United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

For Release on Delivery
Expected at 2:00 p.m. EST
Wednesday, March 17, 2004

UNMANNED AERIAL VEHICLES

Major Management Issues Facing DOD's Development and Fielding Efforts

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Highlights

Highlights of GAO-04-530T, testimony before the Subcommittee on Tactical Air and Land Forces, House Committee on Armed Services

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Why GAO Did This Study

The current generation of unmanned aerial vehicles (UAVs) has been under development since the 1980s. UAVs were used in Afghanistan and Iraq in 2002 and 2003 to observe, track, target, and strike enemy forces. These successes have heightened interest in UAVs within the Department of Defense (DOD). Congress has been particularly interested in DOD's approach to managing the growing number of UAV programs.

GAO was asked to summarize (1) the results of its most current report on DOD's approach to developing and fielding UAVs[1] and the extent to which the approach provides reasonable assurance that its investment will lead to effective integration of UAVs into the force structure, and (2) the major management issues GAO has identified in prior reports on UAV research and development.

What GAO Recommends

In our most recent report, GAO recommends that DOD (1) establish a strategic plan to guide UAV development and fielding and (2) designate the UAV Task Force or other appropriate body to oversee the plan's implementation, ensuring sufficient authority is provided.

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

www.gao.gov/cgi-bin/getrpt?GAO-04-530T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Neal Curtin at (202) 512-4914 or curtinn@gao.gov; or Paul Francis at (202) 512-2811 or francisp@gao.gov.

What GAO Found

GAO's most recent report points out that while DOD has taken some positive steps, its approach to UAV planning still does not provide reasonable assurance that the significant Congressional investment in UAVs will result in their effective integration into the force structure. In 2001, DOD established the joint UAV Planning Task Force in the Office of the Secretary of Defense to promote a common vision for UAV-related efforts and to establish interoperability standards. To communicate its vision and promote UAV interoperability, the task force issued the 2002 UAV *Roadmap*. While the *Roadmap* provides some strategic guidance for the development of UAV technology, neither the *Roadmap* nor other documents represent a comprehensive strategic plan to ensure that the services and other DOD agencies focus development efforts on systems that complement each other, will perform the range of priority missions needed, and avoid duplication. Moreover, the Task Force has only advisory authority and, as such, cannot compel the services to adopt its suggestions.

GAO's prior work supports the need for effective oversight of individual UAV programs at the departmental level. UAVs have suffered from requirements growth, risky acquisition strategies, and uncertain funding support within the services. Some programs have been terminated. Success has been achieved as a result of top-level intervention and innovative acquisition approaches. For example, in 2003, the Office of the Secretary of Defense had to intervene to keep the Unmanned Combat Air Vehicle program viable. As UAV programs grow in the future, they will face challenges in the form of increased funding competition, greater demand for capabilities, and spectrum and airspace limitations. Moreover, UAVs are no longer an additional "nice-to-have" capability; they are becoming essential to the services' ability to conduct modern warfare. Meeting these challenges will require continued strong leadership, building on the UAV *Roadmap* and Planning Task Force as GAO has recommended.

The Air Force Predator UAV

Source: U.S. Air Force.

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to appear before you today to discuss the major management issues that we identified in our current and prior work on the research, development, and fielding of the latest generation of unmanned aerial vehicles (UAV) by the Department of Defense (DOD). The current generation of UAVs has been under development for defense applications since the 1980s, and as DOD continues to transform the way in which it conducts military operations, UAVs are becoming a vital part of the force structure.

For our statement today, you asked us to discuss the results of our most recent report to the subcommittee, which is being released today.[1] In this report, we summarized recent UAV costs and funding, and analyzed DOD's approach to developing and fielding UAVs to see to what extent the approach provides reasonable assurance that UAV programs will be efficiently integrated into the force structure. You also asked that we summarize the major management issues we have identified in prior reports on UAV programs, including our 2003 report on the unmanned combat aerial vehicle.[2]

Summary

In our report being released today, we point out that funding for UAV research and development and procurement has been increasing in recent years, and Congress has actually provided more funds for UAV acquisition than DOD requested. During the past 5 fiscal years, Congress provided about $2.7 billion in funding for UAV development and procurement as compared with about $2.3 billion requested by DOD. Additionally, spending on operations and maintenance for UAVs has been increasing as DOD has begun using UAV systems in recent military operations. This growing spending reflects the importance that Congress has placed on UAVs as they have demonstrated success in recent operations. We also report that DOD's approach to planning for UAVs does not provide reasonable assurance that the investment will result in the effective

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

[2] U.S. General Accounting Office, *Defense Acquisitions: Matching Resources with Requirements Is Key to the Unmanned Combat Air Vehicle Program's Success*, GAO-03-598 (Washington, D.C.: June 30, 2003).

integration of UAV programs into the force structure. We recognize that DOD has taken certain positive steps to improve the UAV program's management. For example, to help manage UAV development, in 2001 DOD established a joint UAV Planning Task Force in the Office of the Secretary of Defense to promote a common vision for UAV-related efforts and to establish interoperability standards. Also, to communicate its vision and promote UAV interoperability, the Task Force issued the 2002 UAV *Roadmap*, which describes current programs, identifies potential missions for UAVs, and provides guidance on developing emerging technologies. Our concern, however, is that neither the *Roadmap* nor other defense planning documents represent a comprehensive strategic plan to ensure that the services and other DOD agencies focus development efforts on systems that complement each other, will perform the range of priority missions needed, and avoid duplication. Moreover, the joint UAV Planning Task Force does not have program directive authority and serves only in an advisory capacity to the Under Secretary of Defense for Acquisitions, Technology, and Logistics. Without a strategic plan and an oversight body with sufficient authority to implement the plan, DOD risks poorly integrating UAVs into the force structure, which could increase development, procurement, and logistics costs, and increase the risk of future interoperability problems. Consequently, in our most recent report we recommended that DOD (1) establish a strategic plan to guide UAV development and fielding and (2) designate the joint UAV Planning Task Force or other appropriate body to oversee the plan's implementation, ensuring sufficient authority is provided.

Our prior work on UAV systems identifies the growing importance of UAVs to effective military operations and the need for the effective oversight of service programs at the departmental level. Over the years, UAV acquisition programs have suffered from requirements growth, risky acquisition strategies, and uncertain funding support within individual services. Some of these programs have been terminated. Program success has been achieved as a result of leadership intervention and the use of innovative approaches like the Advanced Concept Technology Demonstration.[3] DOD's experience with the Unmanned Combat Air Vehicle program is a case in point; intervention by the Office of the Secretary of Defense was necessary to keep the program viable. Over the

[3] The Advanced Concept Technology Demonstration program was initiated by DOD in 1994 as a way to get new technologies that meet critical military needs into the hands of users faster and at less cost than the traditional acquisition process.

years, we have reported that DOD has faced some expensive lessons in managing its UAV program. As UAVs become more and more integral to the way the U.S. military carries out operations, it will become even more important that the department manages its program effectively. UAVs are no longer an additional "nice-to-have" capability; they are becoming essential to the services' ability to conduct modern warfare. The acquisition environment for new UAVs will be characterized by increased funding competition, greater demand for UAV capabilities, and electromagnetic frequency spectrum and airspace limitations. This will require strong leadership at the departmental level, building on the UAV *Roadmap* and efforts of the joint UAV Planning Task Force, to ensure that the most cost-effective solutions are adopted as we have recommended in our previous work.

Background

DOD defines a UAV as a powered aerial vehicle that does not carry a human operator; can be land-, air-, or ship-launched; uses aerodynamic forces to provide lift; can be autonomously or remotely piloted; can be expendable or recoverable; and can carry a lethal or nonlethal payload. Generally, UAVs 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.

UAVs have been used in a variety of forms and for a variety of missions for many years. After the Soviet Union shot down a U-2 spy plane in 1960, certain UAVs were developed to monitor Soviet and Chinese nuclear testing. Israel used UAVs to locate Syrian radars and was able to destroy the Syrian air defense system in Lebanon in 1982. The United States has used UAVs in the Persian Gulf War, Bosnia, Operation Enduring Freedom, and Operation Iraqi Freedom for intelligence, surveillance, and reconnaissance missions and to attack a vehicle carrying suspected terrorists in Yemen in 2002. The United States is also considering using UAVs to assist with border security for homeland security or homeland defense.

The current generation of UAVs has been under development for defense applications since the 1980s. UAVs won considerable acceptance during military operations in Afghanistan and Iraq in 2002 and 2003, respectively. They were used in these operations to observe, track, target, and in some cases strike enemy forces. These and similar successes have heightened interest in UAVs within DOD and the services. In fact, by 2010, DOD plans to have at least 14 different UAVs in the force structure to perform a variety of missions. Moreover, in the fiscal year 2001 National Defense

Authorization Act, Congress established the goal that one-third of the Air Force's deep-strike capability be provided by UAVs by 2010.[4]

The overall management of UAV programs has gone full circle. In 1989 the DOD Director of Defense Research and Engineering set up the UAV Joint Project Office as a single DOD organization with management responsibility for UAV programs. With the Navy as the Executive Agency, within 4 years the Joint Project Office came under criticism for a lack of progress. Replacing the office in 1993, DOD created the Defense Airborne Reconnaissance Office as the primary management oversight and coordination office for all departmentwide manned and unmanned reconnaissance. In 1998, however, this office also came under criticism for its management approach and slow progress in fielding UAVs. In that same year, this office was dissolved and UAV program development and acquisition management was given to the services, while the Assistant Secretary of Defense for Command, Control, Communications and Intelligence was assigned to provide oversight for the Secretary of Defense.

GAO's New Report Calls for Improved Strategic Planning

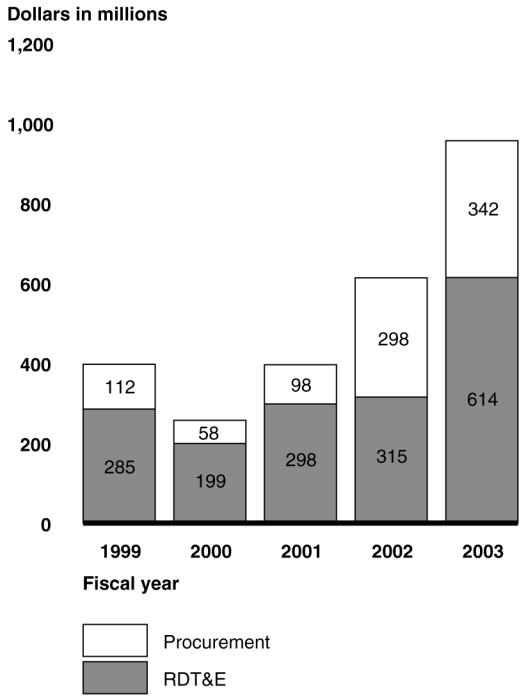
Our report being issued today (*Force Structure: Improved Strategic Planning Can Enhance DOD's Unmanned Aerial Vehicles Efforts*, GAO-04-342, Mar. 17, 2004) analyzes recent funding trends for UAVs and makes recommendations to strengthen DOD's strategic planning and management approach for UAVs.

UAV Funding Has Increased

During the past 5 fiscal years, Congress provided funding for UAV development and procurement that exceeds the amounts requested by DOD, and to date the services have obligated about 99 percent of these funds. To promote the rapid employment of UAVs, Congress appropriated nearly $2.7 billion to develop and acquire UAVs from fiscal year 1999 through fiscal year 2003, compared with the $2.3 billion requested by DOD. The majority of the funds—$1.8 billion (67 percent)—have been for UAV research, development, test, and evaluation. Figure 1 displays the trends in research, development, test, and evaluation and procurement funding from fiscal year 1999 through fiscal year 2003.

[4] P.L. 106-398, Section 220.

Figure 1: UAV Research, Development, Test, and Evaluation (RDT&E) and Procurement Obligations, Fiscal Years 1999-2003



Sources: DOD (data); GAO (analysis).

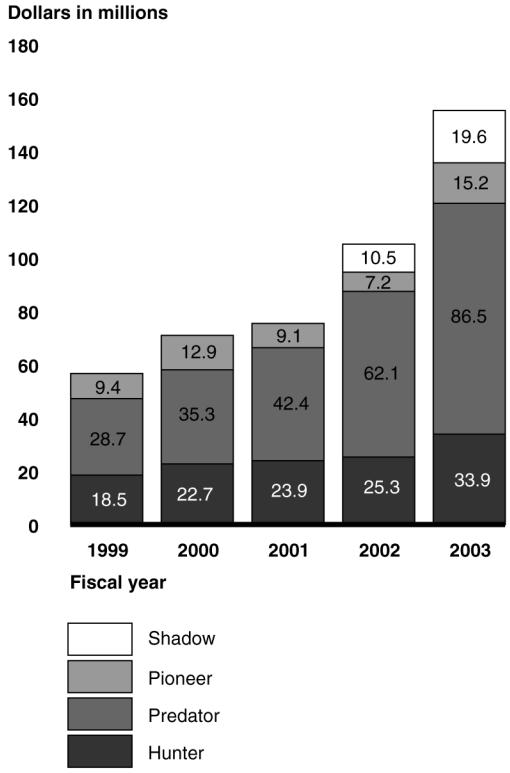
Over these 5 years, only three systems—the Air Force's Predator and Global Hawk, and the Army's Shadow—have matured to the point that they required procurement funding, amounting to about $880 million by fiscal year 2003 and another estimated $938 million needed by fiscal year 2005.

Because Congress has appropriated more funds than requested, the services are able to acquire systems at a greater rate than planned. For example, in fiscal year 2003, the Air Force requested $23 million to buy 7 Predator UAVs, but Congress provided over $131 million, enough to buy 29 Predators. The Air Force had obligated 71 percent of the Predator's fiscal year 2003 funding during its first program year.

The Hunter, Predator, Pioneer, and Shadow are among the UAV systems currently being used, and therefore we determined the level of DOD's operations and maintenance spending from fiscal year 1999 through fiscal year 2003 for these systems. Operations and maintenance funding has steadily increased over that period from about $56.6 million for three of

the systems to $155.2 million in 2003 for all four. These increases are the result of a larger inventory of existing systems and the introduction of new systems. Figure 2 displays the operations and maintenance spending for these UAV systems for fiscal years 1999 to 2003.

Figure 2: Operations and Maintenance Funding for UAVs, for Fiscal Years 1999 to 2003



Sources: DOD (data); GAO (analysis).

Progress Made, but Challenges Remain in UAV Planning

DOD has taken certain positive steps to improve the management of the UAV program by establishing a program focal point in the joint UAV Planning Task Force and trying to communicate a common vision for UAV development, the UAV *Roadmap*. While the creation of the Task Force and the UAV *Roadmap* are important steps to improve the management of the program, they are not enough to reasonably assure that DOD is developing and fielding UAVs efficiently. The Task Force's authority is generally limited to program review and advice, but is insufficient to enforce program direction. Moreover, the UAV *Roadmap* does not constitute a

comprehensive strategic plan for developing and integrating UAVs into force structure.

Some Positive Steps Have Been Taken to Improve Program Management

Since 2000, DOD has taken several positive steps to improve the management of the UAV program. In October 2001, the Under Secretary of Defense for Acquisition, Technology, and Logistics created the joint UAV Planning Task Force as the joint advocate for developing and fielding UAVs. The Task Force is the focal point to coordinate UAV efforts throughout DOD, helping to create a common vision for future UAV-related activities and to establish interoperability standards. For example, the Task Force is charged with developing and coordinating detailed UAV development plans, recommending priorities for development and procurement efforts, and providing the services and defense agencies with implementing guidance for common UAV programs.

The development of the 2002 *Roadmap* has been the Task Force's primary product to communicate its vision and promote interoperability. The *Roadmap* is designed to guide U.S. military planning for UAV development through 2027, and describes current programs, identifies potential missions, and provides guidance on developing emerging technologies. The *Roadmap* is also intended to assist DOD decision makers to build a long-range strategy for UAV development and acquisition in such future planning efforts as the Quadrennial Defense Review or other planning efforts.

The Joint UAV Planning Task Force Has Limited Authority

The joint UAV Planning Task Force's authority is generally limited to program review and advice, but is insufficient to enforce program direction. The Task Force Director testified before the House Armed Services Committee in March 2003 that the Task Force does not have program directive authority, but provides the Under Secretary of Defense for Acquisition, Technology, and Logistics with advice and recommended actions.[5] Without such authority, according to the Director, the Task Force seeks to influence services' programs by making recommendations to them or proposing recommended program changes for consideration by the Under Secretary. According to defense officials, the Task Force has attempted to influence the joint direction of service UAV efforts in a variety of ways, such as reviewing services' budget proposals, conducting

[5] Statement of the Director, Joint UAV Planning Task Force before the Subcommittee on Tactical Air and Land Forces, House Armed Services Committee, March 26, 2003.

periodic program reviews, and participating in various UAV-related task teams and has had some successes, as shown below:

- The Task Force has encouraged the Navy to initially consider an existing UAV (Global Hawk) rather than develop a unique UAV for its Broad Area Marine Surveillance mission.
- The Task Force has worked with the Army's tactical UAV program to encourage it to consider using the Navy's Fire Scout as an initial platform for the Future Combat System class IV UAV.
- The Task Force convinced the Air Force to continue with the Unmanned Combat Aerial Vehicle program last year when the Air Force wanted to terminate it, and the Task Force ultimately helped the then-separate Air Force and Navy programs merge into a joint program.
- The Task Force convinced the Navy not to terminate the Fire Scout rotary wing UAV program as planned.

However, the Task Force cannot compel the services to adopt any of its suggestions and consequently has not always succeeding in influencing service actions. For example, according to DOD officials, no significant progress has been made in achieving better interoperability among the services in UAV platform and sensor coordination, although efforts are continuing in this vein.

DOD Has No Comprehensive Strategic Plan

Neither the *Roadmap* nor other DOD guidance documents represent a comprehensive strategy to guide the development and fielding of UAVs that complement each other, perform the range of missions needed, and avoid duplication. DOD officials acknowledged that the Office of the Secretary of Defense has not issued any guidance that establishes an overall strategy for UAVs in DOD. While high-level DOD strategic-planning documents—such as the National Military Strategy, the Joint Vision 2020, and the Defense Planning Guidance—provide some general encouragement to pursue transformational technologies, including the development of UAVs, these documents do not provide any specific guidance on developing and integrating UAVs into the force structure.

At the same time, while the Joint Requirements Oversight Council[6] has reviewed several UAVs and issued guidance for some systems, neither the Joint Staff nor the council has issued any guidance that would establish a strategic plan or overarching architecture for DOD's current and future UAVs. In June 2003, the Chairman of the Joint Chiefs of Staff created the Joint Capabilities Integration and Development System to provide a top-down capability-based process. Under the system, five boards have been chartered, each representing a major warfighting capability area as follows: (1) command and control, (2) force application, (3) battle space awareness, (4) force protection, and (5) focused logistics. Each board has representatives from the services, the combatant commanders, and certain major functions of the Under Secretary of Defense. Each board is tasked with developing a list of capabilities needed to conduct joint operations in its respective functional areas. The transformation of these capabilities is expected, and the boards are likely to identify specific capabilities that can be met by UAVs. Nonetheless, according to Joint Staff officials, these initiatives will not result in an overarching architecture for UAVs. However, the identification of capabilities that can be met by UAVs is expected to help enhance the understanding of DOD's overall requirement for UAV capabilities.

Moreover, according to officials in the Office of the Secretary of Defense, the UAV *Roadmap* was not intended to provide an overarching architecture for UAVs. The *Roadmap* does state that it is intended to assist DOD decision makers in building a long-range strategy for UAV development and acquisition in such future planning efforts as the Quadrennial Defense Review. Nonetheless, the *Roadmap* represents a start on a strategic plan because it incorporates some of the key components of strategic planning, as shown below:

> **Long-term goals**—The *Roadmap* states its overall purpose and what it hopes to encourage the services to attain. The *Roadmap* refers to the Defense Planning Guidance's intent for UAVs as a capability and indicates that the guidance encourages the rapid advancement of this capability. At the same time, it does not clearly state DOD's overall or long-term goals for its UAV efforts. Similarly, while it states that it wants to provide the services with

[6] The Joint Requirements Oversight Council is a joint organization made up of senior representatives from each of the services to review joint experimentation and make appropriate recommendations to the Chairman of the Joint Chiefs of Staff, CJCSI 3180.1 (Washington, D.C.: Oct. 31, 2002).

clear direction, it does not clearly identify DOD's vision for its UAV force structure through 2027.

Approaches to obtain long-term goals—The *Roadmap's* "Approach" section provides a strategy for developing the *Roadmap* and meeting its goal. This approach primarily deals with identifying requirements and linking them to needed UAV payload capabilities, such as sensors and associated communication links. The approach then ties these requirements to forecasted trends in developing technologies as a means to try to develop a realistic assessment of the state of the technology in the future and the extent to which this technology will be sufficient to meet identified requirements. At the same time, however, the *Roadmap* does not provide a clear description of a strategy for defining how to develop and integrate UAVs into the future force structure. For example, the *Roadmap* does not attempt to establish UAV development or fielding priorities, nor does it identify the most urgent mission-capability requirements. Moreover, without the sufficient identification of priorities, the *Roadmap* cannot link these priorities to current or developing UAV programs and technology.

Performance goals—The *Roadmap* established 49 specific performance goals for a variety of tasks. Some of these goals are aimed at fielding transformational capabilities without specifying the missions to be supported. Others are to establish joint standards and control costs. Nonetheless, of the 49 goals, only 1 deals directly with developing and fielding a specific category of UAV platform to meet a priority mission-capability requirement—the suppression of enemy air defenses or strike electronic attack. The remaining goals, such as developing heavy-fuel aviation engines suitable for UAVs, are predominantly associated with developing UAV or related technologies as well as UAV-related standards and policies to promote more efficient and effective joint UAV operations. However, the *Roadmap* does not establish overall UAV program goals.

Performance indicators—Some of the 49 goals have performance indicators that could be used to evaluate progress, while others do not. Furthermore, the *Roadmap* does not establish indicators that readily assess how well the program will meet the priority mission capabilities.

As the services and defense agencies pursue separate UAV programs, they risk developing systems with duplicate capabilities, potentially higher operating costs, and increased interoperability challenges. The House Appropriations Committee was concerned that without comprehensive planning and review, there is no clear path toward developing a UAV force structure.[7] Thus, the committee directed that each service update or create a UAV roadmap. These roadmaps were to address the services' plans for the development of future UAVs and how current UAVs are being employed. Officials from each of the services indicated that their UAV roadmap was developed to primarily address their individual service's requirements and operational concepts. However, in their views, such guidance as the Joint Vision 2020, National Military Strategy, and Defense Planning Guidance did not constitute strategic plans for UAVs to guide the development of their individual service's UAV roadmap. These officials further stated that the Office of the Secretary of Defense's 2002 UAV *Roadmap* provided some useful guidance, but was not used to guide the development of the service's UAV roadmaps. Moreover, they did not view the Office of the Secretary of Defense's *Roadmap* as either a DOD-wide strategic plan or an overarching architecture for integrating UAVs into the force structure. According to service officials developing the service-level UAV roadmaps, there was little collaboration with other services' UAV efforts.

As we have described for you today, DOD has an opportunity to enhance its strategic planning to improve the management of UAV development and fielding. In the report released to you today, we make two recommendations to assist DOD to enhance its management control over the UAV program. We recommend that DOD establish a strategic plan or set of plans based on mission requirements to guide UAV development and fielding. We also recommend that DOD designate the joint UAV Planning Task Force or another appropriate organization to oversee the implementation of a UAV strategic plan. In responding to our report, DOD stated that it partially concurred with the first recommendation but preferred to address UAV planning through the Joint Capabilities Integration and Development System process. DOD disagreed with the second recommendation saying that it did not need to provide an organization within the department with more authority because it believes that the Undersecretary of Defense for Acquisition, Logistics, and Technology already has sufficient authority to achieve DOD's UAV goals.

[7] Department of Defense Appropriation Bill, 2003 Report, H.R. Rep. No. 107-532 at 207.

Our report states clearly that we continue to support both recommendations. We believe that the growth in the number and cost of UAV programs, and their importance to military capabilities, will need more formalized oversight by DOD.

Oversight Challenge Is Framed by Experiences of the Past and Demands of the Future

Our reviews of system development efforts over the last several decades show that the road to fielding operational UAVs has not been easy. Success has been achieved as a result of intervention by leadership and the use of innovative processes. Even when put on a sound footing, these programs have continued to face new challenges. In the future, UAVs will be growing in number, sophistication, and significance, but will also have to compete for increasingly scarce funds, electromagnetic frequency spectrum, and airspace.

Lessons From Past Experience

Since the mid 1970s, we have reviewed many individual DOD UAV development efforts.[8] A list of our reports is attached in the section entitled "Related GAO Products." Our previous work has highlighted problems that addressed congressional efforts to bring the development process under control and subsequently led to the termination or redesign and retrofit of a number of these development efforts.

In 1988 we reported on a variety of management challenges related to UAV development.[9] At that time, congressional committees had expressed concern about duplication in the services' UAV programs, which ran counter to the committees' wishes that DOD acquire UAVs to meet common service needs. In 1988, we noted that DOD was to provide, at minimum, a UAV master plan that (1) harmonized service requirements, (2) utilized commonality to the maximum extent possible, and (3) made trade-offs between manned and unmanned vehicles in order to provide future cost savings. After budget deliberations for fiscal year 1988, Congress eliminated separate service accounts for individual UAV programs and consolidated that funding into a single Defense Agencies account. This in turn led to the formation of DOD's UAV Joint Projects Office, which promoted joint UAV efforts that would prevent unnecessary

[8] U.S. General Accounting Office, *Status of the Remotely Piloted Aircraft Programs*. GAO/PSAD-77-30 (Washington, D.C.: February 18, 1977).

[9] U.S. General Accounting Office, *Unmanned Vehicles: Assessment of DOD's Unmanned Aerial Vehicle Master Plan*, GAO/NSIAD-89-41BR (Washington, D.C.: Dec. 9, 1988).

duplication. This effort was led by the Defense Airborne Reconnaissance Office within the Office of the Secretary of Defense, which has since been disbanded.

Our analysis of DOD's 1988 UAV master plan identified a number of weaknesses: (1) it did not eliminate duplication, (2) it continued to permit the proliferation of single-service programs, (3) it did not adequately consider cost savings potential from manned and unmanned aircraft trade-offs, and (4) it did not adequately emphasize the importance of common payloads among different UAV platforms.

In testimony presented in April 1997, we recognized the strong support that Congress had provided for DOD's UAV acquisition efforts and how it had encouraged the department to spur related cooperation between the services.[10] We noted that problems with UAV development continued and were leading to cost, schedule, and performance deficiencies; continued duplication of UAV capabilities; and even program cancellations in many instances. In 1997, only one UAV—the Pioneer—had been fielded.

Factors That Limit UAV Development

Since 1997, we have continued to evaluate the department's UAV development efforts, including plans to develop a lethal variant of UAVs called unmanned combat air vehicles. Our reviews over the last 27 years have revealed several reasons why UAV efforts have not been successful, including requirements that outstrip technology, overly ambitious schedules, and difficulties integrating UAV components and UAV testing. We have also found that UAV system acquisitions processes were not protected from what is known as "requirements creep." These requirements changes increase development and procurement costs significantly. For example:

- The Aquila was started in 1979 with a straightforward mission to provide small, propeller-driven UAVs to give group commanders real-time battlefield information about enemy forces beyond ground observers' line of sight.[11] Requirements creep increased complexity and development and anticipated procurement costs significantly. For

[10] U.S. General Accounting Office, *Unmanned Aerial Vehicles: DOD's Acquisition Efforts*, GAO/T-NSIAD-97-138 (Washington, D.C.: April 9, 1997).

[11] U.S. General Accounting Office, *Aquila Remotely Piloted Vehicle: Its Potential Battlefield Contribution Still in Doubt*, GAO/NSIAD-88-19 (Washington, D.C.: October 26, 1987).

example, in 1982 a requirement for night vision capability was added which increased development costs due to the additional payloads and air vehicles needed to meet the new requirement. During operational tests, the Aquila successfully fulfilled all requirements in only 7 of 105 flights.

- When the Air Force's Global Hawk reconnaissance UAV was started in 1994, it was expected to have an average unit flyaway price of $10 million. Changes in the aircraft's range and endurance objectives required the contractor to modify the wings and other structural parts, and by 1999 its cost had increased by almost 50 percent. In our April 2000 report, we concluded that the cost of air vehicles to be produced could increase still further, because the Air Force had not finalized its design requirements.[12] In 2002, the Global Hawk program adopted a higher-risk strategy that calls for both a larger, more advanced aircraft and an accelerated delivery schedule.

- In June 2003 we reported that the original requirements for the Air Force's unmanned combat air vehicle (UCAV) program posed significant, but manageable challenges to build an air vehicle that is affordable throughout its life cycle, highly survivable, and lethal.[13] Subsequently, however, the Air Force added requirements—adding a mission and increasing flying range. This action widened the gap between requirements and resources and increased the challenge for the development program.

Aside from the air vehicle, other ground and airborne systems are also needed for the UAV to be complete. DOD's practice of buying systems before successful completion of testing has repeatedly led to defective systems that were terminated, redesigned, or retrofitted to achieve satisfactory performance. Our reviews have shown that, before production begins, DOD needs to test to ensure that all key parts of the UAV system can work successfully together, and that it can be operated and maintained affordably throughout its lifecycle.

[12] U.S. General Accounting Office, *Unmanned Aerial Vehicles: Progress of the Global Hawk Advanced Concept Technology Demonstration*, GAO/NSIAD-00-78 (Washington, D.C.: April 25, 2000).

[13] GAO-03-598.

- In March 1999, we examined the Medium Range UAV, which began in 1989 as a joint effort of the Navy and Air Force.[14] The Air Force was to design and build the sensor payload, including cameras, a videotape recorder, and a communications data link that would send back the imagery from the UAV. The Navy was to design and build the air vehicle. Splitting and then integrating these development efforts became problematic. The Air Force ran into major payload development difficulties, which impacted payload development costs. As a result of the difficulties, the payload program fell behind schedule, developmental tests on a surrogate manned aircraft[15] were unsuccessful, and the payload was too big to fit in the space the Navy had allotted inside the aircraft. In 1993, the program was terminated.

- In 1999, the Army began low-rate initial production of four Shadow systems at the same time that it began the engineering and manufacturing development phase. In February 2001, the Army sought to revise its acquisition strategy to procure four additional Shadow systems before conducting operational tests. We recommended in a 2000 report that the Army not buy these four additional systems until after operational testing is completed.[16] In our opinion, only operational testing of the system in a realistic environment can show whether the overall system would meet the Army's operational needs. Subsequently, we reported that problems encountered during early tests forced the program to delay completion of operational testing by one year. The results of operational tests revealed that the Shadow was not operationally suitable, survivable, and may not be affordable.

Factors That Lead to UAV Success

Our body of UAV work also made several observations about factors that contribute to success, including the use of innovative approaches and high-level interventions by individuals and organizations. In August 1999, we concluded that DOD's use of Advanced Concept Technology Demonstration projects improved UAV acquisitions because it focused on maturing technology and proving military utility before committing to a

[14] U.S. General Accounting Office, *Unmanned Aerial Vehicles: Medium Range System Components Do Not Fit*, GAO/NSIAD-91-2 (Washington, D.C.: March 25, 1991).

[15] A surrogate manned aircraft is a conventional aircraft with unmanned controls that is being operated as a UAV with a pilot on board to override controls in the event of an emergency.

[16] U.S. General Accounting Office, *Unmanned Aerial Vehicles: Questionable Basis for Revisions to Shadow 200 Acquisition Strategy*, GAO/NSIAD-00-204 (Washington, D.C.: September 26, 2000).

UAV.[17] We found that DOD's Advanced Concept Technology Demonstration approach was consistent with the practices that we typically characterize as leading commercial development efforts. Predator UAV used a 30-month Advanced Concept Technology Demonstration approach and prototypes were deployed in Bosnia in 1995 and 1996 as part of the demonstration. Performance data gathered there convinced military users that Predator was worth acquiring.

High-level individuals intervened to set resource constraints and encouraged evolutionary acquisition strategies on the Air Force's Global Hawk, the Army's Shadow UAV, and the Joint Unmanned Combat Air System programs.

- In the initial Shadow program, the Army's top military acquisition executive reached an agreement with his counterpart in the requirements community that limited the program to "must have" capabilities and restrained resources such as cost. This resulted in the need to make trade-offs—so the Army lowered the performance requirement for the imagery sensor so that existing technology could be used.[18]

- In the Global Hawk program, the Under Secretary of Defense (Acquisition, Technology, and Logistics) became personally involved and insisted that the program take an evolutionary approach, developing and fielding different versions of increasingly capable UAVs. He also placed cost constraints on the initial version, which enabled more advanced imagery sensor capabilities to be deferred for later versions of the UAV.

- In our report on the Unmanned Combat Air Vehicle program, we reported on Air Force plans to have initial deliveries of a lethal-strike-capable aircraft by 2011.[19] The Air Force had abandoned the Unmanned Combat Air Vehicle initial low-risk approach to development, and increased requirements and accelerated its program schedule shortly

[17] U.S. General Accounting Office, *Unmanned Aerial Vehicles: DOD's Demonstration Approach Has Improved Project Outcomes*, GAO/NSIAD-99-33 (Washington, D.C.: August 30, 1999).

[18] U.S. General Accounting Office, *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: March 8, 2001).

[19] GAO-03-598.

before it was to shift to the product development stage. As previously reported, it took intervention by the Office of the Secretary of Defense to resolve requirements and funding challenges and maintain strong oversight over the program. The Task Force also was instrumental in getting the funding restored to the program, creating a joint effort between the Air Force and Navy, and accelerating the Navy's version. Their strong oversight and intervention might have saved the program, which is now known as the Joint Unmanned Combat Air System program.

Future Challenges in Oversight of UAVs

Over the next decade, DOD plans show that UAV investments will increase, greater numbers will be fielded, and these systems will play more significant roles than in the past. In addition to overcoming the problems and pressures that have impaired past programs, managers of future UAV programs will face increasing competition for money, electromagnetic frequency spectrum bandwidth, and airspace.

By 2010, DOD plans to invest $11 billion in UAV acquisitions, quadrupling the number of systems in its inventory today. As UAV programs vie for increased funding, they will have to compete against very large programs, such as the F/A-22 and the Joint Strike Fighter. If the costs of acquisition programs continue to exceed what has been set aside in the budget, competition will intensify and funding could be jeopardized.

Initially, UAVs were seen as complementary systems that augmented capabilities the warfighter already had. They were, in a sense, "another pair of eyes." We are already seeing the evolution of UAVs into more significant roles, for which they provide primary capability. For example, the Global Hawk is being seen as replacing the U-2 reconnaissance aircraft, and the Unmanned Combat Air Vehicle may eventually perform electronic warfare missions that the EA-6 Prowler aircraft performs today. UAVs are figuring prominently in plans to transform the military into a more strategically responsive force. UAVs are expected to be an integral part of this information-based force. For example, UAVs may serve as relay nodes in the Future Combat System's command and control network. As UAVs perform increasingly significant roles, their payloads and designs will likely become more sophisticated.

UAVs depend on the available space in the electromagnetic frequency spectrum to send and receive signals. Such signals are essential to UAV control, communications, and imagery. As the number of UAVs grows, the systems will have to compete for more room on the spectrum. Spectrum

resources are scarce and facing increased demands from sources other than UAVs. Because of the changing nature of warfighting, more and more military systems are coming to depend on the spectrum to guide precision weapons and obtain information superiority. Recently, because of advances in commercial technology, a competition for scarce frequency spectrum has developed between government and nongovernment users.

Moreover, as the growing number of UAV systems become available for military units and civilian agencies, such as the Department of Homeland Security, their operation will also need to be integrated into the national airspace system. Currently, the Federal Aviation Administration requires detailed coordination and approval of UAV flights in the national airspace system. The Federal Aviation Administration and DOD are working on how to better integrate military UAVs within the national air space system. In the future, UAVs are going to be used for homeland security, and their acceptance into civil airspace may be difficult to accomplish until significant work is accomplished in the areas of reliability, regulation, communications, and collision avoidance.

Concluding Remarks

Recent operations are convincing military commanders that UAVs are of real value to the warfighter. That success on the battlefield is leading to more and more demand for UAVs and innovative ways of using them, creating pressures such as a greater need for interoperability of systems and competition for limited resources like money, electromagnetic frequency spectrum, and airspace. The UAVs that are successful today survived an environment characterized by a number of canceled programs, risky strategies, uncoordinated efforts, and uncertain funding. It took additional measures for them to succeed, not the least of which was strong management intervention. In recent years, DOD has taken positive steps to better manage the development of UAVs by creating the joint UAV Planning Task Force and the UAV Roadmap. The question is whether these steps will be sufficient to make the most out of current and future investments in UAVs. We believe that DOD should build on these good steps so that it will be in a better position to provide stewardship over these investments. Taking these steps will give Congress confidence that its investments' in the technology will produce optimum capabilities desired of UAVs.

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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 Acknowledgements

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