional dominance, and they may push ethical boundaries in ways that the United States and its allies and partners will not. The United States must monitor these developments as closely as it does the spread of technologies such as ballistic and cruise missiles for the potential threat posed to the U.S. homeland and forces operating abroad. Early understanding of these threats could allow U.S. policymakers time to determine appropriate responses in the diplomatic sphere.

- *The Department of Homeland Security (DHS) should publicly articulate a set of principles under which it will continue to operate unmanned systems technology*. DHS should acknowledge public concern with unmanned systems in an overall debate about privacy and make transparent the process it has enacted to ensure all applicable laws in the use of the technology are followed. A statement of principles to reassure the public of the care DHS and its components take—

proportionate to the use of any "manned" technology—would be important to build public confidence and avoid overreaction that could limit future use. The Department of Justice and other U.S. domestic agencies could then follow closely DHS's example in this regard.

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[1] *Unmanned Systems Integrated Roadmap FY2013–2038* (U.S. Department of Defense, 2013), 5, http://www.defense.gov/pubs/DOD-USRM-2013.pdf.

[2] "Military-technical revolution" is the most accurate descriptor (not "revolution in military affairs"), as discussed in the excellent section on "military revolutions" in Robert Work and Shawn Brimley, *20YY: Preparing for War in the Robotic Age* (Washington, DC: Center for a New American Security, 2014), 9, http://www.cnas.org/sites/default/files/publications-pdf/CNAS_20YY_WorkBrimley.pdf.

[3] *Unmanned Systems Integrated Roadmap FY2013–2038*.

[4] As the FY13 numbers are an estimate, the final total obligational authority may decrease. The FY14 numbers only represent the presidential budget request initially presented to Congress. They do not reflect any money that might have been cut, saved, or added by Congress in recent budgetary deals. See Office of the Undersecretary of Defense (Comptroller), *National Defense Budget Estimates for FY2014*, May 2013, http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2014/FY14_Green_Book.pdf.

[5] Secretary of Defense Chuck Hagel, "FY15 Budget Preview" (speech, Washington, DC, February 24, 2014), http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1831.

[6] The Navy is revising its UCLASS requirements, and it is true that there may be advanced "black world" programs such as an RQ-180 and that the Air Force's "Next-Generation Bomber" is likely to be optionally manned. However, none of these is yet a program of record with associated budget.

[7] For an excellent discussion of the history and lessons learned on military innovation, see Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010).

[8] For a more detailed overview regarding the spread of UAS technology, see Sarah Kreps and Micah Zenko, "The Next Drone Wars: Preparing for Proliferation," *Foreign Affairs* (March/April 2014), http://www.foreignaffairs.com/articles/140746/sarah-kreps-and-micah-zenko/the-next-drone-wars?cid=rss-security-the_next_drone_wars-000000.

[9] President Barack Obama, "Remarks by the President at the National Defense University" (speech, National Defense University, Fort McNair, Washington, DC, May 23, 2013), http://www.whitehouse.gov/the-press-office/2013/05/23/remarks-president-national-defense-university.

[10] "FAA Selects Six Sites for Unmanned Aircraft Research," Federal Aviation Administration, December 30, 2013, http://www.faa.gov/news/updates/?newsId=75399.

[11] Perhaps somewhat optimistically, the Association for Unmanned Vehicles Systems International finds: "The economic impact of the integration of UAS into the NAS [national airspace system] will total more than $13.6 billion … in the first three years of integration and will grow sustainably for the foreseeable future, cumulating to more than $82.1 billion between 2015 and 2025…. By 2025 total job creation is estimated at 103,776." Darryl Jenkins and Bijan Vasigh, *The Economic Impact of Unmanned Aircraft Systems Integration in the United States* (Washington, DC: Association for Unmanned Vehicle Systems International, 2013), http://higherlogicdownload.s3.amazonaws.com/AUVSI/958c920a-7f9b-4ad2-9807-f9a4e95d1ef1/UploadedImages/New_Economic%20Report%202013%20Full.pdf.

[12] Notable efforts of significant scope and depth on unmanned systems—examining use by the intelligence community for covert missions, private commercial use, deep future analysis, etc.—are ongoing at the Stimson Center, the RAND Corporation, the Center for a New American Security, and elsewhere, and these reports will further grow our collective knowledge on this issue set.

[13] The U.S. Air Force prefers the term "remotely piloted aircraft" or RPA because of its specific reference to a human operator, but the more widely accepted term remains Unmanned Aerial System (UAS). Despite the more accurate use of "system," the widely accepted terms for the ground and maritime domains are Unmanned Ground Vehicle (UGV), Unmanned Surface Vessel (USV), and Unmanned Underwater Vehicle (UUV).

[14] In particular, there has been a focus on the "autonomy" of current UAS, which simply are not autonomous, and a link between the current generation and what must *inevitably* follow. See, for example, Mark Gubrud, "Stopping Killer Robots," *Bulletin of the Atomic Scientists* 70, no. 1 (January 1, 2014): 32–42.

[15] Department of Defense Directive 3000.09 on "Autonomy in Weapons Systems" (http://www.dtic.mil/whs/directives/corres/pdf/300009p.pdf) currently guides policy decisions in this regard and states, "Autonomous and semi-autonomous weapon systems shall be designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force."

[16] While computers have been able to beat the world's best human chess players for decades, human chess masters paired with computers from about 2008 on routinely defeated computers processing chess games alone. Now it appears that new advances in computing may again enable computers to reign supreme. See Max Nisen, "Humans Are on the Verge of Losing One of Their Last Big Advantages over Computers," *Business Insider*, November 5, 2013, http://www.businessinsider.com/computers-beating-humans-at-advanced-chess-2013-11.

[17] Integration efforts to date have been lackluster. See Jeremiah Gertler, *U.S. Unmanned Aerial Systems* (Washington, DC: Congressional Research Service, January 3, 2012), 16–17, http://www.fas.org/sgp/crs/natsec/R42136.pdf.

[18] Robbin Laird, *The Next Phase of Air Power: Crafting and Enabling the Next Aerospace Combat Cloud* (Washington, DC: Second Line of Defense, 2014), http://www.sldinfo.com/the-next-phase-of-air-power-crafting-and-enabling-the-aerospace-combat-cloud.

[19] Thomas Ehrhard, *Air Force UAVs: The Secret History* (Arlington, VA: Mitchell Institute for Airpower Studies, 2010), 21–22.

[20] Ben Emmerson, *Report of the Special Rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism* (New York: United Nations, 2013,) 23, http://www.lawfareblog.com/wp-content/uploads/2013/10/Emmerson-Report.pdf.

[21] Bradley T. Hoagland, *Manning the Next Unmanned Air Force: Developing RPA Pilots of the Future* (Washington, DC: Brookings Institution 2013), http://www.brookings.edu/~/media/Research/Files/Papers/2013/08/06%20Air%20Force%20Drone%20Pilot%20Development%20Hoagland/Manning%20Unmanned%20Force_FINAL_08052013.pdf.

[22] The Army has chosen to make operation of its UAS a noncommissioned officer (NCO) career field. This similarly reduces advocacy because NCOs are not promoted to positions that realistically affect platform acquisition decisionmaking.

[23] Aaron Mehta, "General: DoD Needs ISR Fleet for Contested Environments," *Defense News*, September 18, 2013, http://www.defensenews.com/article/20130918/DEFREG02/309180019/General-DoD-Needs-ISR-Fleet-Contested-Environments. To take just one public instance, head of the U.S. Air Force Air Combat Command Gen. Mike Hostage said:

> "Predators and Reapers are useless in a contested environment.... In terms of how we do ISR in a contested environment, I'm looking at different ways to do with flying platforms and with non-flying platforms.... We have shown our joint partners a way of war they are not going to want us to back away from, and building a fleet of 65 Predator/Reapers [capable of being airborne at any given time] is not the answer."

The U.S. Air Force does not currently have funding or plans for any more survivable follow-on platform to Predator and Reaper.

[24] Secretary of Defense Hagel noted that "this level of coverage will be sufficient to meet our requirements, and we would still be able to surge to an unprecedented 71 combat air patrols under the plan. DoD will continue buying the more capable Reapers until we have an all-Reaper fleet." Hagel also warned that if sequestration-level cuts are re-imposed after the Bipartistan Budget Deal ends in FY16, CAPs would be reduced to 45 and all Global Hawk Block 40 UAS retired. Secretary of Defense Chuck Hagel, "FY15 Budget Preview."

[25] Ibid.

[26] The Navy maintains enthusiasm for the program, including Secretary of the Navy Ray Mabus, who wrote: "Across the entire spectrum of military operations, an integrated force of manned and unmanned platforms is the future. The X-47B's arrested landing aboard USS GEORGE H.W. BUSH showed that the Navy and Marine Corps are riding the bow wave of technological advances to create this 21st century force." Ray Mabus, "Future Platforms: Unmanned Naval Operations," War on the Rocks, January 21, 2014, http://warontherocks.com/2014/01/future-platforms-unmanned-naval-operations/.

[27] David Axe, "Your Quick Guide to Killer Drones," War Is Boring, February 7, 2014, https://medium.com/war-is-boring/7f1b5a4e8ddc.

[28] Former Secretary of Defense Gates writes: "There was an unseemly turf fight in the ISR world over whether the Air Force should control all military drone programs and operations. The Army resisted, and I was on its side; the Air Force was grasping for absolute control of a capability for which it had little

enthusiasm in the first place." Robert M. Gates, *Duty: Memories of a Secretary at War* (New York: Alfred A. Knopf, 2014), 129.

[29] *Unmanned Systems Integrated Roadmap: FY2013–2038*.

[30] Ehrhard, *Air Force UAVs: The Secret History*. Ehrhard's work provides a superb overview of the role of the Defense Airborne Reconnaissance Office and the evolution of UAVs.

[31] Jeanette Steele, "Navy in 2014: Undersea drones, Arctic, Marines on new ships," *San Diego Union-Tribune*, February 1, 2014, http://www.utsandiego.com/news/2014/feb/01/chief-nava-operations-greenert-agenda-2014/?st.

[32] Open-source accounts differ greatly regarding whether Russia, Iran, and Pakistan have fielded an operational armed UAS capability. Evidence is not yet conclusive that any have.

[33] The United States, Israel, and China already produce armed UAS. Other states including Pakistan, India, and Colombia are rumored to have acquired armed UAS from these producer states, but only the United Kingdom is confirmed to successfully operate armed UAS it acquired from the United States. Iran, Italy, Germany, India, Russia, Taiwan, Sweden, Pakistan, Saudi Arabia, the United Arab Emirates, Brazil, and South Africa are known to have active indigenous armed UAS programs. See Peter W. Singer, "The Global Swarm," *Foreign Policy*, March 11, 2013, http://www.foreignpolicy.com/articles/2013/03/11/the_global_swarm?page=0,1; Maya Shwayder and Lisa Mahapatra, "Drones: Which Countries Have Them for Surveillance and Military Operations?" *International Business Times*, May 18, 2013, http://www.ibtimes.com/drones-which-countries-have-them-surveillance-military-operations-map-1264271. Kristin Roberts, "When the Whole World Has Drones," *National Journal*, March 21, 2013, http://www.nationaljournal.com/magazine/when-the-whole-world-has-drones-20130321.

[34] Edward Wong, "Hacking U.S. Secrets, China Pushes for Drones," *New York Times*, September 20, 2013, http://www.nytimes.com/2013/09/21/world/asia/hacking-us-secrets-china-pushes-for-drones.html?_r=0.

[35] "Presidential Policy Directive—United States Conventional Arms Transfer Policy," White House, January 15, 2014, http://www.whitehouse.gov/the-press-office/2014/01/15/presidential-policy-directive-united-states-conventional-arms-transfer-p.

[36] "Guidelines for Sensitive Missile-Relevant Transfers," Missile Technology Control Regime, http://www.mtcr.info/english/guidetext.htm.

[37] "Missile Technology Control Regime (MTCR) Annex Handbook – 2010," p. iii, http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf.

[38] "Guardian UAS Maritime Variant Predator B Face Sheet," Department of Homeland Security, U.S. Customs and Border Protection, http://www.cbp.gov/linkhandler/cgov/newsroom/fact_sheets/marine/guardian_b.ctt/guardian_b.pdf.

[39] CBP previously had five aircraft assigned to the Southwest Border Region, but on January 28, 2014, lost one of these aircraft conducting an operation off the coast of California.

[40] Obama, "Remarks at National Defense University."

About the Author and Project Team

Samuel J. Brannen is a senior fellow in the International Security Program at the Center for Strategic and International Studies (CSIS), where his research focuses on U.S. defense and national security strategy and policy, Turkey, and unmanned systems. Prior to rejoining CSIS in May 2013, he served at the Pentagon as special assistant to the principal deputy under secretary of defense for policy. In that position, he advised and supported the second-ranking U.S. defense policy official on a range of defense and national security matters. From July 2010 to September 2012, Brannen was country director for Turkey, Cyprus, and Malta in the Office of Secretary of Defense. He advised senior Pentagon officials on adapting the U.S.-Turkey defense relationship to changing internal and regional dynamics. Prior to that, he was special assistant to the deputy under secretary of defense for strategy, plans, and forces and assisted in the process and drafting of the 2010 Quadrennial Defense Review.

Before rejoining government at the start of the Obama administration, Brannen held various positions at CSIS from 2002 to 2009, including as a fellow and deputy director of the International Security Program and as assistant director of the Global Strategy Institute. From 2006 to 2007, he served as a loaned employee to the U.S. government, working as a strategist in the Office of the Under Secretary of Defense for Policy, where he concentrated on maritime security and U.S.-European cooperation. He also served as a staff member for the Independent Commission on the Security Forces of Iraq, chaired by General (Ret.) James L. Jones. Brannen holds a B.A. in political science from Trinity University (San Antonio, TX) and an M.A. in international affairs from the George Washington University. He has been awarded the Office of the Secretary of Defense Medal for Exceptional Public Service four times and has received the Department of State Superior Service Award and Secretary of Defense Award for Excellence.

Colonel Ethan Griffin is a U.S. Air Force fellow at CSIS, following a two-year joint tour as military assistant for the executive secretary to the secretary of defense. Previously, he was the commander of the 21st Airlift Squadron at Travis Air Force Base, California, and of the 817th Expeditionary Airlift Squadron at Incirlik Air Base, Turkey. His staff experience includes service as the deputy chief for the Concepts, Strategy, and Wargaming Division, Headquarters U.S. Air Force, Pentagon, as well as for the deputy under secretary of defense for installations and environment and the Air Force vice chief of staff in the Special Airlift Missions program, both while enrolled in the Air Force Intern Program. Griffin also tracked, managed, and reported on air assets and combat air force fires during duty within the U.S. Central Command's (USCENTCOM) Joint Operations Center.

Colonel Griffin is a career aviator and mobility expert officer. He has extensive airlift experience including U.S. combat theater support, noncombatant evacuation operations, airdrop operations, humanitarian actions, and world-wide lift and sustain efforts. He has supported multiple U.S. Operations, including JOINT ENDEAVOR (Bosnia), PROVIDE COMFORT, NORTHERN and SOUTHERN WATCH (Iraq), NOBLE EAGLE, IRAQI FREEDOM, ENDURING FREEDOM, UNIFIED RESPONSE (Haiti), and TOMADACHI (Japan). Griffin received his Air Force commission and B.S. at the University of Virginia in 1994. He holds a master of arts in organizational management from the George Washington University, and masters' degrees from both the U.S. Air Force School of Advance Air and Space

Studies and Air Command and Staff College. He is a distinguished graduate of the Air Force's Specialized Undergraduate Pilot Training (SUPT) Program. He is also a command pilot with instructor and evaluator qualifications, having flown over 3,300 hours in the C-17, T-1, and T-37.

Rhys McCormick is a research assistant with the National Security Program on Industry and Resources (NSPIR) at CSIS. His work focuses on unmanned systems, global defense industrial base issues, and U.S. federal and defense contracting trends. Prior to working at NSPIR, he interned at the Abshire-Inamori Leadership Academy at CSIS and the Peacekeeping and Stability Operations Institute at the U.S. Army War College. He holds a B.S. in security and risk analysis from the Pennsylvania State University with concentrations in both intelligence analysis and modeling and information and cyber security.

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1616 Rhode Island Avenue NW | Washington, DC 20006
t. 202.887.0200 | f. 202.775.3199 | www.csis.org

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