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UNMANNED AIRCRAFT SYSTEMS

Improved Planning and Acquisition Strategies Can Help Address Operational Challenges

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Highlights

Highlights of GAO-06-610T, a testimony before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The current generation of unmanned aircraft systems (UAS) has been in development for defense applications since the 1980's. As of February 2006, the Department of Defense (DOD) had more than 3,000 unmanned aircraft, about 2,000 of which are supporting ongoing operations in Iraq. DOD's 2006 Quadrennial Defense Review validates the importance of unmanned systems and establishes plans to significantly expand investment in unmanned systems and their use in military operations over the next several years. The Congress has been particularly interested in DOD's approach to determining UAS needs and managing the growing number of UAS programs.

This testimony addresses GAO's prior work and preliminary observations on (1) the operational successes and challenges U.S. forces are experiencing with UAS in combat operations, and the extent to which DOD has taken steps to address challenges; (2) DOD's progress in establishing a strategic plan and oversight framework to guide joint and service-specific UAS development efforts and related investment decisions; and (3) our assessment of the Global Hawk and Predator programs' business cases and acquisition strategies and the lessons learned that can be applied to the Joint Unmanned Combat Air Systems program.

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To view the full product, click on the link above. For more information, contact Sharon Pickup at (202) 512-9619 or pickups@gao.gov, or Michael J. Sullivan at (937) 258-7915 or sullivanm@gao.gov.

What GAO Found

DOD has experienced a high level of mission successes with UAS, but continues to face challenges in fully maximizing the use of these assets. In operations in Iraq and Afghanistan, U.S. forces have used UAS for intelligence, surveillance, reconnaissance, and offensive strike missions in support of joint and service-specific operations. As the numbers of UAS operating in the same airspace as manned aircraft grows, DOD continues to face operational challenges related to interoperability, availability of communications bandwidth, and airspace integration. While DOD and the services have taken some positive initial steps to address these challenges, such as issuing guidance and developing initiatives to improve interoperability, limited progress has been made and the effectiveness of these efforts cannot be adequately assessed until they are fully implemented.

While DOD continues to request funds to support service plans for acquiring UAS, it still lacks a viable strategic plan to guide UAS development and investment decisions. Since GAO last reported, DOD established new oversight bodies and updated its UAS Roadmap, but it is too early to tell how the new entities will interrelate and whether they will be able to influence service plans. Also, the updated roadmap identifies broad goals, desired capabilities, and service acquisition plans, but lacks critical elements, such as a clear link among goals, capabilities, and plans, opportunities for joint endeavors, and funding priorities and needs. Until DOD develops a strategic plan, it will not be well positioned to validate requirements, evaluate and integrate services plans, and establish program and funding priorities, nor will Congress have all the information it needs to evaluate funding requests. Such a plan would also help DOD anticipate and minimize the types of challenges that are being experienced today.

While there have been successes on the battlefield, UAS development programs have shared many of the same problems as other major weapon systems that begin an acquisition program too early, with many uncertainties about requirements, funding, and immature technology, design, and production. Unmanned systems have also experienced similar outcomes—changing requirements, cost growth, delays in delivery, performance shortfalls, and reliability and support problems. Future acquisition programs can learn from past efforts to craft better and less risky acquisition plans. Key steps conducive to success include preparing a comprehensive business case, adopting a knowledge-based and incremental acquisition strategy, and sustaining disciplined leadership and direction. Frequent changes to the Joint Unmanned Combat Air Systems technology demonstration program and recent budget actions raise some questions about the Department's priorities and future directions for UAS. Concerns have also been raised about possible duplication of systems as the services look to expand individual fleets. Ongoing Army and Air Force efforts to coordinate the Warrior and Predator programs are encouraging and could be a model for limiting duplication and fostering jointness and interoperability.

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to discuss our work on the Department of Defense's (DOD) unmanned aircraft systems (UAS).[1] As you know, the current generation of UAS has been under development for defense applications since the 1980s and is providing combat forces with intelligence, surveillance, reconnaissance, and strike capabilities that are helping to transform today's military operations. We appeared before you last year to discuss the performance of UAS in current operations, and DOD's progress in improving strategic and acquisition planning. At the time, we testified on our preliminary observations that while unmanned aircraft operations had achieved significant mission successes, emerging operational challenges could affect DOD's ability to maximize the use of UAS to enhance operations and effectively promote force transformation.[2] We also emphasized the need for DOD to develop a strategic plan to guide UAS development and highlighted lessons learned from our prior UAS development and acquisition reviews that could be instructive for the development and fielding of UAS. Since last year's testimony, we issued two reports on these matters and made several recommendations intended to improve DOD's management and acquisition of UAS.[3]

Since last year, we have seen an increasingly high level of UAS use in military operations in Iraq and Afghanistan. Meanwhile, DOD has issued an updated UAS roadmap and recently released its Quadrennial Defense Review (QDR) report, both of which indicate the department is planning to increase its inventory of unmanned aircraft and associated funding requests significantly over the next several years. At the same time, we understand that DOD has initiated several studies to determine intelligence, surveillance, and reconnaissance requirements, including those for UAS, which could affect future investment decisions. We

[1] Until recently, DOD referred to these aircraft as "unmanned aerial vehicles." "Unmanned aircraft" is consistent with the Federal Aviation Administration's classification and emphasizes other components of the system, such as payload, ground stations, and communications equipment.

[2] GAO, *Unmanned Aerial Vehicles: Improved Strategic and Acquisition Planning Can Help Address Emerging Challenges*, GAO-05-395T (Washington, D.C.: Mar. 9, 2005).

[3] GAO, *Unmanned Aircraft Systems: DOD Needs to More Effectively Promote Interoperability and Improve Performance Assessments*, GAO-06-49 (Washington, D.C.: Dec. 13, 2005) and *Unmanned Aircraft Systems: New DOD Programs Can Learn from Past Efforts to Craft Better and Less Risky Acquisition Strategies*, GAO-06-447 (Washington, D.C.: Mar. 15, 2006).

understand Congress has been particularly interested in DOD's approach to determining UAS needs and managing the growing number of UAS programs. We are also aware that DOD has made some changes in its plans for key future UAS acquisitions.

Today, you asked us to discuss the results of our previous reports and our preliminary observations on the ongoing work we are conducting for this Subcommittee on the integration of unmanned aircraft systems into combat operations. Specifically, we will highlight (1) operational successes and challenges U.S. forces are experiencing with UAS in combat operations, and the extent to which DOD has taken steps to address these challenges; (2) DOD's progress in establishing a strategic plan and oversight framework to guide joint and service-specific UAS development efforts and related investment decisions; and (3) our assessment of the Global Hawk and Predator programs' business cases and acquisition strategies and the lessons learned that can be applied to the Joint Unmanned Combat Air Systems (J-UCAS) program. We will be continuing our work on the integration of UAS in combat operations and plan to issue a report to you based on this work later this year.

To address our first two objectives, we interviewed officials and reviewed documentation from the UAS Planning Task Force within the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics; each of the military services; U.S. Joint Forces Command; the Joint Staff; U.S. Central Command (CENTCOM); and other organizations. We also observed Predator training and support to ongoing operations, and updated our previously issued reports on UAS strategic planning and operational challenges. Additionally, we discussed operational challenges with CENTCOM officials and UAS operators who recently returned or are currently supporting operations in Iraq to better understand the use of UAS in ongoing operations. To address our third objective, we interviewed officials and obtained data from the Office of the Secretary of Defense for Acquisition, Technology, and Logistics; Air Force Headquarters; Navy Headquarters; Air Combat Command; Air Force Materiel Command's Aeronautical Systems Center; and prime contractors. We reviewed acquisition strategies, plans, and outcomes for the three largest UAS acquisition programs, the Global Hawk, Predator, and J-UCAS. We compared plans to DOD's acquisition policy preferences and best practices to identify lessons learned for improving future programs.

We conducted our ongoing work from August 2005 to April 2006 in accordance with generally accepted government auditing standards.

Summary

Warfighting commanders are experiencing a high level of mission success with UAS in ongoing operations but, as we observed last year, they continue to face operational challenges in fully maximizing the use of these assets. In operations in Iraq and Afghanistan, U.S. forces have used UAS with great success for intelligence, surveillance, reconnaissance, and offensive strike missions in support of joint and service-specific operations. For example, commanders continue to rely on the Air Force Predator and Army Shadow UAS to help identify improvised explosive devices and locate the enemy forces who planted them, allowing for the detonation of the devices and the capture of the enemy forces. Notwithstanding these successes, interoperability remains a challenge as we previously reported, and integrating UAS into combat operations is becoming more complicated. For example, some UAS components cannot easily exchange and transmit data with ground forces because they were not designed to interoperable standards. Further, the availability of communications bandwidth[4] is constrained, limiting the number of UAS and other systems that can be operated simultaneously, and the amount of data that can be transmitted from the UAS. In the absence of standards requiring sensor payloads to be reprogrammable from one band to another, UAS were designed and built without this flexibility. In our December 2005 report, we recommended that DOD take steps to develop or adjust standards to address these interoperability and bandwidth challenges.[5] Additionally, our preliminary work indicates that airspace integration is a growing challenge as demand for UAS remains high and the number of assets operating in the same airspace as manned aircraft steadily grows. Among other things, unmanned aircraft are deployed and controlled at different levels of command, and have generally been rapidly fielded without the benefit of a commonly accepted concept of operations. As the number and usage of UAS increases, effective airspace integration will be crucial to avoid duplicative deployments of UAS and safety mishaps. While DOD has taken some positive steps to address these challenges and our prior recommendations, such as issuing guidance and developing initiatives to improve interoperability, progress to date has been limited and the effectiveness of these steps cannot be adequately assessed until they are fully implemented.

[4] Bandwidth refers to the available frequencies to support the flight of UAS, to transmit the output of onboard sensors, and to interface with air traffic control centers.

[5] GAO, *Unmanned Aircraft Systems: DOD Needs to More Effectively Promote Interoperability and Improve Performance Assessments*, GAO-06-49 (Washington, D.C.: Dec. 13, 2005).

While DOD continues to request funds for UAS and the services continue to plan, develop, and field UAS systems, it still lacks a robust oversight framework and strategic plan to guide UAS development and investment decisions. Since we last testified, DOD established additional oversight bodies – a Joint Center of Excellence and Joint Material Review Board – to supplement the efforts of its already existing UAS Planning Task force and to facilitate planning and coordination for the acquisition and use of UAS. While these actions appear to be steps in the right direction, it is too early to determine how these entities will interrelate with one another, what impact they will have on addressing the challenges we have identified, and whether they will be able to influence service UAS investment decisions or deployment. While DOD has updated its UAS Roadmap, it is still not a viable strategic plan because it lacks key planning elements. For example, while it describes broad goals, desired capabilities for UAS, and service-specific acquisition plans, it does not provide clear linkages nor does it address the relationship among service plans, opportunities for joint endeavors, investment priorities and related funding needs. As we have previously reported, without a strategic plan and effective oversight framework for using UAS, DOD has little assurance that it will have a basis for validating requirements, integrating service efforts, and establishing program and funding priorities. Furthermore, Congress may not have all the information it needs to evaluate DOD's UAS funding requests. Such a plan would help DOD assure that service plans for developing UAS anticipate and potentially minimize the types of challenges that are emerging today, particularly in the areas of interoperability, bandwidth, and airspace integration.

While there have been successes on the battlefield, UAS development programs have exhibited similar problems as other major weapon systems that began an acquisition program too early, with many uncertainties about requirements and funding, and immature technologies, design, and production. Unmanned systems have also experienced similar outcomes—changing requirements, cost growth, delays in delivery, performance shortfalls, and reliability and support problems. Future acquisition programs can learn from past efforts to craft better and less risky acquisition plans. Key steps conducive to success include (1) establishing a comprehensive business case that matches customer requirements with available resources to include proven technologies, sufficient time, and realistic funding; (2) implementing an incremental, knowledge-based acquisition strategy that separates technology development from product development and minimizes concurrency between testing and production; and (3) maintaining disciplined leadership support and direction. Frequent changes to the Joint Unmanned Combat Air Systems (J-UCAS) technology

demonstration program and recent budget actions raise some questions about the department's priorities and future directions for UAS. Garnering the benefits from improved coordination among the military services' individual programs and maintaining an emphasis on joint development and employment strategy seem to be at some risk. Concerns have also been raised about possible duplication of systems as the services look to expand individual fleets. The ongoing Army and Air Force effort to coordinate the Warrior and Predator programs is encouraging and could be a model for limiting duplication and fostering jointness and interoperability.

Background

DOD defines an unmanned aircraft as a powered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Generally, unmanned aircraft systems consist of the aerial vehicle; a flight control station; information and retrieval or processing stations; and, sometimes, wheeled land vehicles that carry launch and recovery platforms. According to DOD, many elements are needed for the use of UAS, including a systems architecture that allows data to be moved, adequate spectrum and bandwidth for communication, airspace management and deconfliction, common data standards and formats to allow sharing and data fusion, common operating systems, and system interoperability. Potential missions considered appropriate for unmanned aircraft systems have expanded from the original focus on the intelligence, surveillance, and reconnaissance mission areas to the area of limited tactical strike capabilities, with projected plans for persistent ground attack, electronic warfare, and suppression of enemy air defenses.

As shown in table 1, DOD had more than 3,000 unmanned aircraft as of February 2006, compared to fewer than 50 unmanned aircraft in 2000.[6] As of January 2006, more than 2000 of these aircraft were supporting ongoing operations in Iraq. Over 88 percent of the unmanned aircraft currently in inventory are small UAS, those launched by hand or by bungee. As a point of comparison, no small unmanned aircraft were in inventory in 2000.

[6] The total number represents the number of unmanned aircraft, rather than unmanned aircraft systems, and includes test and training assets.

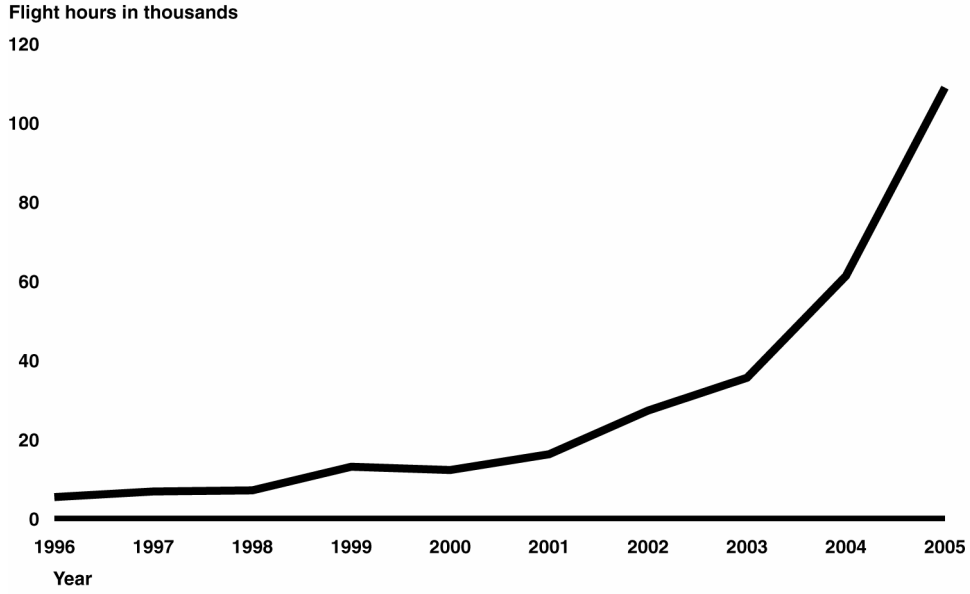
Table 1: Number and Type of Unmanned Aircraft in DOD's Inventory, as of February 2006

Type	System	Service/Command	Total aircraft inventory
Small UAS (weight less than 10 lbs./airspeed less than 100 kts.)	Pointer	Air Force/Special Operations Command	126
	Raven	Army/Air Force/ Special Operations Command	1776
	Dragon Eye	Marine Corps/ Special Operations Command	402
	Force Protection Airborne Surveillance System	Air Force	126
	Swift	Special Operations Command	212
	BATCAM	Air Force	54
Tactical UAS (weight less than 500 lbs./airspeed less than 120 kts.)	Pioneer	Navy and Marine Corps	34
	Shadow 200	Army	140
	Neptune	Special Operations Command	15
	Tern	Special Operations Command	15
	Mako	Special Operations Command	15
	Tigershark	Special Operations Command	6
Theater-level UAS	Predator A	Air Force	70
	I-Gnat	Army	4
	Hunter	Army	32
	Fire Scout	Navy/Army	4
	Predator B	Air Force	6
	Global Hawk	Air Force/Navy	11
Total			**3048**

Source: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

Similarly, UAS flight hours have also increased. For example, as shown in figure 1 below, flight hours have increased from about 5,000 hours in 1996 to 109,000 hours in 2005.

Figure 1: Unmanned Aircraft Flight Hours, 1996–2005



Source: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

Note: Numbers do not reflect small unmanned aircraft.

As the numbers of unmanned aircraft and flight hours have increased, so has UAS funding. Total UAS funding shows an increase from about $363 million in fiscal year 2001 to about $2.06 billion in fiscal year 2006. In addition, the fiscal year 2007 President's Budget projects funding will grow to about $3.02 billion in fiscal year 2011. These figures do not include supplemental funding. DOD has requested approximately $208 million for UAS in its fiscal year 2006 supplemental request.

In December 2002, DOD created the 2002-2027 Unmanned Aerial Vehicles Roadmap, which was designed to guide U.S. military planning for UAS development and describe current programs, identify potential missions for UAS, and provide guidance on developing emerging technologies. In August 2005, DOD issued an updated version of the roadmap covering the period 2005-2030. Like its predecessor, the 2005 roadmap contains broad goals for unmanned systems that support the department's larger goals of fielding transformational capabilities, establishing joint standards, and controlling costs.

Furthermore, DOD's 2006 QDR published in February 2006 validates the importance of unmanned systems. Overall, the QDR provides direction for

accelerating the department's transformation to focus more on combatant commanders' needs and to develop portfolios of joint capabilities. In particular, the QDR report highlighted the department's plans to expand investment in unmanned systems and their use in military operations. For example, it states DOD's intent to nearly double unmanned aircraft coverage by accelerating the acquisition of the Predator and Global Hawk systems. It also plans to restructure the Joint Unmanned Combat Air Systems program and develop an unmanned longer-range carrier-based aircraft to increase naval reach and persistence. Further, the QDR plans to develop a new land-based, penetrating long-range strike capability by 2018 and sets a goal that about 45 percent of the future long-range strike force be unmanned. Lastly, the 2006 QDR directs the Air Force to establish an unmanned aerial vehicle squadron under the U.S. Special Operations Command.

Combat Successes Realized, but Challenges Remain

DOD has experienced a high level of mission success using UAS in combat operations, but faces some operational challenges that could hamper joint operations. We previously identified interoperability and limited bandwidth as challenges and, according to our preliminary work, as the number of unmanned systems increases, airspace integration is becoming a growing challenge. While DOD has taken initial steps to address these challenges, limited progress has been made and the effectiveness of these actions cannot be adequately assessed until they are fully implemented.

Recent UAS Successes in Combat Operations

DOD has achieved significant operational successes in combat operations from its use of a variety of unmanned aircraft and their sensor, communications, and armaments payloads, thereby increasing the demand for and use of UAS. In operations in Iraq and Afghanistan, U.S. forces have used a variety of UAS, such as the Predator, Raven, and Shadow, in integral roles on intelligence, surveillance, reconnaissance, and offensive strike joint or service-specific missions. For example, a Predator UAS provided video to a U.S. military element which provided situational awareness that contributed to the success of a mission that resulted in the capture of an al Qaida operational commander. Similarly, the Army used its Shadow UAS to identify an improvised explosive device and guide U.S. forces to the location of the enemy forces, enabling the capture of the enemy forces and safe detonation of the improvised explosive device.

Additionally, small UAS such as the Raven have been instrumental in enabling troops to find, locate, and destroy numerous targets. For example, a Raven was used to identify a suspicious vehicle in the

courtyard of a residence, which facilitated the discovery of a large weapons and ammunition cache when soldiers conducting the ground combat operations confirmed the vehicle contained explosives. As a result of successes such as these, the demand for and use of UAS are continuing to grow.

DOD Faces Operational Challenges in Integrating UAS into Combat Operations

Notwithstanding these operational successes, DOD continues to face challenges in effectively integrating unmanned systems into joint combat operations, and progress in addressing these challenges has been limited. Key challenges identified in ongoing operations in Iraq and Afghanistan relate to interoperability,[7] the availability of communications bandwidth, and managing UAS and manned systems in the same airspace.

First, while numerous UAS are being called on to conduct important missions in recent operations, interoperability remains a challenge. For example, as we reported in December 2005, some unmanned aircraft sensor and communications payloads and ground stations cannot easily exchange data because they were not designed to interoperable communications standards, even within a single service in certain circumstances. When communication systems are incompatible, operating forces may be required to operate their own UAS to accomplish a mission, rather than using UAS that are already operating in the same area, thus increasing the numbers of systems being operated. To permit the sharing of tactical intelligence obtained by unmanned aircraft sensors, the services or combatant commands have developed certain technical patches that permit compatibility but slow data transmission. DOD guidance requires interoperability and DOD's 2005 roadmap identifies it as a key goal. In the absence of specific standards, the services have tended to initiate separate development programs, specifically tailored to service specific requirements. Officials from U.S. Central Command have also emphasized the need for improved interoperability and standards. For example, the commander of U.S. Central Command recently testified that while UAS have transformed the battlespace and demand for their capabilities is significant, there is a need to develop an integrated architecture of many sensors to support operational units. He further stated that experiences to date highlight the importance of an established

[7] Interoperability is the ability of systems, units, and forces to provide and receive data and information from other systems, units, and forces.

interoperability standard for all intelligence systems that can function in a joint and combined environment.

Second, communications bandwidth continues to represent a major challenge for UAS. Unmanned aircraft and their sensor, armaments, and communications payloads depend on reliable access to communications bandwidth. Bandwidth is needed to support systems that control the flight of certain unmanned aircraft, to transmit data collected by payload sensors, and to interface with air traffic control centers. Because UAS and other weapons or communications systems, including manned aircraft, often operate on the same frequency, certain frequencies can become congested and interference can occur. Such capacity constraints may limit the number of UAS and other systems that can be effectively operated simultaneously and the amount of available data that can be transmitted. Despite having the capability to operate multiple UAS simultaneously, DOD's roadmap states that the limited number of frequencies available often restricts the number of unmanned aircraft airborne at any point in time to one. As we reported in December 2005, the problem with constrained bandwidth cannot be easily overcome without potentially costly modifications to existing systems because DOD has not established standards requiring unmanned aircraft or sensor payloads to be reprogrammable from one band to another.

To address these challenges, we recommended that DOD develop standards, including overall UAS interoperability standards and standards that will allow for future UAS to be reprogrammable to different frequencies. We are also aware that, in the Fiscal Year 2006 National Defense Authorization Act, Congress required that the Secretary of Defense take such steps to ensure that all[8] service tactical unmanned aerial vehicles are equipped and configured so that the data link used is the Tactical Common Data Link and those vehicles use data formats consistent with the architectural standard for tactical UAS.[9] We understand that some of the military services have provided a report to Congress to identify which systems are currently in compliance with the Tactical Data Link requirement. According to DOD, use of this link is

[8] The Undersecretary of Defense for Acquisition, Technology, and Logistics may waive the applicability of these requirements to any tactical UAS if the Undersecretary determines and certifies to the congressional defense committees that it would be technologically infeasible or uneconomically acceptable to integrate a tactical data link.

[9] Pub. L. No. 109-163 § 141 (2006).

expected to reduce the amount of bandwidth used and allow the UAS to utilize a broader band of frequencies; however, it will not totally alleviate the problem because it is too heavy to use on small UAS and may result in shifting the frequency congestion to other bands.

Third, our preliminary work indicates that effectively integrating UAS into the airspace is becoming a growing challenge in ongoing operations. With the growing numbers and increasing use of UAS of various types and sizes to support combat missions, particularly in Iraq, coordination, integration, and deconfliction of airspace among UAS and manned systems are becoming more complex. In addition to limitations on communications interoperability, UAS are deployed and controlled at different levels of command. Furthermore, UAS have generally been rapidly fielded without the benefit of a commonly accepted concept of operations for the different types of UAS, including tactics, techniques, and procedures for employment and use of assets. According to U.S. Central Command officials, because there are numerous UAS in theater now, many with multirole capabilities and disparate command and control, the potential exists for deployment of multiple UAS capabilities to support the same operation. Moreover, UAS are not currently equipped with the capability to sense and avoid other unmanned or manned aircraft but instead rely on procedural control methods for deconfliction. While aware of only a few mishaps, many of the officials we spoke with are concerned about problems in the future as the numbers of UAS steadily increase. For example, according to a U.S. Central Command official, there have been some collisions between small UAS and helicopters. Army officials stated that they were aware of one collision between a Raven UAS and a helicopter. The cause of the collision was attributed to the helicopter pilot being outside of his designated flight area. With the number of UAS in support of ongoing operations increasing, effective airspace integration is critical to maximize service capabilities, avoid duplicative deployments, and minimize safety mishaps.

DOD is taking some initial steps to address interoperability, bandwidth, and airspace integration challenges, but progress has been limited. For example, to promote interoperability and address bandwidth issues, in December 2005 DOD issued guidance reminding the services that common data link[10] remains the DOD standard for all intelligence, surveillance, and

[10] The common data link is a family of full-duplex, jam-resistant, point-to-point microwave communication links developed by the U.S. government and used in imagery and signals intelligence collections systems.

reconnaissance links. Further, DOD continues to refine its guidance for improved interoperability and supportability of information technology and national security systems, which include UAS. In March 2006, the Chairman of the Joint Chiefs of Staff issued an instruction addressing certification and validation of DOD information technology and national security systems acquisition programs to meet emerging key interoperability performance parameters, such as information exchange.[11] Additionally, DOD's 2005 roadmap contains an appendix which outlines interoperability standards. However, DOD officials acknowledge that the UAS roadmap and the parameters included in the March guidance are evolving and neither provides an inclusive list of all standards required to achieve interoperability. The services are also initiating efforts to improve interoperability. For example, the Army and Marine Corps are moving to a "one system" ground control station to allow multiple UAS platforms to be operated by a single ground control station. In addition, the Air Force has demonstrated a multiaircraft control ground control station that would control up to four Predator air vehicles at any one time. Furthermore, an initiative originally started by the Air Force—as the Remote Operations Video Enhanced Receiver System—has been embraced by each of the services to enable ground forces to receive information directly from certain airborne unmanned aircraft. Also, the Army has begun to integrate Blue Force Tracker[12] into some of its UAS to improve situational awareness. All of these efforts are in preliminary stages and, while these steps are positive, their effectiveness cannot be adequately assessed until they are fully implemented.

Progress Made but Additional Elements Needed to Establish a UAS Strategic Plan and Effective Oversight

While DOD has made some progress, it still lacks a robust oversight framework and strategic plan to guide UAS development and investment decisions. DOD's progress includes an update to its roadmap and the establishment of new oversight bodies to facilitate planning and coordination regarding the development, procurement, and use of UAS. Despite our prior recommendations on the subject, DOD's updated roadmap still lacks key planning elements such as a clear link between goals, capabilities, plans, funding priorities, and needs. Therefore, it is not yet a viable strategic plan for guiding UAS development and investment.

[11] CJCSI 6212.01D (Washington, D.C.: Mar. 8, 2006).

[12] Blue Force Tracker is a satellite-based tracking and communications system that enables users to monitor the location of other Blue Force Tracker-equipped aircraft and vehicles.

Additional UAS Oversight Bodies Established

As you may recall, in October 2001, the Under Secretary of Defense for Acquisition, Technology, and Logistics created the Joint Unmanned Aerial Vehicle Planning Task Force (now known as the UAS Planning Task Force) to provide oversight for the department's UAS programs and to provide guidance, as necessary, to promote interoperability and commonality. To communicate its vision and promote commonality of UAS systems, the Task Force published its first UAS roadmap in 2002 and an updated version in 2005. The roadmap describes current programs, identifies potential missions, and provides guidance on emerging technologies. According to DOD officials, the Task Force is currently focused on coordinating with the services as they procure and field greater numbers of UAS in an effort to ensure the military services avoid duplication of systems, while developing integrated systems that can work together in joint combat operations.

To supplement the efforts of its UAS Planning Task Force, DOD has established two additional UAS oversight bodies since we last testified. For example, in July 2005, the Joint Requirements Oversight Council[13] established a new Joint Unmanned Aircraft Systems Center of Excellence to focus on UAS operational issues and the Joint UAS Material Review Board[14] to address joint UAS material issues and prioritize solutions. The Center of Excellence—assisted by an advisory council composed of representatives from each of the combatant commands, the services, and the Joint UAS Material Review Board—is responsible for facilitating the development and integration of UAS common operating standards, capabilities, concepts, doctrine, tactics, techniques, procedures, and training. The Center of Excellence has been charged with developing a joint concept of operations for unmanned aircraft systems. According to center officials, the concept of operations will likely address issues such as interoperability and airspace integration.

[13] The Joint Requirements Oversight Council is a joint organization made up of the Vice Chairman of the Joint Chiefs of Staff and a four-star officer designated from each of the services that bases recommendations to the Chairman on interaction with combatant commanders and the Joint Staff Director-led Joint Warfighting Capability Assessment teams that perform detailed assessments of programmatic alternatives, tradeoffs, risks, bill-payers, and effectiveness. CJCSI 3180.01 (Washington, D.C.: Oct 31, 2002).

[14] This group was formerly known as the Joint UAV Overarching Integrated Process Team and was rechartered to form the Joint Material Review Board and tasked with addressing UAS material issues.

The Material Review Board is chartered to provide a forum to identify or resolve requirements and corresponding material issues regarding interoperability and commonality, prioritize potential solutions, assess the focus of current and future programs, and seek strategies common to all services. The Material Review Board is composed of members from each of the services, Joint Staff, Office of the Secretary of Defense, and Joint Forces Command. Due to the broad nature of UAS, at various times other stakeholders, such as the combatant commanders, also attend board meetings. Additionally, the board is not a standing body with full-time members, but rather an organization that meets periodically.

The Joint Requirements Oversight Council also tasked both the Center of Excellence and the Material Review Board with submitting recommendations to the Joint Capabilities Integration and Development System and with coordinating service-sponsored UAS submissions.[15] DOD officials state that having the center and board serve in this coordination role will allow them to leverage service developmental efforts, capabilities, and requirements to enable joint interoperability, and reduce duplication of effort. As of March 2006, the center and board were in the process of organizing, establishing guidance and procedures, conducting initial meetings, and identifying initial efforts.

In addition to the UAS Joint Planning Task Force, DOD views the new oversight bodies as means to more effectively manage service UAS programs. While these changes appear to be steps in the right direction, it is unknown whether they will provide an effective oversight framework. It is too early to tell how these entities will interrelate or what impact they will have in addressing interoperability issues and the other challenges we have identified. While DOD intends for these entities to play a role in guiding service UAS acquisition, planning, prioritization, and execution of unmanned air systems, it is also unclear to what extent they will be able to influence the services because none of the entities are chartered with the authority to direct the military services to adopt any of their suggestions. Rather, they act in an advisory capacity and make recommendations to the services and Joint Requirements Oversight Council.

[15] In June 2003, the Chairman of the Joint Chiefs of Staff created the Joint Capabilities Integration and Development System process. It is a collaborative system that DOD uses to identify capability gaps and integrated solutions to resolve these gaps.

Updated UAS Roadmap Better Identifies Challenges but Still Lacks Key Strategic Plan Elements

Notwithstanding our prior recommendations on the subject, DOD's updated UAS roadmap lacks key planning elements and is not a strategic plan that can guide UAS development and investment decisions. As we have previously testified and reported, a strategic plan and effective oversight can be helpful in guiding efforts to develop and field UAS and to address the types of challenges that are emerging with integrating UAS into the force structure. Specifically, we emphasized that while DOD's 2002 roadmap contained some elements of a strategic plan—in that it identified approaches to attaining long-term goals and assessed in part, annual performance goals and performance indictors that identified progress towards these goals—it only minimally addressed other elements, such as the interrelationship between service-specific efforts, opportunities for joint endeavors, or funding issues.[16] We reported that although the joint UAS Planning Task Force had taken a positive step by developing the Unmanned Aerial Vehicles Roadmap 2002-2027, a key planning document, neither it nor other DOD guidance documents represented a comprehensive strategic plan to guide the development and fielding of UAS. We further reported that without a strategic framework and an oversight body with sufficient program directive authority to implement planning, DOD had little assurance its investment would result in UAS programs being effectively integrated into the force structure. Consequently, we found that DOD risked increased costs, future interoperability problems, and duplication among the military services. We recommended that DOD establish a strategic plan and designate the Task Force or another body to oversee implementation of the plan.

Since that time, DOD has established the previously discussed entities and the UAS Planning Task Force published an updated roadmap—the Unmanned Aircraft Systems Roadmap 2005-2030. Similar to its predecessor, the 2005 roadmap contains some elements of a strategic plan such as broad long-term goals and priorities, but lacks other crucial elements of a strategic plan, such as milestones and performance measures for achieving these goals and priorities. While it also describes desired capabilities for UAS, operational issues or challenges based on ongoing operations, and service-specific acquisition plans, it does not provide a clear link among the goals, desired capabilities, and plans, nor does it sufficiently address the interrelationship among service plans to each other and how they promote joint operations, opportunities for joint

[16] GAO, *Force Structure: Improved Strategic Planning Can Enhance DOD's Unmanned Aerial Vehicles Efforts*, GAO-04-342 (Washington, D.C.: Mar. 17, 2004).

endeavors, and investment priorities and related funding needs. We believe the roadmap does not provide specific guidance on UAS development or related force structure integration. In fact, the roadmap clearly states that it neither authorizes specific UAS nor prioritizes the requirements, as this is the responsibility of the services and the Joint Requirements Oversight Council. DOD officials acknowledged to us that the updated roadmap is not a strategic plan and does not contain details about force structure, resources, and other capability implementation issues, but rather emphasizes technology. U.S. Central Command officials have cited the need for an integrated roadmap for UAS to ensure interoperability is achieved and that new UAS systems neither interfere with nor limit mission performance. We continue to believe that a strategic plan is needed to better position DOD to validate requirements, evaluate services plans, integrate service efforts, and establish program and funding priorities. Without a strategic plan, Congress may not have all the information it needs to evaluate DOD's UAS funding requests. Furthermore, a strategic plan and oversight framework would help DOD assure that service plans for developing UAS anticipate and potentially minimize the types of challenges that are emerging today, particularly in the areas of interoperability, bandwidth, and airspace integration.

Unmanned Aircraft Programs Provide Lessons Learned for Future Systems to Craft Better and Less Risky Acquisition Strategies

While there have been successes on the battlefield, UAS development programs have exhibited similar problems as other major weapon systems that began an acquisition program too early, with many uncertainties about requirements and funding, and immature technologies, design, and production. Unmanned systems have also experienced similar outcomes—changing requirements, cost growth, delays in delivery, performance shortfalls, and reliability and support problems. Future acquisition programs can learn from past efforts to limit risks and improve outcomes by establishing comprehensive business cases to match customer requirements and available resources and by adopting disciplined knowledge-based and incremental acquisition strategies consistent with DOD acquisition policy preferences and best practices. Recent management decisions and budget actions raise some questions about the department's priorities, future direction for UAS, and possible duplication of systems. Ongoing Army and Air Force efforts to coordinate acquisitions, logistics, and employment of two similar systems are encouraging.

Acquisition Strategies and Outcomes Experienced by Current Programs Can Be Used to Improve Future Systems

We recently reported on DOD's three largest UAS programs.[17] We analyzed and contrasted the acquisition strategies and outcomes of the Air Force's Global Hawk and Predator programs. We identified lessons learned that could benefit the Joint Unmanned Combat Air Systems technology demonstration and other future systems.

The Global Hawk and Predator programs had similar beginnings, but followed different acquisition strategies that resulted in different outcomes. While both programs began with top leadership support and accomplished successful, focused demonstration efforts, Global Hawk switched to a high-risk acquisition strategy by accelerating development and production. With the substantial overlap in development, test, and production, the program experienced significant gaps in knowledge about technology, design, and manufacturing capabilities while requiring sizable funding. As a result, serious cost and schedule problems have ensued, some required capabilities have been deferred or dropped, operational tests have identified performance problems, and the Global Hawk program is being restructured for the fourth time. In contrast, the Predator program has pursued an acquisition strategy that is more consistent with DOD's revised acquisition guidance and commercial best practices for a more structured and evolutionary acquisition approach. While the Predator program has some overlap in development and production and has experienced some problems, the program's cost growth and schedule delays have been relatively minor, and testing of prototypes in operational environments has already begun.

There are trends that run consistently through the Global Hawk and Predator programs, similar to trends in other major defense acquisition programs that we have reviewed. That is, when DOD provides strong leadership at an appropriate organizational level, it enables innovative, evolutionary, and disciplined processes to work. Once leadership is removed or diminished, programs have tended to lose control of requirements and add technical and funding risks. We have also found that after successful demonstrations to quickly field systems with existing technologies, problems were encountered after the programs transitioned into the system development phase of the acquisition process. The services pushed programs into production without maturing processes

[17] GAO, *Unmanned Aircraft Systems: New DOD Programs Can Learn from Past Efforts to Craft Better and Less Risky Acquisition Strategies*, GAO-06-447 (Washington, D.C.: Mar. 15, 2006).

and also began to add new requirements that stretched beyond technology and design resources. Inadequate technology, design, and production knowledge increased risk and led to cost, schedule, and performance problems.

The J-UCAS technology demonstration program and its offspring could benefit from the lessons learned in the Global Hawk and Predator programs. Since its inception, the J-UCAS program has been in flux. Program leadership, funding, and priorities have changed several times. The recent Quadrennial Defense Review has directed another restructuring into a Navy program to demonstrate a carrier-based unmanned combat air system. The Air Force plans to consider J-UCAS technologies and accomplishments in its efforts to develop a new long-range strike capability. Before DOD commits to major acquisition development programs for the Navy and Air Force, it has the opportunity and time to develop the knowledge needed to prepare solid and feasible business cases and to adopt disciplined, evolutionary strategies consistent with DOD acquisition policy preferences and best practices to support advanced unmanned systems acquisitions. Refining requirements based on proven technologies and a feasible design based on systems engineering are best accomplished in the concept and technology development phase that precedes the start of a system acquisition program. During this early phase, the environment is conducive to changes in requirements that can be accomplished more cost-effectively than after systems integration begins and large organizations of engineers, suppliers, and manufacturers are formed to prepare for the start of system production.

Key lessons that can be applied to J-UCAS and other future systems include

- maintaining disciplined leadership support and direction similar to that experienced early in Global Hawk from the Under Secretary of Defense for Acquisition, Technology, and Logistics and with the Predator's Task Force Arnold (a senior group of Air Force leaders that helped the program maintain a tight focus on program requirements and direction);

- establishing a clear business case that justifies initial investments and constrains individual program requirements to match available resources based on proven technologies, engineering knowledge, and

time available before committing to system development and demonstration;

- implementing an incremental acquisition strategy preferred by defense policy and best practices that separates technology development from product development and minimizes concurrency between testing and production;

- establishing and enforcing controls that require knowledge and demonstrations to ensure that appropriate knowledge is captured and used at critical decision junctures before moving programs forward and investing more money; and

- managing according to realistic funding requirements that fully resource product development and production based on a cost estimate that has been informed by proven technologies and a preliminary design.

Additionally, lessons learned from the transition of the Global Hawk and Predator systems from technology demonstrations into system production and operation are important. The advanced concept technology demonstration can be a valuable tool to prove concepts and military utility before committing time and funds to a major system acquisition. Designing in product reliability and producibility, and making informed trade-offs among alternative support approaches are key aspects of development and can save substantial money in operating and maintaining systems during their lifetimes. However, if these operational aspects of system development are not addressed early before production, they can have major negative impacts on life-cycle costs. The original Predator demonstration effort did not emphasize design and development tasks that make a system more reliable and supportable. This made the transition from demonstration to acquisition more difficult and the Air Force had to organize a team to respond and resolve reliability and supportability issues.

Future Direction of DOD's UAS Acquisitions

Frequent changes to J-UCAS and recent budget actions raise some questions about the department's priorities and future direction for unmanned aircraft systems, which a strategic plan would help address. Garnering the benefits from improved coordination among the military services' individual programs and maintaining an emphasis on joint development and fielding strategy seem to be at some risk.

In terms of overall investment, while development and procurement funding have significantly increased since the terror attacks in September 2001, annual funding requested in fiscal year 2007 for unmanned aircraft systems is $1.7 billion, while DOD's funding for tactical aviation programs in 2007 is $25.1 billion. The total funding programmed in the fiscal year 2006 defense budget request was $15.4 billion and $153.9 billion, respectively. The near-term investment plans laid out in the fiscal year 2007 budget request are smaller than the amounts projected over the same period in the fiscal year 2005 budget.

The termination of the J-UCAS as a joint technology demonstration program and uncertain, evolving future plans for its offspring also seem somewhat at odds with official plans for jointness. The J-UCAS was one of the top priorities in DOD's roadmap published in August 2005 and was cited as leading the way to the next generation of unmanned aircraft—extending missions beyond the original focus on intelligence, surveillance, and reconnaissance capabilities to persistent, survivable, and advanced combat capabilities with increased levels of autonomy. A weaponized, stealthy unmanned aircraft was also selected as the most effective solution to close capability gaps identified in the joint strike enabler initial capabilities document published in December 2004. The system envisioned was to provide a penetrating and persistent strike aircraft against high-threat enemy air defenses and other high-value ground targets. Before J-UCAS became a joint program in October 2003, the Air Force had planned to accelerate its own unmanned combat air system with initial deliveries in fiscal year 2007. It appears to us that Air Force support for such a system waned when it became a joint program on a less aggressive fielding schedule.

Also uncertain is how many crossover benefits can be mutually provided by separate Navy and Air Force efforts as restructured. The Navy is starting up its own program in fiscal year 2007 with about $1.8 billion in funds cut from the J-UCAS program. Some of the remaining J-UCAS programmed funding was redirected to the Air Force's long-range strike program and other efforts. Requirements are somewhat divergent. The Navy appears to be most interested in fielding a relatively small aircraft of moderate endurance that may operate solo from aircraft carriers to provide surveillance for the battle group. The Air Force's future striker will likely be a larger land-based platform able to operate in groups, with a longer range requiring aerial refueling and employing a large weapons-carrying capacity. The Air Force is expected to use J-UCAS experience in conducting an analysis of alternatives during 2006 of the future striker, which may be manned, unmanned, or some combination. Air Force plans

are still evolving at this time and it is unclear how much of the previous investment in J-UCAS technology and continuing Navy efforts will benefit the Air Force program.

As the J-UCAS evolves one more time—and efforts return to the individual services—some key challenges will exist to maintain the advantages that were offered by a joint effort. The services need to be aware of those advantages and not arbitrarily reject them for parochial reasons. For example, exploiting past plans for common operating systems, components, and payloads could offer cost savings in acquisition and life-cycle support as well as improved interoperability. In particular, the common operating system could be a cutting edge tool to integrate and provide for interoperability of air vehicles, allowing groups of unmanned aircraft to fly in a coordinated manner and function autonomously (without human input). A top priority when the Defense Advanced Research Projects Agency led J-UCAS, the common operating system is now likely to be terminated, according to a program official.

Concerns have also been raised about possible duplication of DOD unmanned aircraft systems as the services look to expand individual fleets. The joint decision of the Air Force and Army to develop a memorandum of understanding on the Predator and Warrior programs is encouraging and could be a model for inhibiting duplication and fostering synergy of efforts. These two systems are similar in mission and design and are manufactured by the same contractor. The services agreed to a collaborative solution in terms of acquisition, logistics, and employment and to optimize funding and leverage current and future systems to rapidly field identified capabilities. A more detailed memorandum of understanding is expected soon to articulate the path forward for each of the services in respect to developing complementary capabilities. One possible outcome could be a decision to acquire one system to meet the needs of both services. We note, however, that the Air Force recently substantially increased its planned investments in Predator A to buy much greater quantities; this year's funding estimates through 2011 are 165 percent more than was estimated for the same period last year. It would seem more prudent to do the analysis and reach the collaborative decisions with the Army before committing to increased investments.

Mr. Chairman, this concludes our prepared statement. We would be happy to answer any questions that you or members of the Subcommittee may have.

Contacts and Staff Acknowledgments

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