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Intelligence Collection Platforms: Satellites, Manned Aircraft, and UAVs

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(name redacted)
and
Richard A. Best, Jr.
Specialist in National Defense
Foreign Affairs and National Defense Division

ABSTRACT

Imagery--images derived from photography, radar, and electro-optical devices similar to television--is a vital tool to policymakers and military commanders. It is the basis for the precise attacks on enemy forces and infrastructure that are expected to be at the center of future military operations. The principal imagery collection platforms--satellites, manned reconnaissance aircraft, and unmanned aerial vehicles (UAVs)--have all been controversial due to cost factors and operational limitations. Often based on cutting-edge technology, they are acquired and maintained in different government organizations, complicating efforts to achieve a balanced mix and hold costs down. Congress has taken a number of initiatives to strengthen the acquisition process, but challenges remain. This report provides a basic overview of the role of imagery in policymaking and military planning, the capabilities and limitations of different imagery collection platforms, and the evolving organizational relationships that govern the acquisition and use of imagery. Special attention is given to past congressional concerns and legislative provisions that have had a major influence on imagery collection efforts. This report will be updated as events warrant.

Intelligence Collection Platforms: Satellites, Manned Aircraft, and UAVs

Summary

Imagery—photographs or electro-optical transmissions similar to television—is a key component of contemporary military planning and operations as well as civilian decisionmaking. This report provides an overview of the various imagery collection platforms, their strengths and limitations, the evolving organizational relationships that govern their use, as well as the steps Congress has taken to strengthen imagery capabilities.

Imagery allows military commanders to undertake operations using precision-guided munitions with minimal civilian and friendly casualties; it also has a wide variety of civilian uses, providing overhead perspectives of environmental changes, natural disasters, or activities, such as mass burials, that foreign entities wish to hide.

Imagery is collected by satellites, manned reconnaissance aircraft, and unmanned aerial vehicles (UAVs). Satellite programs, initiated by the Intelligence Community in the midst of the Cold War; continue to be uniquely valuable but remain costly and commercial satellite imagery, now becoming available, may render some Government programs redundant. Manned reconnaissance aircraft continue to be widely used (as U-2s fly over Iraq), but the Defense Department and the services have often been reluctant to acquire replacement planes, preferring to invest scarce funds in bombers and fighters. UAVs are promising and potentially cost effective, but acquisition programs have been frustratingly slow and few operational systems are currently available despite a decade of efforts.

Often critical of the executive branch's management of imagery, Congress has shaped the acquisition of collection platforms through a number of initiatives. It has encouraged the procurement of larger numbers of smaller satellites that can be used more flexibly than the Cold War systems. It has urged the services to retain or acquire manned reconnaissance aircraft, a message that the Defense Department appears to have received. The potential of UAVs has been appreciated for some time, but the slow pace of acquisition programs led Congress to mandate the establishment of a centralized effort in 1993. When, however, difficulties persisted, many Members called for the Defense Airborne Reconnaissance Office to be abolished, a step that the Pentagon intends to take by October 1998.

Efforts to acquire and utilize imagery are complicated by two major factors in additional to inevitable budgetary considerations. The first is technological; imagery acquisition systems, especially UAVs, are not mature systems. They are subject to trial-and-error experimentation, cancellations, delays, and cost overruns. The second is organizational; imagery collection and analysis involves a number of agencies, inside and outside the Department of Defense, and coordination is complex and difficult. Furthermore, imagery is produced in response to the disparate and not inevitably compatible requirements of Washington decisionmakers and military commanders. Congressional oversight is undertaken by a number of different committees. Taken together these factors make imagery an especially important and difficult issue for policymakers in both Congress and the executive branch.

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Introduction

Imagery—images derived from photography, radar, and electro-optical devices similar to television—has become a vital tool for U.S. policymakers and military commanders even those at tactical levels. The ability to see reliable images of buildings, roads, bridges, fortifications, and troop concentrations generally enhances decisionmaking and, in a combat situation, allows action against enemy targets that could reduce significantly the danger to friendly troops and civilians. Imagery is the basis for the precise attacks on enemy forces and infrastructure that are expected to be at the center of military operations in the next century. New capabilities include devices to detect predetermined types of equipment, such as a tank, even when camouflaged, as well as moving targets. Imagery collection has undeniably become a crucial element of force planning in the post-Cold War world.

Imagery is obtained from satellites in space, from manned aircraft with cameras configured for specific missions, and, more recently, from unmanned aerial vehicles (UAVs)—pilotless drones some little bigger than model airplanes—that can take pictures without putting a pilot at risk of shootdown or capture. Each type of platform has strengths and limitations in collecting imagery, and each requires significant investment in an era of lower defense spending. The platforms are equipped with cameras, electro-optical devices, and synthetic aperture radars which produce radar-derived images that resemble photographs.

Congress has been greatly concerned with imagery and has taken a number of initiatives in an effort to improve the effectiveness of all three types of programs. There remain, however, a number of major challenges that are likely to persist:

- The increasing complexity of designing a balanced force of satellites, manned reconnaissance aircraft, and UAVs for uncertain post-Cold War missions. In addition to encouraging UAV acquisition, Congress has expressed its support for manned reconnaissance aircraft programs despite apparent reluctance among some in the Department of Defense (DOD).

- The diffusion of decision-making authority for imagery collection platforms within the executive branch and Congress. Congress mandated the establishment of a centralized office in DOD for airborne reconnaissance in 1993; the House voted to dis-establish it in 1997. DOD announced in March 1998 that it is to be dissolved and its responsibilities transferred to the services and other Defense agencies by the end of FY1998.

- Significant cost concerns affect the multi-billion dollar satellite effort and the services' ability to support manned reconnaissance aircraft. Congress strongly supported the development of smaller and less costly but also somewhat less capable satellites.

- Delivery of an adequate number of operational UAVs has been difficult to achieve. Congress has specifically addressed UAV procurement expressing strong complaints about perceived deficiencies in some DOD efforts.

- The increasing availability of commercial imagery and the questions regarding its ability to meet current and future Government requirements. Although Congress has supported sales of high-quality commercial satellites imagery and its purchase by DOD, there is no consensus that Government satellites programs can be significantly scaled back across the board.

- Technical and organization challenges involved in making imagery available in useable formats and in real-time to appropriate decisionmakers. In the wake of the Persian Gulf War experience, Congress funded a number of initiatives to improve imagery dissemination, but it is widely recognized that this must be an ongoing effort.

Manned reconnaissance aircraft face an even more uncertain future. Although the U-2, developed during the Eisenhower Administration, continues to be employed in a wide variety of reconnaissance missions, the Clinton Administration vetoed funding for continued operation of its more sophisticated, but costly, successor, the SR-71 Blackbird. The services have deactivated tactical reconnaissance aircraft, in large measure for budgetary reasons, and many observers believe that they have not energetically pursued planning for successor versions.

Based on experience in the Persian Gulf War and in Bosnia, UAVs show great promise for collecting imagery that is otherwise unavailable. The acquisition process, however, has been marked by several false starts, delays, and, for a number or reasons, an inability to produce operating systems in adequate numbers that some observers have blamed on the Defense Airborne Reconnaissance Office (DARO)—the much-criticized Defense Department office that has overseen UAV programs. Several programs have been canceled despite major investments of time and money. Others have yet to achieve expected capabilities. In 1997 the House of Representatives passed legislation mandating the dissolution of DARO. Even though subsequently enacted legislation was less sweeping, in March 1998 DOD announced its own plan to restructure airborne reconnaissance programs including the abolition of DARO by the following October.

The executive branch has made what some observers view as uneven progress in the past few years in regard to imagery collection efforts, even as Congress has taken a number of initiatives on its own. A major concern is organizational. The responsibility for acquiring and operating collection platforms is diffuse and not widely understood. A fundamental distinction exists between "national" and "tactical" systems, *i.e.* those that support the nation's senior policymakers and those that

provide intelligence to military commanders at increasingly lower echelons of command. Some observers suggest that the national/tactical distinctions that are reflected in the separate organizations have produced an unnecessarily expensive and not wholly coordinated effort. Others maintain that congressional budgetary categories and overlapping committee jurisdictions have also contributed to this alleged problem. Public discussion of imagery collection systems has been limited by the complexity of the issues as well as by classification of essential data, especially in regard to satellite programs, whose existence was not even acknowledged until very recent years.

It is the purpose of this report to describe the role of imagery to policymaking and military planning; to examine the capabilities and limitations of the three primary types of imagery collection platforms; to review the evolving organizational relationships that govern the acquisition and use of imagery; and to describe recent congressional actions regarding imagery platforms. Although a comprehensive assessment of imagery programs would have to be classified, it is possible to describe the parameters of the issue in general terms, as a basis for more detailed consideration.

The Role of Overhead Reconnaissance

Overhead reconnaissance has long been important to military operations, and it will be essential to post-Cold War planning and operations, since it is closely tied to the use of precision-guided munitions and information warfare strategies expected to characterize post-Cold War combat. Designing an effective approach (or "architecture") to imagery collection is, however, complicated by the different types of collection platforms, by the significant problems in adapting them to different types of military environments, and by administrative and oversight mechanisms that have developed both in the executive branch and Congress.

Imagery collection platforms have evolved over the course of many decades and have been integrated in military and civilian decisionmaking processes in different ways. Overhead imagery was first used by Union forces in the Civil War with photographers working from balloons. In World War I, aircraft undertook overhead reconnaissance of enemy forces along the trenches of northern France. In the interwar years, photographic equipment was installed on specially configured aircraft and airborne reconnaissance was eventually recognized as a separate military discipline. During World War II aerial photography was employed for targeting bomber attacks on Germany and Japan and for making battle damage assessments.[1]

In the Cold War era, fear of a surprise conventional or nuclear attack by the Soviet Union drove the development of high-altitude reconnaissance aircraft such as the U-2 and satellites dedicated to monitoring military activities in the vast expanses

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[1] See George W. Goddard with DeWitt S. Copp, *Overview: A Life-Long Adventure in Aerial Photography* (Garden City, NY: Doubleday, 1969); George A. Larson and William O'Dwyer, "Photo-Reconnaissance: The Early Years," *Air Power History*, Spring 1998.

of Soviet territories.[2] Overhead reconnaissance proved indispensable in determining the size, strength, and disposition of a massive Soviet military machine that many feared could launch a devastating attack on the United States or Western Europe. This effort, probably the most important achievement of the U.S. Intelligence Community, provided the basis for shaping U.S. strategic forces and for negotiating a series of major arms control agreements with Moscow.[3]

As demonstrated in the Persian Gulf War of 1991, innovative reconnaissance capabilities have emerged as an integral component of a military technical revolution that is shaping warfighting in the post-Cold War world. The widely publicized use of precision-guided munitions (PGMs) in Desert Storm depended upon the availability of precise imagery intelligence. Subsequent defense planning aims to make such intelligence available in real-time at virtually all levels of military operations as part of an effort to achieve dominant battlefield awareness. Problems identified in Desert Storm relating to inadequate and incompatible communications and insufficient wide-area imagery are still being addressed. The need for real-time imagery has led to an emphasis on electro-optical systems that can be transmitted digitally, although it is recognized that photography, which usually requires longer processing times, can provide uniquely valuable details and better wide-area coverage.[4] Imagery technologies continue to be refined, as means are sought to acquire images at night, through clouds and smoke, and to isolate objects of particular interest.

Military operations in Bosnia have provided a laboratory for innovative uses of imagery. U.S. satellite imagery has assisted in the location of opposing military forces (as well as of hidden mass burial sites). Manned aircraft are regularly used for reconnaissance missions. UAVs are launched from ground stations first in Albania and more recently in Hungary. Different platforms with different collection capabilities can be used "synergistically" to acquire more complete evidence than would be possible from single collectors; evidence acquired by one system can also be used to alert (or "cross-cue") another platform that is more suitable for obtaining the needed information.

Some observers report that the utilization of intelligence information by tactical commanders is uneven at best. A Defense Science Board Task Force has noted that there is little capability to catalogue and retrieve video imagery. [5] Some commands

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[2]Prior to the availability of the U-2 there were a handful of highly dangerous overflights of Soviet territory by specially configured bombers in a combined U.S.-British effort. See R. Cargill Hall, "The Truth About Overflights," *MHQ: the Quarterly Journal of Military History*, Spring 1997.

[3]See Dino A. Brugioni, "The Art and Science of Photoreconnaissance," *Scientific American*, March 1996; Richard M. Bissell, Jr. with Jonathan E. Lewis and Frances T. Pudlo, *Reflections of a Cold Warrior: From Yalta to the Bay of Pigs* (New Haven, CT: Yale University Press, 1996).

[4]See Jeffrey T. Richelson, "The Future of Space Reconnaissance," *Scientific American*, January 1991, pp. 38-39.

[5]Defense Science Board, *Improved Application of Intelligence to the Battlefield*, May-July, (continued...)

are inundated with large quantities of unusable imagery. The flow of information down to tactical levels can be too slow for operational use. Most lower-level tactical commanders do not have their own reconnaissance assets. Some commanders and even intelligence officers are not adequately trained to take advantage of imagery that is available. The presence of outdated communications equipment designed for Cold War missions has led to widespread reliance on "workarounds," adjustments to systems that allow their use in ways for which they were not designed.[6]

With the end of the Cold War, the Defense Department and Congress have undertaken a number of studies and reassessments to change the focus of U.S. military forces from the threat of strategic warfare with the Soviet Union to an array of missions ranging from peacekeeping to major theater wars. A distinct feature of virtually all such studies is the importance of PGMs and requirements for increasing amounts of precise, real-time intelligence or information.

- The May 1997 **Quadrennial Defense Review (QDR)** describes information superiority as the "backbone of military innovation" built upon "a robust multi-sensor information grid providing dominant awareness of the battlespace to our commanders and forces."[7]

- The Joint Chiefs of Staff's ***Joint Vision 2010*** foresees a military environment where, "[w]ith precision targeting and longer range systems, commanders can achieve the necessary destruction or suppression of enemy forces with fewer systems, thereby reducing the need for time - consuming and risky massing of people and equipment. Improved command and control, based on fused, all-source, real-time intelligence will reduce the need to assemble maneuver formations days and hours in advance of attacks."[8]

- The December 1997 **Report of the National Defense Panel** suggests that the U.S. may be on the cusp of a military revolution "characterized, in part, by a rapidly growing potential to detect, identify, and track far greater numbers of targets, over a larger area, for a longer time than ever before, and to order and move this information much more quickly and effectively than ever before."[9]

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[5](...continued)
1996, p. 47. The Task Force advocated making available "video archives which allow a user to 'punch in xyz coordinates' days after its collection and retrieve the latest imagery or a temporal sequence of imagery." Ibid.

[6]See Kenneth Allard, "Information Operations in Bosnia: A Preliminary Assessment, *American Intelligence Journal*, Vol. 17, Nos. 3&4, 1997.

[7] Department of Defense, *Report of the Quadrennial Defense Review*, May 1997, p. 39.

[8] Joint Chiefs of Staff, *Joint Vision 2010*, July 1997, p. 18.

[9] Department of Defense, National Defense Panel, *Transforming Defense: National Security in the 21st Century*, December 1997, p. 43.

All observers recognize that the effort to locate all potential targets within a battlefield in real-time is increasingly achievable and has become crucial to success. As Secretary of Defense William Cohen has written:

> The conceptual framework for how US forces will fight in the future is *Joint Vision 2010*, which charts a path to ensure that US forces will be able to conduct decisive operations in any environment. . . .
>
> At the heart of *Joint Vision 2010* is the ability to collect, process, and disseminate a steady flow of information to US forces throughout the battlespace, while denying the enemy ability to gain and use battle-relevant information.[10]

Capabilities for collecting and disseminating imagery have grown enormously in recent years as part of the larger expansion in information technologies, but determining and acquiring an optimal combination of platforms has proven to be a major challenge. Given the number of potential missions, the different and rapidly changing technologies involved, and the fact that reconnaissance platforms do not fit neatly into traditional service missions and procurement categories, it is unlikely that there is any one "best mix" of systems. Indeed, almost all observers would accept the need for a certain amount of redundancy, given the unforeseeable requirements for future military operations. Nonetheless, uncertainties surrounding platform acquisition efforts and use by operating forces should, observers suggest, be given greater attention, given the importance of imagery and the considerable costs involved.

Acquiring and operating imagery collection platforms is, of course, only one part of the situation. Once imagery is obtained, it must be made available to decisionmakers in useable forms. Processing and dissemination proved to be major bottlenecks during Desert Storm; compatibility of systems operated by the separate services (let alone the forces of allied nations) has been an ongoing concern at a time when joint operations have become increasingly routine. In addition, the great changes in availability of all types of information, including imagery, have significant implications for organizing military forces, even if one avoids easy generalizations about "revolutions in military affairs." When precise information can be made available to tactical levels in real-time, there will be more opportunity for initiatives—as well as risks—to be taken by leaders of smaller units, as opposed to carrying out smaller parts of larger plans formulated by higher headquarters. This is especially applicable in limited engagements and peacekeeping operations.

Allard discusses the implications of this availability for the structure of military organizations:

> Information technology is uniquely affected by people, their training, their procedures, and the time they take to perform them: but the combination of these factors in combat or operational settings is constantly and curiously underestimated. And we have barely begun to address the organizational implications

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[10] William S. Cohen, *Defense Reform Initiative Report*, November 1997, p. ii.

of modern information technology: in synchronizing the political and military sides of a peacekeeping operation; in reducing top-heavy headquarters; and in substituting commercial products and services for outmoded military equipment and redundant support structures.[11]

Platforms for Imagery Collection

All three types of overhead collection platforms—satellites, manned reconnaissance aircraft, and UAVs—are used to collect imagery intelligence today. The choice of a system for a specific mission depends upon a number of factors, including platform availability, the potential risk to platforms and operators, and the particular type of information needed. Determining the best acquisition strategy requires not only on an assessment of the strengths and limitations of different platforms, but also relies on highly tentative assumptions about likely future missions.

Satellites

Satellites possess many tangible advantages over other reconnaissance platforms. Satellites orbiting in space do not violate the airspace and sovereignty of other nations. Space operations have been accepted as legal under international law, whereas aerial reconnaissance without the permission of the country overflown by manned aircraft or UAVs has not.[12] Furthermore, even if a nation objected to overflight of its territory by satellites, destroying or disrupting a satellite presents major technological obstacles that few nations, except, potentially, Russia, could overcome. In any event, no lives are directly at risk should a satellite be lost.

Satellite programs were developed and continued to be "national" programs designed primarily to meet the needs of Washington-area policymakers. Satellites are developed, launched, and operated by the National Reconnaissance Office (NRO). Although the NRO is part of the Defense Department, it is, as its name indicates, a national agency that serves consumers outside DOD, including the White House and the State Department. For many years, the NRO was enveloped in secrecy, even its existence being classified. Since 1992, however, its role has been officially acknowledged and there has been more extensive public discussion of satellite programs.

Much Cold War satellite collection was designed to acquire highly detailed images of specific targets (such as ICBM silos) in limited geographical areas. Although "wide-area" coverage had been available for some years, military commanders during the Persian Gulf War, sought larger quantities of wide-area coverage of Iraqi troop dispositions than were available. Press reports indicate that current satellites are being modified to provide more broad area coverage in real-time.[13] Wide coverage is particularly useful for mapping targets for airstrikes, and

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[11]Allard, "Information Operations in Bosnia," p. 58.

[12] There is, however, no agreement on the precise extent of national airspace.

[13]See "KH-11 Recons Modified," *Aviation Week & Space Technology*, October 9, 1995, p.
(continued...)

for monitoring large areas. Satellites are also capable of carrying several sensors; infra-red and radar-imaging technologies that can enable them to "see" through smoke, clouds, and the dark of night. Close-look telephoto cameras produce images with resolution as fine as can be captured by all but the lowest-flying aerial platforms. In the early 1960s, film from satellites was parachuted back to Earth and processing could take days or week; by contrast, today's satellites can transmit electro-optical imagery directly to ground stations in real-time.[14]

The biggest drawback to reconnaissance satellites is their cost. Budget data for intelligence satellite systems is classified, but the Administration has indicated that the FY1996 DOD space budget amounted to $11.5 billion and the request for DOD's unclassified space programs for FY1997 was $5.7 billion.[15] Even without detailed budget data, it is apparent that reconnaissance satellites reach multi-billion-dollar levels each year. A press source indicates that the advanced KH-11 satellite costs $750 million to $1 billion each with its booster costing another $250-300 million.[16] As a result, there is clearly a limited number of satellites, and capabilities for launching additional platforms in an emergency are limited. The high costs of launching satellites have led to an emphasis on a relatively small number of sophisticated systems.[17] Satellite orbits are generally fixed and, while they can be shifted to meet new requirements, doing so consumes limited fuel. Satellite imagery is the "gold standard," but coverage will always be limited and expenses high. In the aftermath of the reported inability of the Intelligence Community to discern preparations for the nuclear tests that India conducted in May 1998, observers have pointed to the growing sophistication of foreign countries in masking their activities when satellites are overhead as well as the fact that the number of satellites currently deployed are not designed to provide constant, global coverage.

Although details about satellite programs have historically been highly classified and closely guarded, differences over the question of smaller satellites ("smallsats") that are 20-25% lighter and with one-half the capacity of previous systems some of which weigh over 30,000 pounds *vs.* large satellites have been publicly discussed at some length. In 1995 a majority of the House Intelligence Committee expressed support for the smaller satellites, but several Members cautioned that sizable risks and substantial long-term costs could be involved in replacing the larger versions originally

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[13](...continued)
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[14]The official history of the development of the satellite program is found in Kevin C. Ruffner, ed., *Corona: America's First Satellite Program* (Washington: Center for the Study of Intelligence, Central Intelligence Agency, 1995); see also Curtis Peebles, *The Corona Project: America's First Spy Satellites* (Annapolis, MD: Naval Institute Press, 1997).

[15] See (name redacted), *U.S. Space Programs*, CRS Issue Brief IB92011.

[16] See Craig Covault, "Advanced KH-11 Broadens U.S. Recon Capability," *Aviation Week & Space Technology*, January 6, 1997, p. 24.

[17]See Commission on the Roles and Capabilities of the United States Intelligence Community, *Preparing for the 21st Century* (Washington: Government Printing Office, 1996), p. 117.

planned.[18] An executive branch assessment, released on June 28, 1996, essentially accepted the case for smaller satellites that would weigh 20-25% of then-current systems and having 40-50% of then-current capabilities.[19]

A major factor that led to reassessment of the plans for larger satellites (known as the 8X and expected to weigh more than 20 tons) was the potential cost savings involved in smaller satellites that were less expensive on a unit-by-unit basis, and could be deployed more flexibly for specific post-Cold War missions (rather than having to launch a large satellite with many capabilities for a narrow mission). It was further argued that a continuous production line for smaller satellites would make better use of the intelligence industrial base than occasional production of larger versions. Similarly, new technologies could be introduced on a piecemeal basis rather than requiring redesign of a large system. As a result of these considerations, the NRO began work on a Future Imagery Architectures Plan that would include a series of smaller satellites. According to recent press accounts, production of smaller satellites should begin in 1998 with initial launches scheduled for 2003.[20]

The Defense Department purchases commercial satellite imagery from both domestic and foreign suppliers, but the extent to which it can substitute for imagery produced by Government satellites is unclear. The Senate Intelligence Committee, echoing a Defense Science Board report, has urged greater reliance on commercial imagery.[21] On the other hand, military satellites are designed for some unique military missions that cannot be fulfilled by civilian versions. The one-meter resolution of the best proposed commercial satellites may still not be as detailed as that of Government satellites. Many observers argue, in addition, that maintaining a satellite reconnaissance capability is a vital national interest that cannot be delegated to commercial firms that, in any event, might not be able to meet Government requirements in emergencies. The National Imagery and Mapping Agency has, however, recently announced a Commercial Imagery Initiative to improve government access to imagery produced in the private sector. [22]

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[18] U.S. Congress, House of Representatives, 104th Congress, 1st session, Permanent Select Committee on Intelligence, *Intelligence Authorization Act for Fiscal* Year *1996*, House Report 104-138, Part 1, June 14, 1995, pp. 16, 54.

[19] House Permanent Select Committee on Intelligence, Press Release, June 28, 1996.

[20]See Walter Pincus, "Smaller Spy Satellites May Give U.S. Stealth Capability Over Trouble Spots," *Washington Post*, February 1, 1998, p. A9; also, "NRO presses new imagery satellite architecture," *Aerospace Daily*, May 1, 1997, p. 175.

[21] See U.S. Congress, Senate, 105th Congress, 1st session, Select Committee on Intelligence, *Authorizing Appropriations for Fiscal Year 1998 for the Intelligence Activities of the United States Government and the Central Intelligence Agency Retirement and Disability System and for Other Purposes*, S. Rept. 105-24, June 9, 1997, p. 7; U.S. Congress, Senate, 105th Congress, 2d session, Select Committee on Intelligence, *Authorizing Appropriations for Fiscal Year 1999 for the Intelligence Activities of the United States Government and the Central Intelligence Agency Retirement and Disability System and for Other Purposes*, S. Rept. 105-185, May 7, 1998, p. 7.

[22] See "NIMA seeks innovative commercial satellite imagery ideas," *Aerospace Daily*, April
(continued...)

During the Cold War the U.S. sought to ensure that the industrial base for producing satellites remained robust; the extent to which this version of an "industrial policy" remains necessary in the post-Cold War era, in which commercial satellite imagery is widely available, is uncertain and disputed. [23] An industrial base for constructing top secret reconnaissance might be advantageous for technology and security reasons, but it is costly.

Manned Reconnaissance Platforms

Manned reconnaissance aircraft, both tactical and strategic, have been indispensable over the last few decades for the purposes of intelligence collection and battlefield support. The very nature of manned reconnaissance carries with it some advantages over platforms with no human operator. The "man-in-the-loop" capability permits greater flexibility, allowing for instant alterations to original flightplans and on-the-spot decisionmaking regarding unexpected targets. This flexibility might allow, for example, a manned reconnaissance aircraft to be diverted to photograph an installation that its crew noticed off of the designated flight path. This initiative would gather imagery that would not have been collected by a drone system or a satellite.

In addition to their flexibility, manned reconnaissance platforms are extremely responsive. In some cases, reconnaissance aircraft can be quickly deployed during a crisis to any part of the world in a matter of hours. An element of surprise can also be gained, as the arrival of aerial reconnaissance assets can either be masked (through stealth technologies) or high speeds can be used—an important advantage over satellites whose orbits are essentially fixed and widely known by foreign governments. These platforms can also be used to fly low over targets to obtain fine details, although this capability is rarely drawn upon.

Familiarity of the services with the manned reconnaissance mission is a third major advantage offered by these platforms. The first role of aircraft for military applications was airborne observation of ground targets. Many reconnaissance platforms are created by equipping familiar transport aircraft with special cameras or other sensors. Today, most of the airframes used by the services for this task are well known, and have been flown successfully for many years. The Air Force's F-16 and RC-135 Rivet Joint and the Navy's F-14 Tomcat, FA/18 Hornet, and E-P3 Orion are all time-tested airframes that have seen many years of service. While the aircraft themselves may have remained essentially constant, however, the sensors held inside or attached to their exteriors have undergone multiple upgrades. Some reconnaissance aircraft collect signals intelligence (sigint) as well as, or instead of, imagery.

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[22](...continued)
17, 1998, p. 102.

[23] See Joseph C. Anselmo, "Commercial Satellites Zoom in on Military Imagery Monopoly," *Aviation Week & Space Technology*, September 22, 1997; also, David P. Radzanowski, *Public and Commercial Land Remote Sensing From Space: Landsat 7*, Lewis *and* Clark, *and Private Systems*, CRS Report 95-346 SPR, February 23, 1995.

The Navy and Air Force have also attached "pods" containing cameras and other sensors to fighter aircraft. TARPS (Tactical Air Reconnaissance Pod System) enables a few units of widely deployed combat aircraft to be devoted to reconnaissance missions. This practice provides savings both in procurement and in maintenance costs since unique platforms are not involved. TARPS-configured aircraft used in Desert Storm only had film-based sensors, but some of the Air National Guard F-16 aircraft deployed to Bosnian missions use a newly developed digital reconnaissance pod that allows downloads of digitized images to be distributed out into the field many hours faster than standard film.[24] The Navy also has plans under consideration to acquire a reconnaissance variant of the F/A-18 in the next century.[25] The House Intelligence Committee supports a podded reconnaissance capability, but not one focused strictly on the F-18.

The **U-2** has been the most important manned platform dedicated to reconnaissance.[26] The high-altitude aircraft (that flies above 65,000 feet) was designed and built by Lockheed Corporation for the Central Intelligence Agency (CIA) in the Eisenhower Administration, prior to the availability of satellites, and provided invaluable evidence of Soviet military capabilities. Despite the diplomatic embarrassment that resulted from the shootdown of a U-2 piloted by Francis Gary Powers by the Soviets in May 1960, U-2s, with significant upgrades and modifications to both aircraft and sensors, have continued to be important components of the U.S. reconnaissance effort.

Originally deployed solely for national missions by the CIA, in recent years the 31 U-2s now available have been operated by the Air Force for both strategic and tactical missions. U-2s have long had the capability to collect signals intelligence in addition to imagery, and both can be transmitted directly to ground sites in near-real-time. In the Persian Gulf War they flew over 2,200 hours during January and February 1991, providing a clear picture of Iraqi Army field positions that was available from no other source, along with intelligence on missile launchers, bomb damage assessment (BDA), and evidence of the Iraqis dumping oil in the Gulf.[27]

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[24] David A. Fulghum, "Virginian F-16s to Watch Bosnian Battlefields," *Aviation Week & Space Technology*, May 27, 1996, p. 40.

[25]See U.S. Congress, House of Representatives, Permanent Select Committee on Intelligence, *Intelligence Authorization Act for Fiscal Year 1999*, H. Rept. 105-508, May 5, 1998, p. 23. On occasion, the absence of dedicated reconnaissance aircraft has prompted the use of hand-held cameras by pilots in attack aircraft; see Daniel E. Moore, Jr., "Bosnia, Tanks, and '... From the Sea,'" *U.S. Naval Institute Proceedings*, December 1994.

[26] There is an extensive literature on the U-2s, as well as an exhibit at the National Air and Space Museum. See especially Ben R. Rich and Leo Janos, *Skunk Works: A Personal Memoir of My Years at Lockheed* (Boston: Little Brown, 1994); Bissell, *Reflections of a Cold Warrior*; and Chris Pocock, "U-2: The Second Generation," *World Airpower Journal*, Spring 1997. Some U-2s were originally described as TR-1s, but the common designator is used in this Report.

[27] See Coy F. Cross II, *The Dragon Lady Meets the Challenge: The U-2 in Desert Storm* (Beale Air Force Base, CA: 9th Reconnaissance Wing, n.d.).

U-2s continue to be deployed for reconnaissance operations over Iraq, drawing protests from the Iraqi leadership. In 1997, the House Intelligence Committee criticized the Air Force for its reluctance to upgrade its U-2s and noted that it "does not believe the U-2 will be fully replaced or retired for many years and is not willing to forego improvements to this workhorse aircraft."[28] They are, of course, not invulnerable, as was demonstrated by the Soviets in 1960 and by the Chinese, who shot down several U-2s over the Chinese mainland in the 1960s.

As a result of the U-2's vulnerability to surface-to-air missiles, the **SR-71** Blackbird, was developed in the early 1960s with significantly enhanced speed—faster than Mach 3, and capable of flying higher than 80,000 feet, and with a longer range, and a small radar cross section that arguably made it the first truly stealthy aircraft. The SR-71 is also capable of carrying several different types of cameras and sensors. Straight overhead camera resolution has been reported in the press as being nine inches, while side-looking camera shots can reportedly produce usable images in approximately a 75-mile-wide swath although resolution decreases as the distance from the plane increases.[29] A high-resolution radar system is often carried on the SR-71 as well, which provides the craft with the ability to produce quality images in all weather and daylight conditions.[30]

According to press reports, more than 1,000 unsuccessful attempts to intercept the SR-71 (especially by the North Koreans) have been made. The SR-71 was utilized for overflights of heavily defended North Vietnamese air space during the Vietnam War.[31] In addition to near-invulnerability to air defenses, the SR-71 also holds the advantage of surprise. While satellite paths are typically predictable and regular, the SR-71 can be sent out to an area of interest at any time. Its speed gives it the capability to photograph up to 100,000 square miles in an hour and limits an adversary's window of opportunity to intercept the plane, or ability to hide sensitive activities.[32]

The expense of operating the SR-71 has, however, discouraged its continued use. The entire fleet of 20 SR-71s was retired by the Bush Administration in December 1989. SR-71s were not deployed in the Persian Gulf War although some observers argued that they could have been usefully employed in that conflict. The aircraft continued, however, to have supporters in Congress who believed that some

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[28]U.S. Congress, House of Representatives, 105th Congress, 1st session, Permanent Select Committee on Intelligence, *Intelligence Authorization Act for Fiscal Year 1998*, House Report 105-135, Part 1, June 18, 1997, p. 33.

[29] See Jeffrey Richelson, "Air Force Tries to Shoot Down Its Own Spy," *Los Angeles Times*, April 9, 1989, p. V-3; "JCS Requests SR-71 Reconstitution Be Considered for Gulf Crisis,"*Defense Daily*, August 30, 1990, p. 339.

[30]An interesting description of the development of the SR-71 is found in Rich and Janos, *Skunk Works;* see also, Steve Pace, *Lockheed Skunk Works* (Osceola, WI: Motorbooks, 1992).

[31] See Richelson, "Air Force Tries to Shoot Down Its Own Spy," p. V-3.

[32]See Lonnie Brodie, "Can the U.S. Afford to Retire the SR-71 Blackbird?," *Defense Electronics*, September 1989, p. 58.

of the existing Blackbird inventory should be maintained in an operational status. The Defense Authorization Act for FY1995 (P.L. 103-337) authorized $100 million to reactivate the program. For FY1996 Congress authorized $5 million for modifying two aircraft (although an additional $30 million had been appropriated). In FY1997 Congress authorized $30 million in operations and maintenance funding for the program. Since mid-1997 two SR-71s have operated out of Air Force bases in California. Operations and maintenance funding amounting to $30 million over five years for the SR-71 was included in the FY1998 Defense Appropriation Act (P.L. 105-56). These provisions, however, were subjected to a "line-item veto" by President Clinton on October 14, 1997 because the Defense Department had "determined that it would not make a significant contribution to US military capability."[33] In November 1997, after the Iraqis threatened to shoot down any U-2s flown over their country, some Members and outside observers suggested that the President reconsider his veto, since the SR-71 is considerably less vulnerable to interdiction than the U-2.

Proponents of the SR-71 argue that the incremental cost of retaining the two planes is relatively low, given that they are in operational condition. They add that SR-71 can obtain intelligence with low risk of a shootdown and loss of a pilot. Further, they note that the UAVs designed to supply capabilities possessed by the SR-71 may not be deployed for some time. Opponents of the SR-71 counter that the aircraft is very expensive to operate and that intelligence that it can collect can be obtained from other platforms. They also maintain that there is relatively low risk to U-2s flying over Iraq, given high-altitude flightpaths, the availability of armed escorts, and degradation of Iraqi air defenses.

The U-2 and SR-71 were originally designed for national intelligence collection while the services had their own reconnaissance aircraft to collect imagery for tactical requirements. In recent years, many of the services' aircraft devoted to imagery collection, such as the RF-4s operated by the Marine Corps and the Air Force were phased out of inventories prior to Desert Storm, in large measure as a result of cost considerations as well as the potential availability of other collection platforms. There is, however, concern in Congress and elsewhere that the deemphasis of manned platforms may have been excessive especially since existing and programmed UAVs cannot replace the capabilities they have demonstrated.

Air Force **RC-135s**, which are modified tankers, primarily tasked with sigint missions, have been scheduled to be fitted with new engines to permit their use well into the next century.[34] The F-22 advanced fighter that will be delivered to the Air Force in coming years will more than likely have a reconnaissance variant, much as

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[33]Cancellation of Dollar Amount of Discretionary Budget Authority, printed in *Federal Register*, October 15, 1997, p. 53704.

[34]The House Intelligence Committee, however, has expressed concern with the commitment of the Air Force (and DOD) to this project, describing its efforts thus far as "woefully negligent." House Report 105-135, Part 1, p. 38.

the F-16 does. Extended capabilities would be made possible in theory due to the stealthy nature of the F-22.[35]

Beginning in the late 1950s, the Navy acquired some 240 ground-based **P-3** Orion aircraft to undertake open-ocean antisubmarine searches. The P-3, considered by some as basically a World War II-era platform, is a four-engine turboprop capable of carrying a variety of sensors and undertaking lengthy reconnaissance missions. With the significant lessening of the foreign submarine threat, the Navy's Pas have been widely used in ground surveillance missions such as ones flown over Bosnia by P-3s equipped with one-of-a-kind video cameras originally designed for airborne test and special operations[36]. Some in the Navy, concerned about missions against shore targets in coming years, have sought to retain P-3s with enhanced ground surveillance capabilities in its order of battle.

This concern has been shared by some Members of Congress. For FY1998, additional funding was authorized to upgrade the P-3s for ground surveillance missions within the next decade in anticipation of a follow-on system to be developed. The House National Security Committee noted that in the past year, Pas "have played major roles in joint naval operations in Bosnia, Liberia, Central Africa, the Formosa Strait and the Strait of Hormuz by providing littoral and overland surveillance."[37] The Senate Armed Services Committee took account of what it termed "persistent under funding" of P-3 modernization and strongly criticized the Navy's apparent unwillingness to budget sufficient funds to modernize the P-3s to meet established requirements.[38] The authorizing conference committee in adding $10 million for P-3 modernization, noted, "the continuing disparity between the operational requirements of the unified commanders-in-chief (CINCs) and the Navy's plans for modernization of the P-3C fleet."[39]

The Army has recently introduced a light transport aircraft (resembling a commuter plane), the **RC-7** Airborne Reconnaissance Low (ARL), with a variety of sensors, including electro-optical cameras, that can provide valuable capabilities at less cost than other manned platforms. Three RC-7s currently available have been deployed to monitor the demilitarized zone on the Korean peninsula.[40] The House

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[35]See David A. Fulghum, "Elint, SEAD Roles Seen for Stealth F-22," *Aviation Week & Space Technology*, June 10, 1996.

[36] See David A. Fulgham, "U.S. Navy Reconnaissance Crucial in Albania, Bosnia," *Aviation Week & Space Technology*, March 31, 1997.

[37] U.S. Congress, House of Representatives, 105th Congress, 1st session, Committee on National Security, *National Defense Authorization Act for Fiscal Year 1998*, House Report 105-132, June 16, 1997, p. 65.

[38] U.S. Congress, Senate, 105th Congress, 1st session, Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 1998*, Senate Report 105-29, June 17, 1997, p. 70-72.

[39] U.S. Congress, 105th Congress, 1st session, Committee of Conference, *National Defense Authorization Act for Fiscal Year 1998*, House Report 105-340, October 23, 1997, p. 613.

[40]See David A. Fulghum, "Multisensor Observations Key to Army's RC-7," *Aviation Week*

(continued...)

Intelligence Committee has twice expressed concern with Army reprogramming initiatives for the ARL reportedly taken without appropriate notification and without receiving the consent of oversight committees.[41]

Manned reconnaissance aircraft are not without significant limitations. Perhaps most importantly, the manned reconnaissance platforms in use today are vulnerable to interception by hostile air defenses. The vulnerability of manned platforms to interception necessitates restricting their operation to the fringes of the battlefield or in such areas where air superiority has been achieved. Although cameras and sensors do have considerable range, especially those sensors used for sigint missions, stand-off collection may not produce imagery with clarity and detail equal to what can be obtained directly overhead.

Manned reconnaissance aircraft also involve considerable costs, both for procurement and for maintenance, especially in the case of unique aircraft types such as the SR-71. Efforts to obtain procurement and operations and maintenance funding for reconnaissance systems must compete with other programs, often with higher priorities (sometimes directly related to core service missions).

Closely tied to the problem of interception are the political considerations involved in overflying another sovereign nation. Just as the Soviet Union vehemently objected to U-2 overflights in the 1950s, few states today will quietly accept such a violation of their sovereignty and airspace. A country that is being overflown despite its objections will almost certainly denounce the United States in international political forums, or attempt to intercept future overflights. The political ramifications of this exposure, or the danger of losing a pilot, may be sufficient to preclude these types of flights.

Another drawback to the manned reconnaissance effort is the need for basing. Reconnaissance missions can be operated from a U.S. base, but distances to areas of interest may be too long and overflights rights over foreign countries not granted; foreign bases may be available, but in a crisis situation the host country may decline to allow U.S. reconnaissance flights to operate from its territory. Although strategic platforms like the U-2 and SR-71 have tremendous reach when coupled with aerial refueling, some corners of the world would escape even their grasp.

Time over target is another issue concerning manned reconnaissance platforms. Loitering over target areas allows for a larger quantity of sigint and imagery to be captured, and also allows for easier recognition of actively developing situations on the ground. Although some platforms, such as the U-2 and the RC-135, have the ability to loiter over target areas for a number of hours without refueling, most aerial platforms, including the SR-71, lack this capability. Fighter aircraft converted to the reconnaissance role, such as the Navy F-14 Tomcat and Air Force F-16, also consume

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[40](...continued)
& Space Technology, November 24, 1997.

[41] See U.S. Congress, House of Representatives, 104th Congress, 2d session, Permanent Select Committee on Intelligence, *Intelligence Authorization Act for Fiscal Year 1997*, House Report 104-578, Part 1, May 15, 1996, p. 11; House Report 105-135, Part 1, p. 45.

too much fuel to stay over targets for long periods. This relatively rapid consumption of fuel, coupled with their high operating speeds, hinders the ability of these platforms to stay over an area of interest.

Although manned reconnaissance aircraft continue to be extensively deployed, plans for acquisition of additional systems is uncertain. Funding for U-2 operations is continued, but there are no plans for follow-on versions. President Clinton vetoed funds for maintaining the SR-71 in operational status. Planned procurement of Joint Surveillance Target Attack Radar System (JSTARS), a Boeing 707 aircraft with ground-search radars that proved highly effective in Desert Storm, has been reduced in the QDR from 19 to 13.[42] The Navy, however, received funds in the FY1998 Defense Authorization Act for upgrading P-3 maritime patrol aircraft that are used for reconnaissance purposes and planning is underway for a follow-on platform in the next century. As noted above, the approach has been to attach reconnaissance pods to fighter aircraft and deploy them on reconnaissance missions, avoiding the need to acquire and maintain separate platforms. The House Intelligence Committee expressed its strong support for attaching reconnaissance pods to naval F-18s.[43]

Congress added funding for airborne reconnaissance efforts in the FY1998 Defense Authorization Act (P.L. 105-85) in several airborne reconnaissance procurement categories, totaling $106 million.[44] Additions to P-3 upgrades, as noted above, also were included. The FY1998 Defense Appropriations Act (P.L. 105-56) added some $29 million to U-2 upgrades and provided $30 million for SR-71 operations (later rescinded by a line-item veto).

The *UAV Annual Report for 1997* suggests that the congressional message was received. DARO's FY1999-2003 five-year plan calls for 51.3 percent of DOD's investment in airborne reconnaissance to go to manned reconnaissance, whereas for the period FY1998-2003 the 1996 Annual Report called for only 33% to go to manned reconnaissance.[45] The DARO report notes, nonetheless, that through 2010 there will be "a gradual migration towards UAV dominance in airborne" collection."[46] DOD has requested some $620 million for UAV programs in FY1999.

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[42]JSTARS is not considered a reconnaissance or intelligence collection system *per se*, but is rather categorized as a command and control platform with highly effective ground-search radars.

[43] See House Report 105-135, Part 1, pp. 46, 48. The Conference Report does not indicate actions taken in this regard in conference; presumably, they are described in the classified schedule of authorizations.

[44] See House Report 105-340, pp. 538-539. Some Research and Development funding levels for UAV systems were reduced, however; see ibid., p. 643.

[45] As noted in *Aerospace Daily*, January 12, 1998, p. 45.

[46] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition & Technology), *UAV Annual Report FY 1997*, November 6, 1997, p. 15.

Unmanned Aerial Vehicles (UAVs)

Unmanned aerial vehicles offer several advantages over manned aircraft as well as satellites. Although UAVs were used during the Vietnam conflict, the absence of a real-time communications capability and precise locating data limited their effectiveness. UAVs proved their value during Desert Storm when they gathered information to support both Army and Marine Corps operations. The widespread use of tactical UAVs could significantly enhance the availability of intelligence to lower-level commanders by providing them with an imagery collection platform under their direct control.[47]

Some observers believe that high altitude endurance UAVs will eventually be able to capture imagery that at present can be collected only by satellites. A conclusive judgment on eventual UAV capabilities, as yet unproven, cannot be made, especially in view of the classified nature of the evidence. UAVs, no matter how stealthy, will probably remain somewhat more vulnerable to interception than satellites; in some circumstances they may have to be launched and controlled from ground sites outside of the United States that may themselves be vulnerable to attack; and, when development costs are taken into consideration, UAV programs may not necessarily be less expensive than satellites.

A major advantage of UAVs is that no pilot is required to operate them. Avoiding unnecessary casualties has always been a goal of U.S. military operations and UAVs support that objective, inasmuch as they can be sent into heavily defended airspace without raising concerns about losing pilots.[48] In addition, highly capable UAVs are being designed and tested that are a fraction of the size of manned reconnaissance aircraft, thus cutting down on their radar signatures and producing a measure of stealthiness unrelated to materials or speed. UAV designs that allow for extremely long operating endurance as well as high altitudes are expected to replicate some of the capabilities of reconnaissance satellites at fractions of the cost.

Current UAV planning is based on 6 systems:

- Tactical UAVs — **Pioneer**—derived from an Israeli system with procurement starting in 1985, with nine systems (with five air vehicles each) operational. It has a flight radius of 100 nautical miles (NM), an endurance of five hours, and a maximum altitude of 15,000 feet. Currently, Pioneers are mainly used for training purposes.

- The **Hunter**, another tactical UAV, is used for support and training operations. It has a radius of 144 NM, an altitude of 15,000 feet, and an eleven-hour endurance. There are seven Hunter systems with eight air vehicles each.

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[47]See Richard A. Best, Jr., *Intelligence Technology in the Post-Cold War Era: The Role of Unmanned Aerial Vehicles (UAVs)*, CRS Report 93-686F, July 26, 1993.

[48] See Glenn W. Goodman, Jr., "New Eyes in the Sky," *Armed Forces Journal International*, July 1996: pp. 32, 34.

- Another tactical system, the **Outrider**, designed to provide near-real-time imagery, has a radius of more than 108 NM, a maximum altitude of 15,000 feet, and an endurance of over 3.5 hours. The Outrider is an Advanced Concept Technology Demonstration (ACTD) program that is designed to make the platform available to operating forces for assessment prior to the initiation of regular procurement. Four Outrider systems with four air vehicles each are scheduled to be delivered in FY1998.

- **Predator** — formerly known as a Medium Altitude Endurance UAV, is a derivative of the Gnat 750, originally procured for the CIA. It provides long-range, long-dwell intelligence. It has a radius of 400 NM, an endurance of around 35 hours, and a maximum altitude of 25,000 feet. Predators were also an ACTD with initial units deployed to Bosnia; DOD has moved to obtain 12 systems of four air vehicles each through regular procurement procedures. A ship-based version was considered, but the Navy decided to rely on other shore-based UAVs.

- High altitude endurance (HAE) UAVs — designed for long-range deployment, and "wide-area surveillance or long sensor dwell" over a target area. **Global Hawk** has a radius of 3,000 NM, an endurance of 38 hours, and an altitude of 65,000 feet. Two Global Hawks are being delivered for testing.

- Another HAE UAV, **DarkStar**, would be stealthy and thus able to provide critical intelligence from specific, highly defended areas. It has a radius of at least 500 NM, an endurance of 12 hours, and an altitude of 50,000 feet. Two air vehicles have been delivered, although one crashed in April 1996 and two additional vehicles are being fabricated.

DARO has envisioned a UAV force mix of about 240 tactical UAVs, 48 Predators, and 35 HAE UAVs.[49]

Individual tactical UAV systems will undoubtedly cost less than satellites and most piloted aircraft, especially when put into large-scale production. Over the past two decades, DOD has invested about $2 billion in UAV development and procurement. For FY1998 the Administration requested some $504 million for funding the UAV effort and Congress ultimately appropriated some $510 million.[50] The Administration projects acquisition funding totaling some $1.8 billion for UAV programs during the period FY1998-2003. One tactical platform, the Outrider, reportedly costs about $350,000 for one air vehicle. These sums, while sizable, pale in comparison with the cost of modern fighter aircraft that can cost $80 million each.

There have been, however, distinct problems with UAV programs. The UAV acquisition process has been prolonged and, in the view of some observers, highly inefficient. The establishment of a DOD-wide procurement effort, while minimizing duplication of effort, has had the disadvantage of removing UAV procurement from

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[49]*UAV Annual Report FY1997*, p. 14.

[50]*UAV Annual Report FY1997*, p.3; these numbers do not reflect undistributed reductions.

the services that will use them. Despite years of effort, relatively few UAVs have been or are currently deployed in military operations. As a result, there is not yet a sizable number of personnel experienced with UAV operations, especially in combat operations, nor has a mature infrastructure been established to support them or to utilize their imagery production capabilities.

Some observers suggest that there has been a tendency to seek all-purpose platforms that can be used in almost any contingency. By introducing a wide range of different sensors and communications equipment, procurement officials may make planned UAVs overly expensive with designs that are not necessarily optimized for the most likely types of missions. In addition, the effort to make UAVs usable by more than one service has also introduced complexities and delays. (Especially difficult are problems involved in making UAVs recoverable onboard ships.) Other observers note that current and planned UAVs, while less costly than manned aircraft and satellites, are not so inexpensive that they can really be considered as expendable, especially when the costs of surveillance and communications equipment are considered.

Other observers caution that foreign countries will eventually develop effective countermeasures against UAVs. Although one of the advantages of UAVs is that they do not require a pilot to operate them, advocates of manned aircraft would point out this can also be an inherent weakness of the UAV. Human intelligence in the cockpit allows for adjustment to unexpected circumstances and exploitation of opportunities as they arise.

Along with some Members of Congress, the General Accounting Office (GAO) has been especially critical of DOD's efforts at UAV procurement, both before and after the creation of DARO in 1993[51]. The use of ACTDs instead of customary procurement procedures has been criticized as leading to acquisition of available platforms that cannot meet actual military requirements. (Normal procurement processes would be used for subsequent operational units, incorporating changes based on evaluation of the ACTD.) Taken as a whole, according to GAO:

> ... [DOD's] UAV acquisition efforts to date have been disappointing. Since Aquila began in 1979, of eight UAV programs, three have been terminated (Aquila, Hunter, Medium Range), three remain in development (Outrider, Global Hawk, DarkStar), and one is now transitioning to low rate production (Predator). Only one of the eight, Pioneer, has been fielded as an operational system. We estimate DOD has spent more than $2 billion for development and/or procurement on these eight UAV programs over the past 18 years. [52]

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[51] The CIA has also been involved in procuring UAVs, a tactical version known as the Gnat and a long endurance stealth version (known as Tier 3) that was subsequently canceled, but CIA programs are not reviewed by the GAO.

[52] General Accounting Office, *Unmanned Aerial Vehicles: DOD's Acquisition Efforts: Statement of Louis J. Rodrigues, Director, Defense Acquisition Issues, National Security and International Affairs Division*, GAO/T-NSIAD-97-138, April 9, 1997, p. 1.

Defenders of the UAV effort maintain that the process is lengthy because of the need to sort out requirements of different missions and because the technology is new and untried Mishaps with test vehicles, while regrettable, are an inevitable part of acquiring new platforms as they were with the satellite program. UAV proponents argue that the performance of UAVs in Desert Storm and in Bosnia fully justifies continued procurement, but that the arrival of significant numbers of operational units will take some years, given current constraints on Defense spending. According to DARO Director, Major General Kenneth R. Israel, "FY1997 has been a transition year. The UAV community has persevered both in meeting acquisition challenges and in integrating projected UAV capabilities into military operations wherever useful."[53] Even the strong criticisms of DARO by some in the 105th Congress did not reflect opposition to UAVs, but rather a determination to make more and better UAVs available.

Organizational Complexities

In addition to the technological challenges involved in collecting and using imagery are complex organizational relationships among a number of DOD and Intelligence Community agencies and the overlapping responsibilities of several congressional committees. The requirements of a number of agencies and budgetary realities have led all observers to conclude that it would be impossible either to establish a single entity responsible for collecting, analyzing, and disseminating imagery from satellites, manned aircraft, and UAVs or to let each agency undertake its own imagery effort in isolation from others. Thus it has been found necessary to establish coordinative mechanisms that inevitably involve compromises and some overlap.

A large measure of complexity also derives from distinctions between the two long-established categories of national and tactical intelligence. National intelligence refers to information necessary for Washington-level policymaking by the White House, Federal agencies, and the Congress. National intelligence would include such topics as the location of foreign missile silos, dispositions of military forces in hostile states, and evidence of production facilities for weapons of mass destruction. Tactical intelligence, on the other hand, refers to information needed by military commanders in specific situations—the organization of opposing forces, their location, their equipment, missions, and immediate intentions.

"National" intelligence agencies such as the Central Intelligence Agency (CIA), the National Security Agency (NSA), the Defense Intelligence Agency (DIA), the National Reconnaissance Office (NRO), and the National Imagery and Mapping Agency (NIMA) have major roles in the collection, analysis, and dissemination of national-level imagery to the White House and the Department of State and Defense.

Tactical commanders throughout the world deploy imagery collection platforms including various types of manned reconnaissance aircraft and UAVs to acquire information that is needed for their missions; their intelligence staffs analyze and disseminate it locally (and, on occasion, to higher echelons and civilian agencies as well). The intelligence organizations of the military services support field units in

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[53] *UAV Annual Report, FY1997,* p. 2.

acquiring and analyzing tactical intelligence (although they also work with national-level agencies.)

Platforms procured for and operated by the CIA are national programs; Defense Department programs can be either national or tactical. Some programs built by and for the CIA, *viz.* the U-2 and SR-71 and the Gnat UAV, have subsequently been turned over to the military services for tactical purposes.

Distinctions between national and tactical intelligence can easily blur, especially in crises in which national policymakers focus intensely on local developments on an hour-by-hour (or minute-by-minute) basis. Advances in computer and communications capabilities have meant that national intelligence can be shared with tactical commanders in real-time and tactical data can be readily forwarded to Washington headquarters. Programs have been established to facilitate the tactical exploitation of national intelligence capabilities and, conversely, national exploitation of tactical capabilities.[54] Nonetheless, the distinction is important for understanding many of the questions relating to overhead imagery. National and tactical programs appear in different parts of the Defense and intelligence budgets, and some observers express concern that budget items have been brought together late in the budgetary cycle and that coordination has not always been apparent. Tactical collection systems whose primary function is to provide targeting data of immediate use to a weapons system are not programmed and budgeted as intelligence systems but as operational systems even though they can provide important information on designated targets and their environment.[55]

In Congress, national programs are directly overseen by the two intelligence committees (the Senate Select Committee on Intelligence (SSCI) and the House Permanent Select Committee on Intelligence (HPSCI)). Tactical programs are overseen by the Senate Armed Services Committee and by both HPSCI and the House National Security Committee.

Under the guidance of the Director of Central Intelligence (DCI), satellite procurement is the responsibility of the NRO with most, if not all, of its funding being part of the National Foreign Intelligence Program (NFIP), (the collection of programs that provides intelligence to national-level decisionmakers and is overseen by the two

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[54] The House Intelligence Committee argues, however, that these programs may have outlived their usefulness. "The Committee believes that the tactical 'operationalization' of space has become commonplace within military doctrine, planning, and execution. Space, today, has become simply another dimension of warfare, and is now less an enigma; we should, as a result, require fewer specialized projects to inform, educate, and provide improved capabilities." House Report 105-135, Part 1, p. 52.

[55] See Dan Elkins, *An Intelligence Resource Manager's Guide*, 1997 ed. (Washington: Joint Military Intelligence Training Center, 1997), p. 58. The Senate Armed Services Committee has suggested that some programs in the TIARA category should be transferred to other accounts of the military services. See U.S. Senate, 105th Congress, 1st session, Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 1998*, S. Rept. 105-29, p. 310. Section 931 of the FY1998 Defense Authorization Act (P.L. 105-340) required that the Secretary of Defense review TIARA systems to ensure that they are properly categorized.

intelligence committees). [56] The NRO's role in managing satellite programs has been complicated by controversies surrounding the construction of an office building in a Virginia suburb of Washington and the existence of large "carry-forward" accounts that led critics to call for the agency's abolition or drastic reform. A panel headed by retired Admiral David Jeremiah concluded in 1996 that while further reforms in management were needed, the NRO remained the "right organizational answer to nation's space reconnaissance needs in the future." The Jeremiah Panel emphasized the need to take advantage of technological innovations to achieve near-continuous global coverage, the capability to remain over one area for long periods, and hard-target characterization.[57] Nevertheless, questions persist about the direction and management of satellite acquisition efforts.

Whereas the NRO is responsible for managing and operating satellite systems, the National Imagery and Mapping Agency is the national-level agency charged with analyzing the product of satellite and other imagery collection efforts and making it available in usable forms to intelligence consumers. NIMA was established in 1996 pursuant to the National Defense Authorization Act for FY1997 (P.L. 104-201). Resulting from dissatisfaction with the Persian Gulf War experience when it proved difficult to move imagery to those decisionmakers who needed it most, NIMA replaced several Intelligence Community entities as well as the Defense Mapping Agency, which was previously not considered an intelligence organization. NIMA is a combat support agency of the Defense Department, but it also tasks collection systems and analyzes imagery in support of national consumers. NIMA has not been without start-up difficulties; the House Intelligence Committee has recently stated that "it has been almost impossible to get consistent budget information from NIMA on detailed questions."[58]

Tasking is a crucial part of imagery collection and analysis. In accordance with P.L. 104-201, the DCI has authority (unless otherwise directed by the President) to approve and prioritize collection requirements levied on national imagery collection assets including satellites. The DCI establishes these requirements in consultation with national-level consumers, most prominently the White House and the State and Defense Departments. The tasking process requires, but has not invariably had, input from senior officials most knowledgeable about current and projected policy concerns. Some observers have suggested that the Intelligence Community's lack of foreknowledge of the Indian nuclear tests of May 1998 may have been caused not only by analysts missing crucial indicators and India's careful deception efforts, but also by an absence of focused requirements by policy-level officials.

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[56]According to press reports, the Defense Advanced Research Projects Agency (DARPA) has discussed plans to launch a constellation of small satellites that would be directly controlled by theater commanders rather than by the NRO. See David A. Fulghum and Joseph C. Anselmo, "DARPA Pitches Small Sats for Tactical Reconnaissance," *Aviation Week & Space Technology*, June 9, 1997. Plans to evaluate this proposal, originally known as Starlite and subsequently labeled Discover II, are reportedly under consideration by DARPA, the Air Force, and the NRO. See "DARPA/USAF/NRO plan space-based SAR/MTI development," *Aerospace Daily*, March 19, 1998, p. 416.

[57]National Reconnaissance Office, *Jeremiah Panel - Final Report*, August 26, 1996.

[58]House Report 105-508, p. 12.

Manned reconnaissance aircraft are currently operated by the four military services. As such, acquisition efforts are included in the services' research and development and procurement programs that are submitted to Congress. As noted above, the services have tended to move away from dedicated reconnaissance aircraft and to rely on reconnaissance variants of combat or transport aircraft. This tendency, however, complicates efforts to achieve a comprehensive imagery capability, especially one that is coordinated with systems managed by other agencies. In some cases as also noted above, the services have sought imagery collection programs without coordination with other services, agencies, or appropriate congressional oversight committees.

Organizational disputes have affected UAV programs for over a decade. After the abandonment of the ill-fated Aquila UAV effort by the Army in 1987, observers argued that the services consistently downplayed UAVs because of a preference for piloted aircraft (derisively termed "the silk scarf syndrome") and other capabilities closer to their core missions. Sensitive to arguments that there is an inherent bias, especially among Air Force and Navy aviators, in favor of manned aircraft, and concerned with limited progress in UAV acquisition, in 1993 Congress mandated a consolidated DOD-wide effort that led to the establishment of DARO. [59] It was hoped that a consolidated DOD-wide effort would accomplish more in an area of new technologies that were not closely tied to any individual service.

Subsequently, however, congressional critics concluded that DARO has had limited success in fielding UAV systems and some Members urged that the organization should be dis-established and its responsibilities transferred to the Director of the Defense Intelligence Agency. In 1997, the House Intelligence Committee, noting that it "has not been comfortable with the management structure put in place to manage the [Defense Airborne Reconnaissance Program], nor with the extent to which the DARO has assumed authority over service reconnaissance system acquisition equities," called for the dis-establishment of DARO. [60] On the other hand, DARO was defended by Defense Department officials, the Senate Intelligence Committee, and by several Members of the House Intelligence Committee.[61]

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[59] The Conference Report (U.S. Congress, 103d Congress, 1st session, House Report 103-357, November 10, 1993) on the National Defense Authorization Act for FY1994 (P.L. 103-160) expressed concern "about the lack of progress the UAV JPO [Joint Program Office, an entity created to coordinate UAV acquisition] is making. The conferees have also expressed disappointment with the proliferation of unique vehicle programs which have been designed to fill disparate categories of requirements." (Page 597.) Congress further required a new UAV management structure and that programs from unmanned and manned reconnaissance, sensor development and ground station support should be directed by the Office of the Undersecretary of Defense for Acquisition and Technology. (Page 444.) DARO was established the same month the Conference Report was approved.

[60] House Report 105-135, Part 1, p. 37. Abolition of DARO was mandated by Section 608 of H.R. 1775, as passed by the House on July 9, 1997.

[61] See the Minority Views and the letter from the Acting Under Secretary of Defense (Acquisition and Technology) contained in House Report 105-135, Part 1, pp. 79-80. The Senate Intelligence Committee went further, recommending that even more reconnaissance be

(continued...)

The FY1998 Defense Authorization Act (P.L. 105-340) did not mandate disestablishment of DARO, but section 905 transferred responsibilities for acquisition of systems, budgeting, and program management for individual airborne programs to the military departments. Moreover, the Conference Report indicated a general dissatisfaction with the results of UAV procurement efforts: "The congressional defense committees have repeatedly stated concerns with respect to both manned and unmanned airborne reconnaissance, yet there has been little improvement noted." The conferees saw DARO's role as providing "management oversight,"—coordinating budget developments, ensuring adherence to standards and interoperability requirements, and avoiding unnecessary duplication of effort. Such oversight, according to the Conference Report, should not include execution of operations and maintenance funding, or acting as the acquisition agent for airborne reconnaissance systems.[62]

Although DARO did survive congressional criticisms in 1997, in March 1998 DOD announced that, as part of a reorganization of the Office of the Secretary of Defense (OSD), DARO would be dissolved and its responsibilities transferred to the Office of the Assistant Secretary of Defense for Command, Control, Communications, Intelligence, Surveillance, and Reconnaissance (C^3ISR). That office will provide policy guidance, develop long-range plans, and allocate resources to the services, and retain "funding supervision." The services will become responsible for managing UAV programs for the Outrider and Predator. Observers are divided over the extent to which the delays and difficulties in UAV acquisition plans can be attributed to managerial shortcomings by DARO, but giving the services responsibilities for increasingly important UAV programs could, it is hoped, lead to more energetic attainment of the goals. The new organization is designed to provide better integration of space and airborne platforms.

The organizational complexities surrounding imagery programs are likely to persist. While all parties appear to be content to let the military services acquire and operate manned reconnaissance aircraft largely for tactical missions, new arrangements have been established to ensure that satellite and UAV programs involve close coordination among different agencies to avoid unnecessary duplication of effort and that both national and tactical requirements are satisfied. Although these types of arrangements are inherently difficult and require constant oversight, observers anticipate that they can support a more effective imagery program.

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[61](...continued)
placed under DARO's authority; Senate Report 105-24, p. 12. The Senate Committee argued: "Created less than four years ago, the DARO has demonstrated effective management of resources and programs. One of the hallmarks of effective business practices is centralized decision making coupled with decentralized execution. This has been a DARO hallmark."

[62]House Report 105-340, p. 784. In a floor statement, Representative Dicks maintained that "this provision does not alter DARO's current role or responsibilities since, Department of Defense officials have stressed, DARO has not, does not and will not manage programs." *Congressional Record*, November 7, 1997, p. H10177.

Imagery for the Future: Issues for Congress

The nation's imagery effort in coming decades will probably be characterized by larger numbers of smaller satellites, by continued reliance on manned reconnaissance aircraft, and by greater availability of UAVs. Major questions remain: to what extent UAVs can replace or supplement either satellites or manned aircraft; to what extent commercial satellite imagery can satisfy government needs; and the size and shape of the manned reconnaissance effort. Congress will have a major role in shaping the resolution of these issues as it has influenced imagery programs in the past. Congress supported highly secret initiatives to acquire U-2s, SR-71s, and satellites beginning in the 1950s. In the 1990s Congress has encouraged the acquisition of UAVs and has made specific, if changing, recommendations regarding the UAV procurement infrastructure. Congress has championed the shift to smaller satellites and has emphasized the continuing need for manned reconnaissance aircraft.

UAV procurement is almost certain to remain a special congressional focus. Some observers express confidence that recent changes in DOD management of reconnaissance efforts will improve the UAV acquisition process, but others express skepticism that differing requirements for UAVs can be easily resolved or that production efforts can be streamlined in the near term.

Congress has not been concerned only with the procurement of imagery collection systems. It is widely recognized that analyzing (or "exploiting") the vast quantities of imagery collected is a major challenge and a potential source of waste and duplication of effort. In some cases, imagery is collected at considerable expense, only to be stored while analysts are overwhelmed with other materials. A staff study conducted in 1996 by the House Intelligence Committee described such difficulties and discussed a number of initiatives that might enable imagery analysts to make use of technologies like automated target recognition systems and more flexible and user friendly workstations that could enable them to support intelligence consumers better. [63] The House version of the FY1999 Intelligence Authorization bill calls for a study of these and related problems to be completed by March 1999.[64] Some observers also argue that many mid-level personnel are not adequately trained to take advantage of imagery available from disparate sources. Establishing operating procedures, building a body of lessons learned, and training operators and analysts are inherent responsibilities of the executive branch, but Congress has oversight responsibilities that some observers expect to be actively exercised in coming years.

Given the dynamic technologies, it remains uncertain whether it is possible to design a "master plan" that would yield an optimal mix, in light of the different advantages and limitations of specific platforms for different types of missions. DARO is recognized to have made an important contribution in developing imagery

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[63] "IMINT: Imagery Intelligence," in U.S. Congress, House of Representatives, 104th Congress, Permanent Select Committee on Intelligence, *IC21: Intelligence Community in the 21st Century*, Staff Study, April 9, 1996.

[64] House Report 105-508, p. 26.

architectures for multiple systems to encourage interoperability. But establishing a comprehensive plan will be administratively difficult, given the acquisition processes for the different platforms that are also overseen by different congressional committees, the competing needs of national and tactical consumers, and the unique concerns of each of the four services. It is especially hard to design imagery platforms for the wide variety of contingencies in terrain (littoral areas or far inland, deserts or mountains) and opposing forces (armored divisions to urban guerillas).

Even the most careful study undertaken by experienced experts could produce a mix of platforms and systems that would not be optimally configured for the next crisis in the fast-moving post-Cold War environment. Some observers suggest that Congress should undertake a overall assessment of all imagery efforts although such an effort would have to be based on contributions from several oversight committees. In any event, Congress will need to balance funding requirements of imagery collection against other military and intelligence requirements.