CONGRESSIONAL BUDGET OFFICE
U.S. Congress
Washington, DC 20515

Douglas Holtz-Eakin, Director

September 12, 2005

Honorable C.W. Bill Young
Chairman
Subcommittee on Defense
Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

In response to the Subcommittee's request, the Congressional Budget Office (CBO) has examined the long-term implications of the Department of Defense's plans for major unclassified military space programs. The attached report describes the resource demands—and the sizes and ages of satellite constellations—that would result from implementing the Administration's current plans through 2024.

The report was prepared by Robie Samanta Roy of the National Security Division and Ray Hall of the Budget Analysis Division. Dr. Samanta Roy is CBO's staff point of contact for this effort; he can be reached at (202) 226-2900.

Sincerely,

Douglas Holtz-Eakin

Attachment

cc: Honorable John P. Murtha
Ranking Member

Honorable Jerry Lewis
Chairman
Committee on Appropriations

Honorable David R. Obey
Ranking Member

The Long-Term Implications of Current Plans for Investment in Major Unclassified Military Space Programs

September 12, 2005

The Congress of the United States ■ Congressional Budget Office

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Summary and Introduction

Under the President's budget request for 2006 and the associated Future Years Defense Program (FYDP) for 2006 through 2011, funding for development and procurement of major unclassified space systems would grow by more than 40 percent next year (to $6.9 billion from $4.9 billion in 2005) and would double by 2011.[1] Those planned investments primarily focus on developing new systems—some of which their proponents regard as transformational—to replace existing space systems. Although the overall budget proposed by the Department of Defense (DoD) for both unclassified and classified space programs—including costs for research, development, test, and evaluation (RDT&E); procurement; and operation and support—is about 2.5 percent higher for 2006 than for 2005, the investment portion for major unclassified programs is 43 percent higher.[2] Thus, under that proposal, investment spending for such programs would grow from 22 percent of DoD's total space budget this year to 31 percent in 2006.[3]

At the request of the Chairman of the House Appropriations Committee's Defense Subcommittee, the Congressional Budget Office (CBO) has examined the long-term implications of DoD's plans for investment in unclassified military space programs. CBO's analysis considers the resource demands that would result from implementing the Administration's current plans through 2024, as well as the sizes and ages of the resulting constellations of satellites. The analysis is based on the 2006-2011 FYDP and CBO's projections of the implications of that FYDP through 2024, given the longer-term goals that DoD has stated for its current programs and plans. This report provides a more detailed description of the space-related programs included in CBO's forthcoming paper on *The Long-Term Implications of Current Defense Plans and Alternatives*.

DoD divides space systems into four broad categories according to their purpose:

- Force enhancement—which includes systems to provide communications; information about position, velocity, and time for navigation; intelligence, surveillance,

1. Unless otherwise indicated, all years referred to in this report are fiscal years, and all dollar amounts are expressed in 2006 dollars of total obligational authority. The FYDP is a database that contains a record of defense forces and spending since 1962 as well as the Department of Defense's estimates of funding needs for the next five or six years based on the department's current plans for all of its programs. The FYDP is produced each year and submitted to the Congress as part of the President's budget request.

2. The Congressional Budget Office defines unclassified space programs as those with content that is not highly classified. That definition excludes systems managed by the National Reconnaissance Office, which are highly classified.

3. DoD's budget request (including RDT&E, procurement, and operation and support costs) for all space programs was $22.12 billion for 2005 (in 2006 dollars) and $22.66 billion for 2006. See Marcia Smith, *U.S. Space Programs: Civilian, Military, and Commercial,* CRS Issue Brief IB92011 (Congressional Research Service, August 9, 2005).

and reconnaissance (ISR); integrated tactical warning and attack assessment (also known as missile warning); and environmental (weather) monitoring;

- Space control—such as ground- and space-based sensors to enhance situational awareness in space, as well as defensive and offensive capabilities to protect U.S. space assets from enemy attack;

- Force application—such as conventional munitions deployed from or through space; and

- Space support—which includes space lift (launches) and satellite operations.

DoD's emphasis on what it calls transformational space systems is exemplified by two programs, which together account for almost one-third of all investment in major unclassified military space programs in CBO's projection. The Transformational Satellite Communications System (TSAT) is intended to provide high-capacity communications capabilities for military users around the globe, and the Space Radar is designed to provide global ISR capabilities to detect and track targets. Together, projected funding for those two programs totals $15.7 billion over the 2006-2011 period of the FYDP and $40.4 billion over the 2006-2024 period—roughly 4 percent to 5 percent of the Air Force's total investment funding during those periods.

In addition, the Air Force continues to pursue the Space-Based Infrared System in high-Earth orbit (known as SBIRS-High) to replace current Defense Support Program satellites that provide warning of missile launches. The Air Force also plans to develop the next generation of Global Positioning System (GPS) satellites, the next generation of weather satellites, and new capabilities for responsive launch (the ability to get satellites into orbit rapidly) and space control.

Under the current FYDP, annual investment spending for major unclassified space systems would peak at almost $10 billion, with military satellite communications (MILSATCOM) composing the largest share (see Figure 1).[4] Under CBO's long-term projection of the implications of the FYDP, the annual demand for investment funding would decline after 2010 as programs made the transition from development to procurement, assuming that currently planned schedules were met.

The numbers reported here for the FYDP and CBO's projection generally reflect only the costs associated with the space segments of various programs (when those costs can be separately identified in the FYDP). They exclude the costs of developing and procuring the systems necessary to collect, process, and disseminate data on the ground.[5]

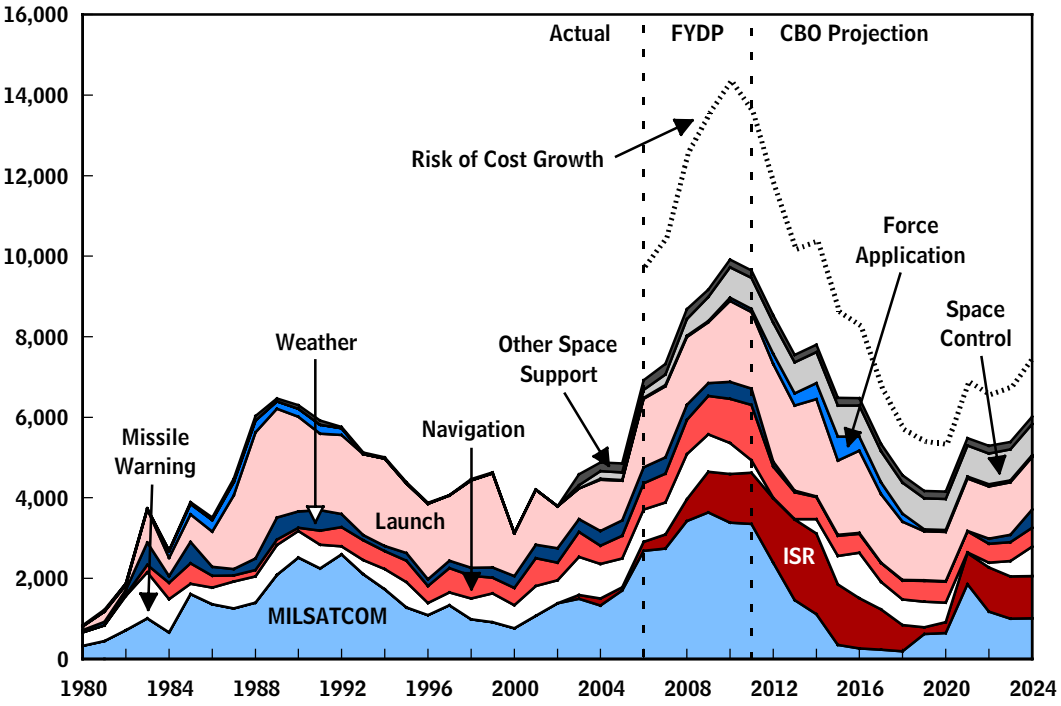
4. Historical data, as well as indexes of inflation, come from the FYDP.

5. CBO did not separately project costs for ground infrastructure for a variety of reasons, including a lack of detailed unclassified data on funding for that infrastructure.

Figure 1.

Investment in Major Unclassified Military Space Programs

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Notes: FYDP = 2006 Future Years Defense Program; MILSATCOM = military satellite communications; ISR = intelligence, surveillance, and reconnaissance.

The investment costs shown in this figure comprise research, development, test, evaluation, and procurement associated with major unclassified programs; they exclude general research and development related to space technologies.

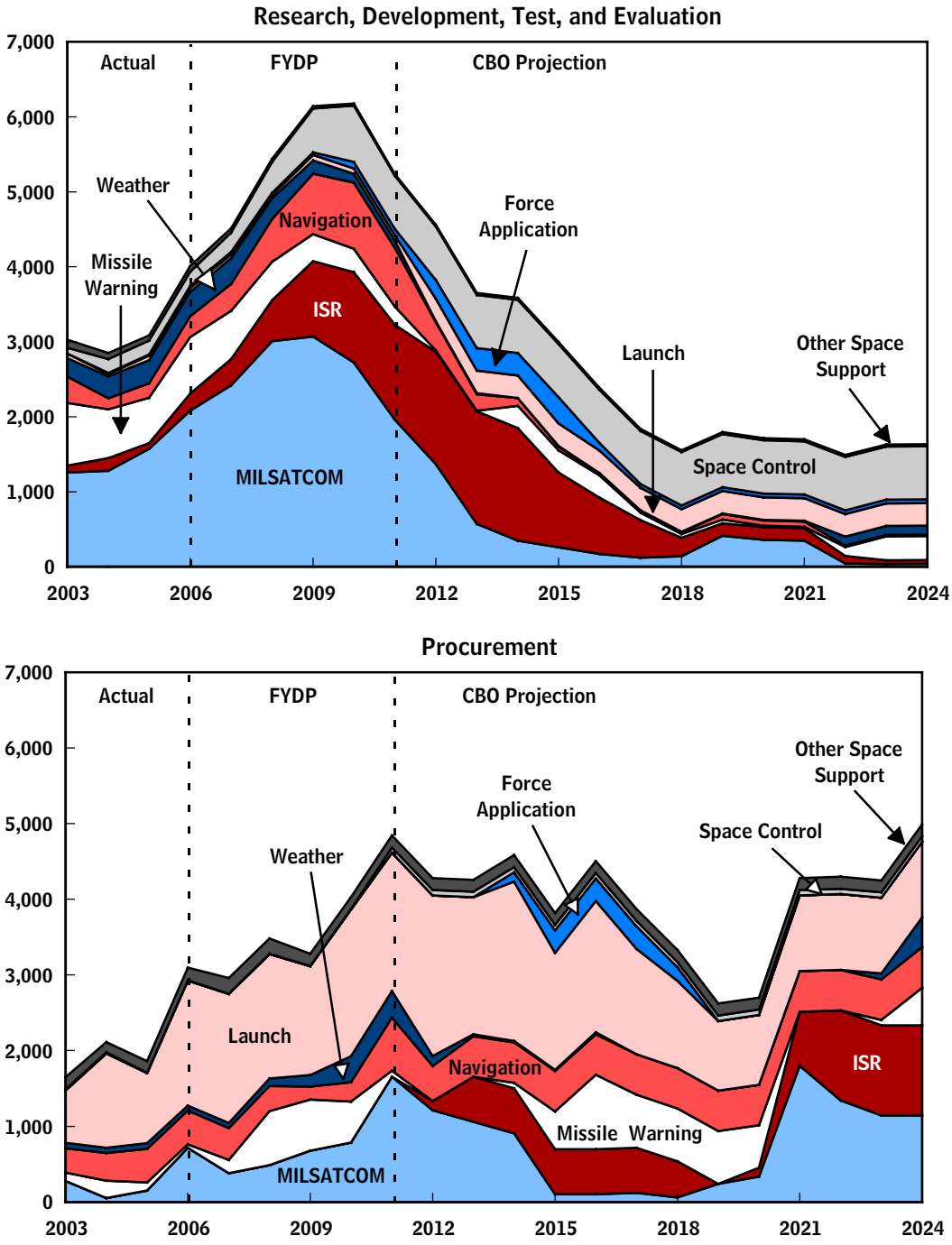
CBO's projection of the long-term implications of the 2006 FYDP assumes that procurement of individual satellites is spread over two years (20 percent/80 percent) and that construction takes four years. Satellites are assumed to have an average lifetime of eight years. The projection assumes that constellations of satellites are reconstituted as necessary and that block upgrades occur as planned.

Beyond 2019, CBO's projection generally includes the funding needed to sustain all constellations of satellites with only incremental improvements, rather than the greater amounts that would be necessary to develop another new generation of systems with substantially greater capabilities. That approach explains the declining and then relatively flat level of RDT&E funding in the later years of CBO's projection (see Figure 2). The RDT&E funding that DoD actually requests for unclassified space programs in those years could be greater than CBO projects for a variety of reasons, such as cost growth, schedule slippage, or new programs not contained in DoD's

Figure 2.

RDT&E and Procurement Costs of Major Unclassified Military Space Programs

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Note: FYDP = 2006 Future Years Defense Program; MILSATCOM = military satellite communications; ISR = intelligence, surveillance, and reconnaissance.

present plans. Conversely, if currently planned programs were substantially reduced in scope or canceled, actual funding requests could be smaller than CBO projects.

A challenge facing DoD, which is not unique to unclassified military space programs, is cost growth. Historically, RDT&E costs for DoD's space systems have grown by an average of 69 percent from the original development estimates, and procurement costs have risen by 19 percent, on average. If costs grew at those rates in the future, investment needs would peak at $14.4 billion—rather than $10.0 billion—in 2010, CBO projects (see Figure 1).[6]

In addition to cost growth, past DoD space programs have seen their schedules slip to varying degrees. However, DoD's space systems have historically lasted longer than their design lifetimes.[7] Hence, unless significant additional slippage occurs in schedules for satellites now being developed, it appears unlikely, in most cases, that current capabilities will decline substantially.

Military Satellite Communications

MILSATCOM systems are generally divided into three major categories that are based on the part of the radio spectrum they use: wideband, or super high frequency (SHF); protected, or extremely high frequency (EHF); and narrowband, or ultra high frequency (UHF). The TSAT program combines both wideband and protected capabilities. Under the 2006 FYDP and CBO's projection of its implications through 2024, MILSATCOM investment includes $27 billion in Air Force funding for wideband and protected systems and $5 billion in Navy funding for narrowband systems. Annual investment demands would decline substantially by 2016, CBO projects, assuming that the currently planned schedule for the TSAT program could be achieved (see Figure 3). Funding needs would rise again beginning around 2019 as constellations of communications satellites were reconstituted.

Wideband

The wideband systems now in operation include the Defense Satellite Communications System (DSCS), a constellation of five primary satellites plus a number of older residual-capability satellites, and the Global Broadcast Service, which consists of payloads on three Navy UHF Follow-On (UFO) satellites.[8] Although the DSCS satellites were originally expected to have a service life of 10 years, they are lasting longer than anticipated. The last DSCS satellite was launched in 2003, and the constellation is

6. For a detailed discussion of how CBO develops cost-risk projections for investment, see Congressional Budget Office, *The Long-Term Implications of Current Defense Plans* (January 2003), pp. 44-46.

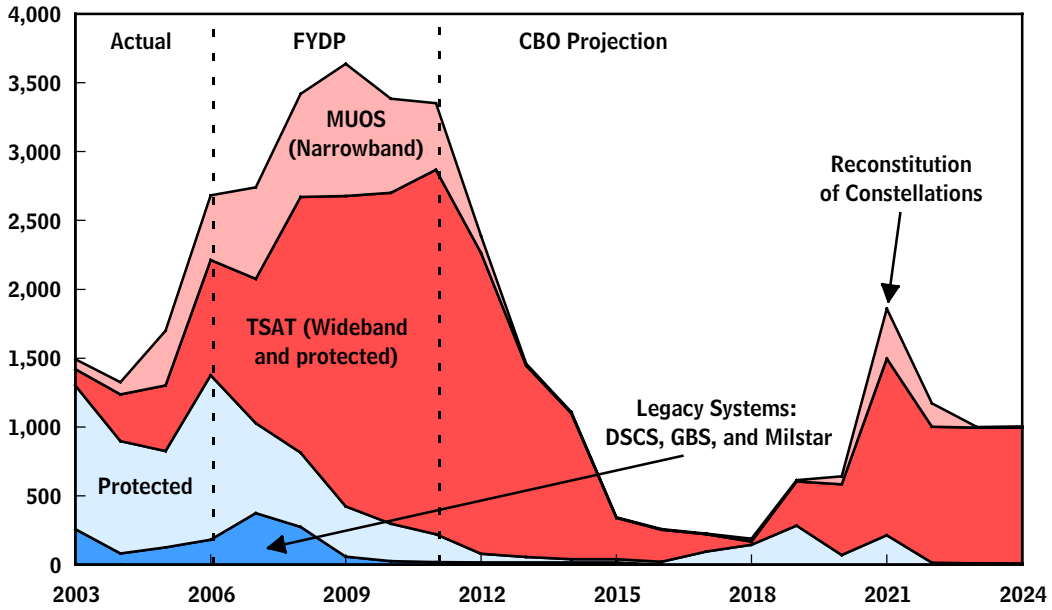
7. Information about the lifetimes of satellites was drawn from material provided to CBO by the Air Force.

8. DoD augments those wideband capabilities by leasing commercial satellite communications services; the costs of those services are excluded from CBO's long-term projection.

Figure 3.

Investment in Military Satellite Communications Programs

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Notes: FYDP = 2006 Future Years Defense Program; MUOS = Mobile User Objective System; TSAT = Transformational Satellite Communications System; DSCS = Defense Satellite Communications System; GBS = Global Broadcast Service.

Projected investment costs exclude the ground-terminal portion of satellite communications programs.

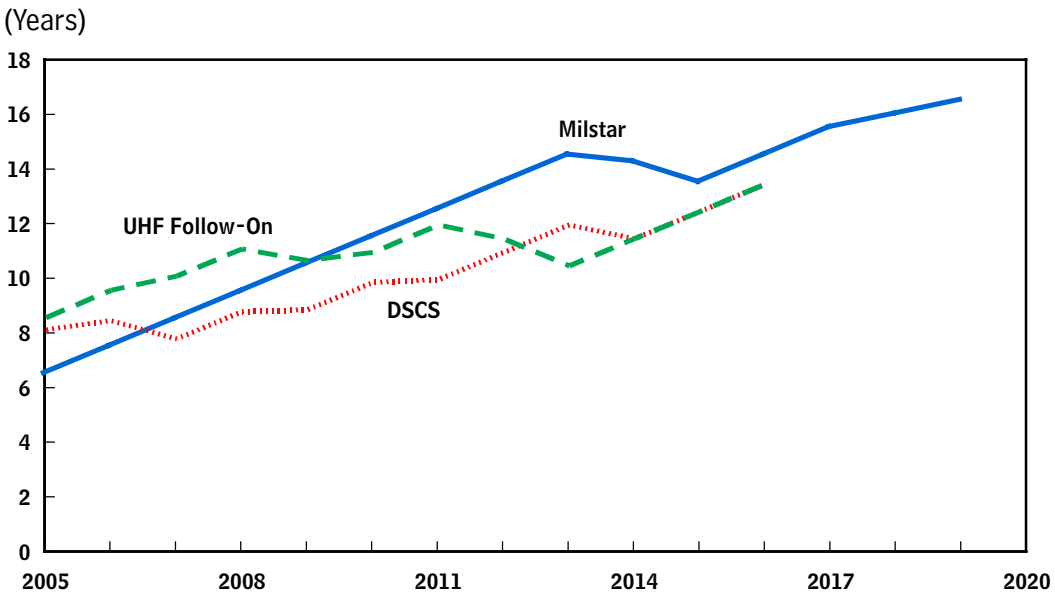
now expected to be operational through 2015, at which point its satellites would have an average age of more than 12 years (see Figure 4). DoD anticipates that the Global Broadcast Service payloads, for their part, will continue operating through 2010 or slightly beyond. Both systems are due to be replaced by five Wideband Gapfiller System (WGS) satellites that the Air Force is developing. Current plans call for the first WGS satellite to be launched in 2006, with the constellation of WGS satellites providing wideband services beyond 2017.

Protected

DoD's capacity for protected satellite communications comes from five Milstar satellites, which are expected to be operational at least until 2014. Like DSCS satellites, Milstar satellites are exceeding their design lifetime, and some may be available beyond that time frame. The satellites that compose the Milstar constellation will be an average of 10 years old by 2009 (see Figure 4). The previous year, a constellation of three new Advanced EHF satellites is expected to begin replacing Milstar. Besides developing those satellites—which are designed to provide coverage of the globe up to

Figure 4.

Projected Age of Existing Constellations of Military Communications Satellites



Source: Congressional Budget Office based on data from the Department of Defense.

Note: UHF = ultra high frequency; DSCS = Defense Satellite Communications System.

about 65 degrees of latitude—the Air Force is pursuing programs to improve protected-communications capabilities over the northern polar regions. Two Interim Polar payloads are scheduled to be operational by 2006 and to be replaced by two Enhanced Polar payloads around 2013. In addition, the TSAT constellation is currently intended to consist of five satellites connected using laser cross-links and to provide both wideband and protected services. Its initial launch is planned for about 2013.

Narrowband

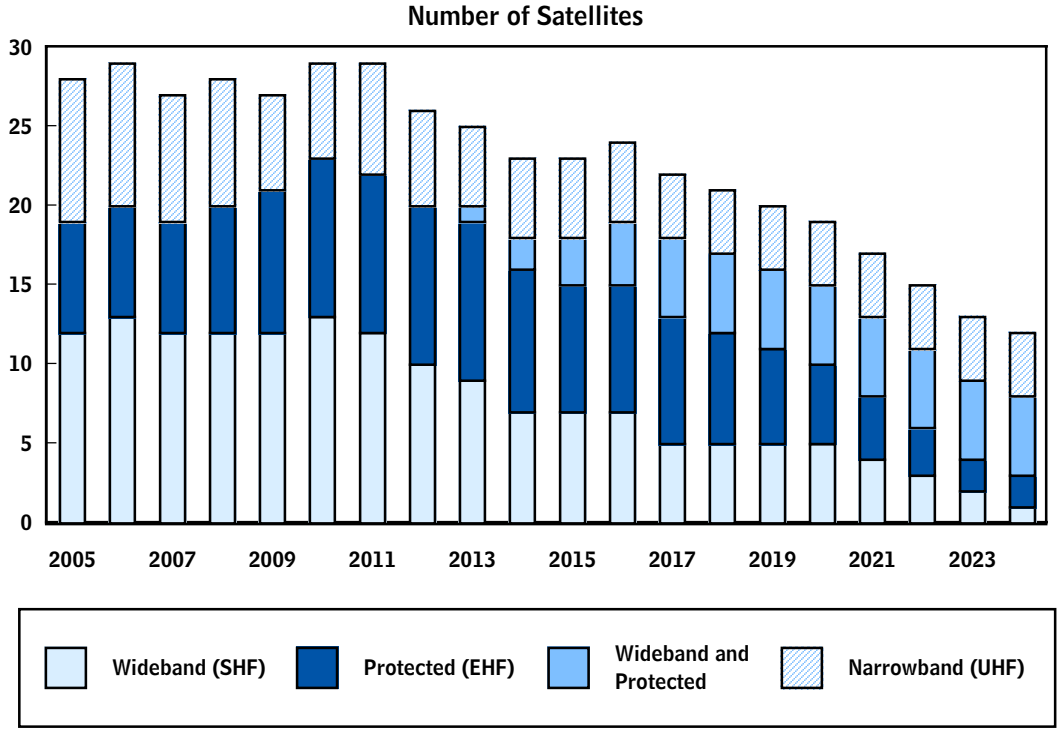
The nine Navy UFO satellites now in orbit (out of a total of 11 launched) provide DoD's current narrowband-communications capability.[9] That constellation is due to be replaced, starting in 2010, by five Mobile User Objective System (MUOS) satellites that the Navy is developing. However, three of the satellites in the UFO constellation might fail by the end of 2008. If that happened, there would be little margin to accommodate slippage in the launch date of the first MUOS satellite.

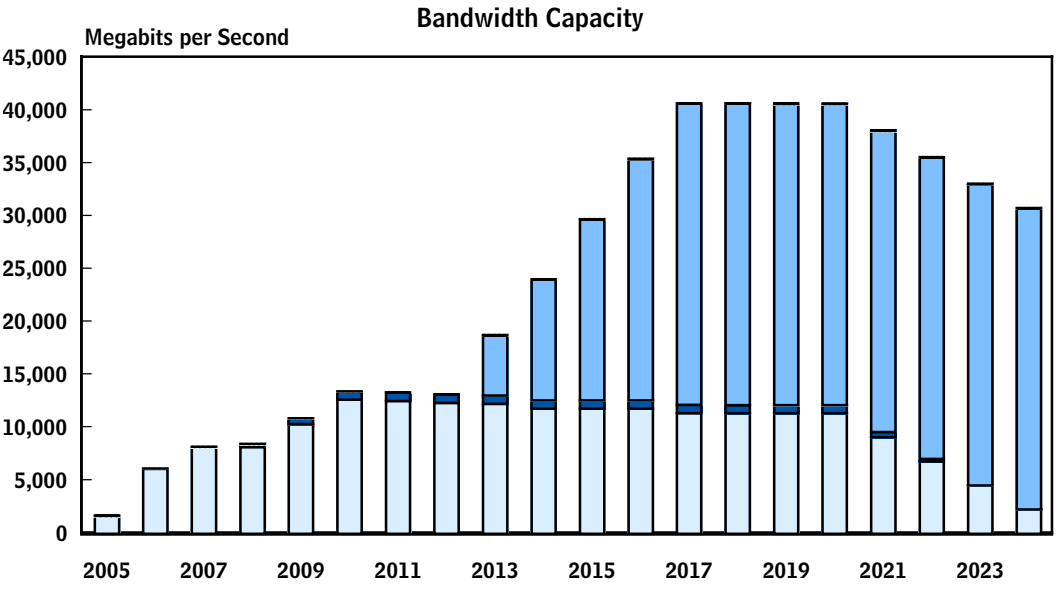
DoD is pursuing those various MILSATCOM programs for several major reasons, including the need to keep pace with rapidly growing requirements for communica-

9. Eight of those satellites also carry EHF payloads, and as noted earlier, three carry Global Broadcast Service payloads.

Figure 5.

Projected Size and Bandwidth Capacity of Military Satellite Communications Systems





Source: Congressional Budget Office based on data from the Department of Defense.

Note: SHF = super high frequency; EHF = extremely high frequency; UHF = ultra high frequency.

tions bandwidth and the need to replace today's aging constellations. Those programs are experiencing cost growth and schedule slippage, however. For example, a comparison of current and original estimates shows that costs for the Advanced EHF program have risen by 49 percent and that costs for the Wideband Gapfiller System have increased by 42 percent. In addition, both programs' planned schedules have slipped by at least a year. CBO projects that the communications bandwidth available to DoD will decline after 2020, even if the TSAT program meets current expectations for capacity and launch schedule (see Figure 5). If existing constellations do not last as long as envisioned or new constellations experience delays in deployment, the decline in the availability of bandwidth may begin sooner.

Position, Velocity, Time, and Navigation

The Air Force's Global Positioning System constellation consists of 24 satellites that have been developed through a series of block upgrades. Currently, the Air Force is launching Block IIR-M satellites, which incorporate two new military signals and a second civilian signal. It plans to start launching Block IIF satellites, which will broadcast a third signal for civilian use, in 2007. The first Block III satellites are planned for launch in 2013; they are supposed to include improvements in features such as antijam capability and satellite cross-links for more-accurate signals.

The plans in the 2006 FYDP imply total investment spending of $12.5 billion for the GPS through 2024, CBO projects, assuming that three satellites are launched each year after 2011 and that only incremental improvements are made to the features of the Block III satellites. The average age of the GPS constellation will stabilize at about six years after 2014, CBO projects—well within the expected 10-year (or greater) lifetime of those satellites (see Figure 6).

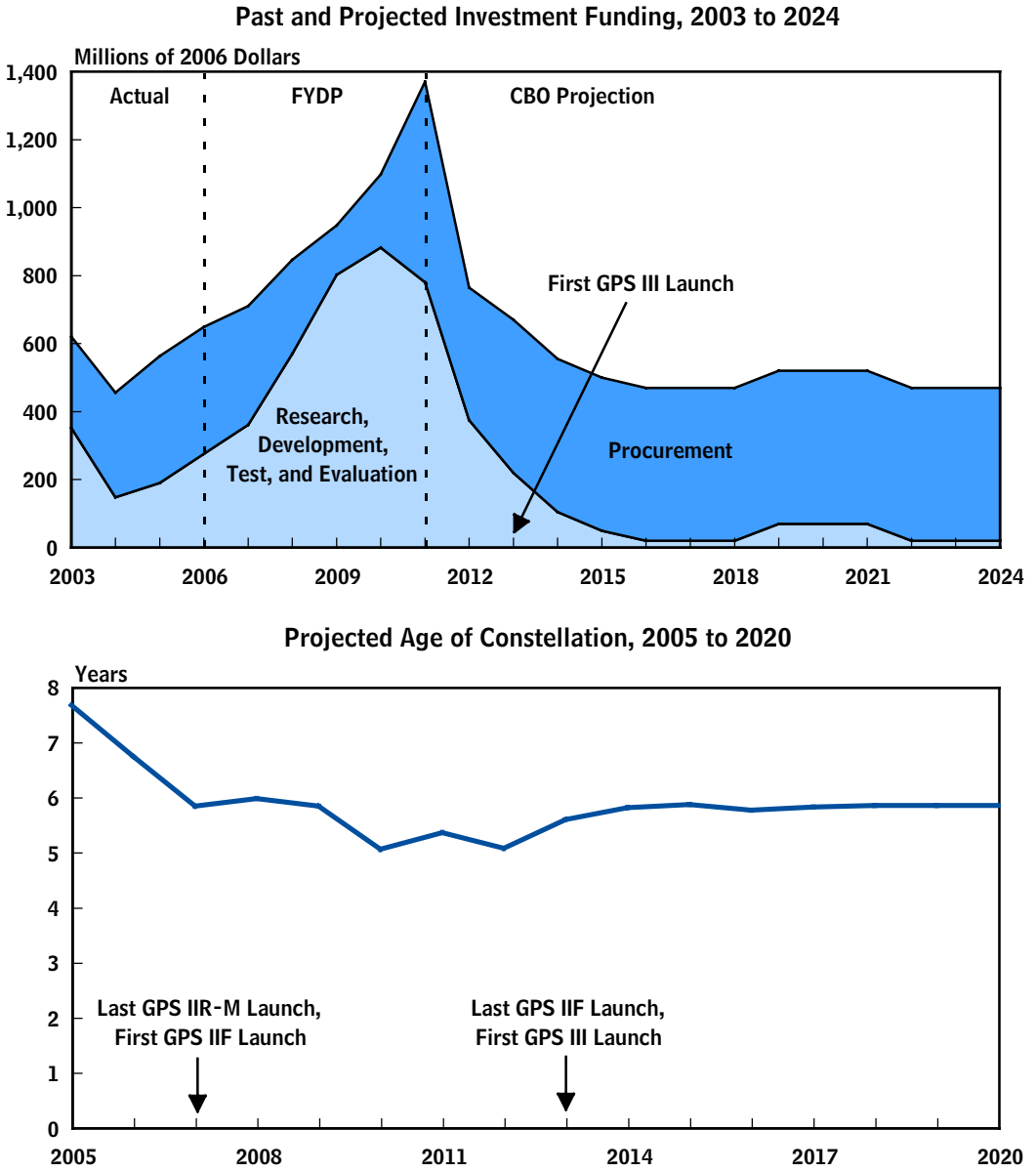
Intelligence, Surveillance, and Reconnaissance

One of the transformational efforts in the Air Force's current plans is the Space Radar program (formerly known as Space-Based Radar). As now envisioned, Space Radar would provide the capability to detect and track mobile targets in all weather conditions and would be launched beginning about 2015. Current plans call for a constellation of approximately nine satellites with synthetic aperture radar mapping and surface moving target indication capabilities, although earlier plans had envisioned constellation sizes of at least 24 satellites in order to provide near-continuous tracking capability. The 2006 FYDP and CBO's long-term projection include $19 billion through 2024 for the space segment of Space Radar (see Figure 7).[10] CBO assumed that starting in 2023, the constellation would be reconstituted or possibly increased

10. That projection uses a rough cost for Space Radar satellites of $500 million each, assuming a potential weight of about 7,000 pounds and costs of about $70,000 per pound. CBO is currently studying alternatives to Space Radar and is developing more-detailed estimates of the potential costs of those satellites. The more-detailed estimates may be higher or lower than the rough estimate used here.

Figure 6.

Investment in and Age of the Global Positioning System



Source: Congressional Budget Office based on data from the Department of Defense.

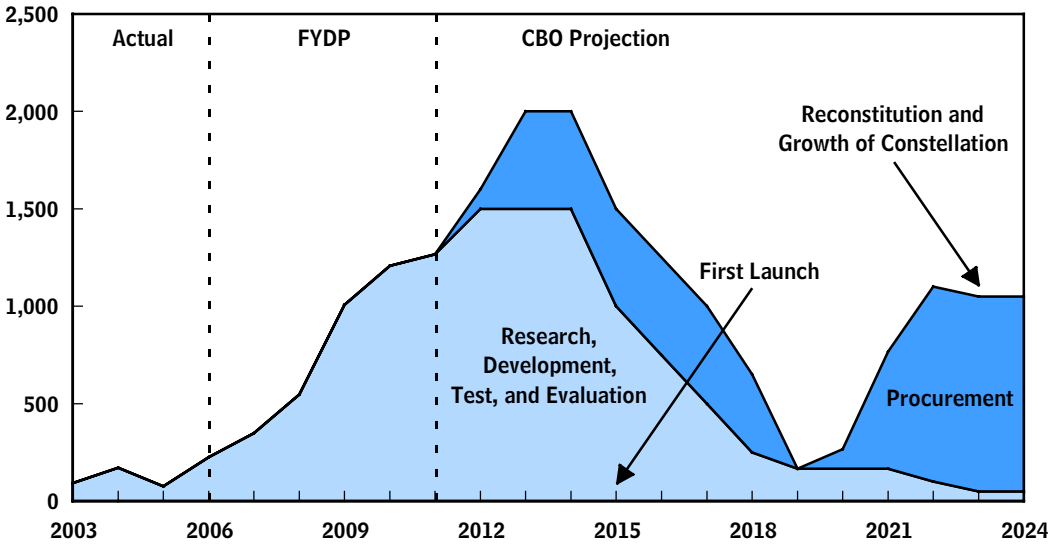
Notes: FYDP = 2006 Future Years Defense Program; GPS = Global Positioning System.

Investment funding excludes funding for user equipment.

Figure 7.

Investment in the Space Radar Program

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Notes: FYDP = 2006 Future Years Defense Program.

Excludes funding for the ground segment of the program.

in size. Recent reports indicate that DoD estimates total life-cycle costs for a nine-satellite Space Radar constellation (including the ground segment) at $34 billion.[11]

Missile Warning

Currently, the Air Force maintains a constellation of geostationary satellites, called the Defense Support Program (DSP), to provide warning of ballistic missile launches and some assessment of the nature of the associated attack (such as a missile's intended target). The most recent launch of a DSP satellite occurred in 2004, and the last DSP satellite will be put into orbit in calendar year 2006.

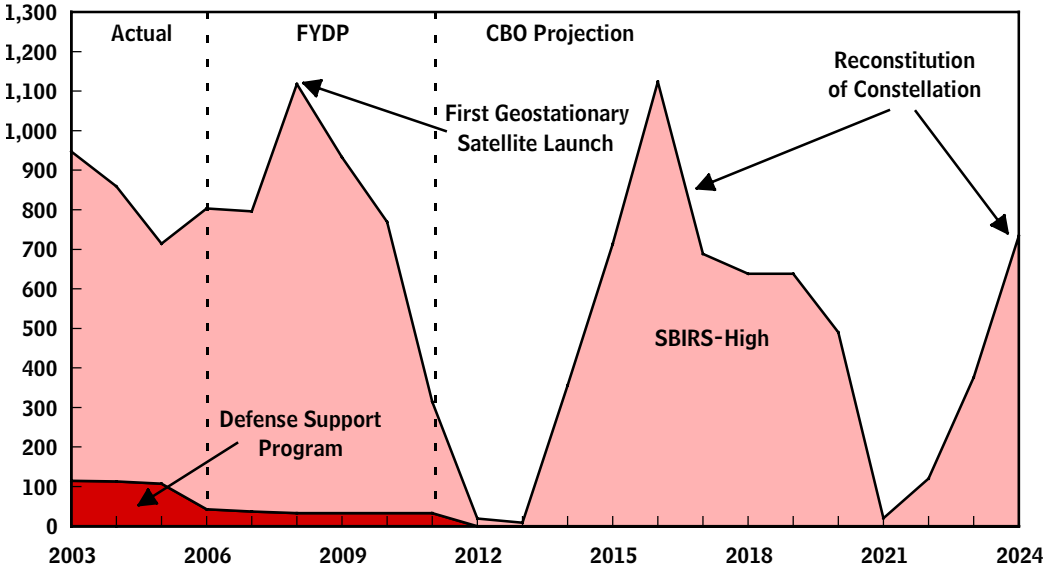
The successor to the Defense Support Program is the SBIRS-High program, which is intended to provide better detection and assessment capabilities. SBIRS-High consists of five satellites in geostationary orbits as well as two sensor payloads carried on other satellites in highly elliptical orbits. Initial launch of the geostationary satellites is planned for 2008, although the program is facing significant cost growth. Its total cost

11. That figure, which includes acquisition costs and 12 years of operating costs in 2004 dollars, is based on estimates by the Office of the Secretary of Defense's Cost Analysis Improvement Group, as cited in House Committee on Appropriations, *Department of Defense Appropriations Bill, 2005*, report to accompany H.R. 4613, Report 108-553 (June 18, 2004).

Figure 8.

Investment in Missile-Warning Satellites

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Note: FYDP = 2006 Future Years Defense Program; SBIRS-High = Space-Based Infrared System in high-Earth orbit.

jumped by 150 percent between 1996 and 2004, and the program has experienced three Nunn-McCurdy Act breaches.[12]

Under the 2006 FYDP and CBO's projection of its implications, investment spending for DSP and SBIRS-High would total about $11 billion through 2024, including costs to reconstitute SBIRS-High (see Figure 8). The age of the DSP constellation and its projected life expectancy are such that only a significant slippage in the schedule for SBIRS-High would reduce DoD's current missile-warning capabilities.

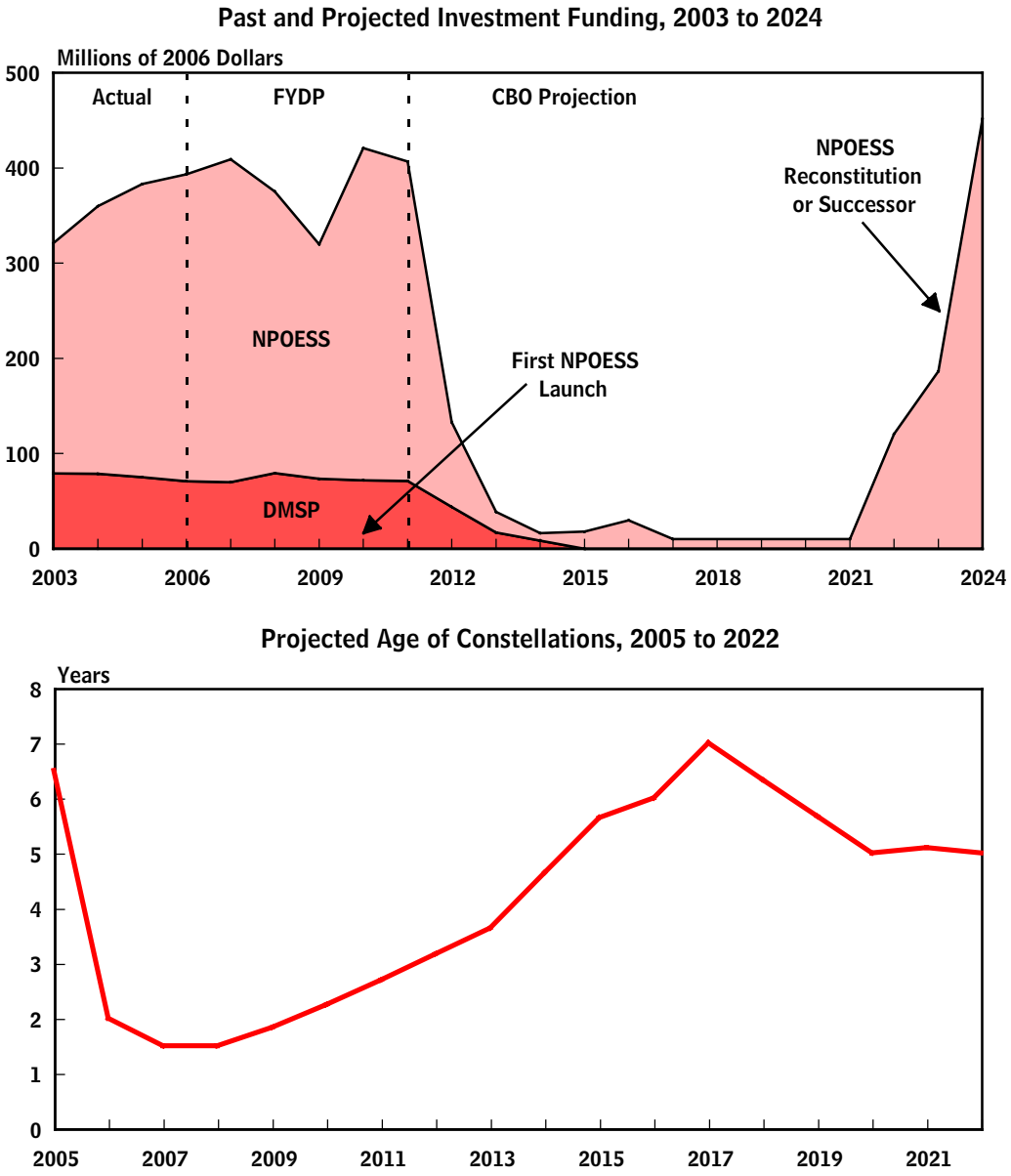
Environmental Monitoring

DoD has access to five environmental monitoring satellites (commonly called weather satellites) at present—three that are part of the Defense Meteorological Satellite Pro-

12. General Accounting Office, *Defense Acquisitions: Assessments of Selected Major Weapons Programs,* GAO-05-301 (March 2005). Under the Nunn-McCurdy Act (10 U.S.C. 2433), the Congress must be notified when a major defense acquisition program experiences a cost increase of at least 15 percent. If the increase is 25 percent or more, the Secretary of Defense must certify to the Congress that the program is essential to national security and adequately managed, that no feasible alternatives exist, and that the new cost estimates are reasonable; otherwise, funding for the program may be suspended.

Figure 9.

Investment in and Age of Weather Satellites



Source: Congressional Budget Office based on data from the Department of Defense.

Note: FYDP = 2006 Future Years Defense Program; NPOESS = National Polar-Orbiting Operational Environmental Satellite System; DMSP = Defense Meteorological Satellite Program.

gram (DMSP) plus two from the U.S. Polar-Orbiting Operational Environmental Satellite program. Beginning about 2015, those systems will be replaced by three satellites of the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) and one European Meteorological Operational Satellite.

Carrying out the plans in the 2006 FYDP would require a total of $3.4 billion in investment funding through 2024 for the DMSP and NPOESS programs, CBO projects. Under current plans, four DMSP satellites remain to be launched, with the last launch planned for no earlier than 2012. The NPOESS program is buying six satellites, the first of which is scheduled to be launched in 2010, with funding split equally between the Air Force and the Department of Commerce. A number of sensors for those satellites have experienced development problems, however, which have significantly affected the program's cost and schedule. DoD now projects a cost overrun of more than $500 million (in then-year dollars) over the life of the program, and a mission to test-fly three high-risk NPOESS sensors has been delayed by 18 months.

If current plans are carried out, the average age of DoD's weather satellites will peak at seven years in 2017 (see Figure 9 on page 13). NPOESS satellites are intended to last longer than DMSP satellites, which had a design life of three years, although they have exceeded that span. (The oldest operational DMSP satellite was launched 10 years ago.)

Space Launch

Space-launch systems include the Evolved Expendable Launch Vehicle (EELV), which DoD uses to put most of its satellites into orbit, and the new Operationally Responsive Spacelift (ORS) program, which is trying to develop launchers capable of rapidly placing payloads into orbit. The EELV program currently uses two types of launchers: Delta IV and Atlas V rockets. Both types can carry medium-sized payloads (about 10 to 15 metric tons), but only the Delta IV family now includes an operational heavy-lift variant for putting larger payloads (up to about 25 metric tons) into low-Earth orbit. The ORS program is seeking to develop a launch vehicle for relatively small payloads. Given the lack of well-defined goals for the program, CBO assumed in its projection that ORS would consist only of continuing research and development.

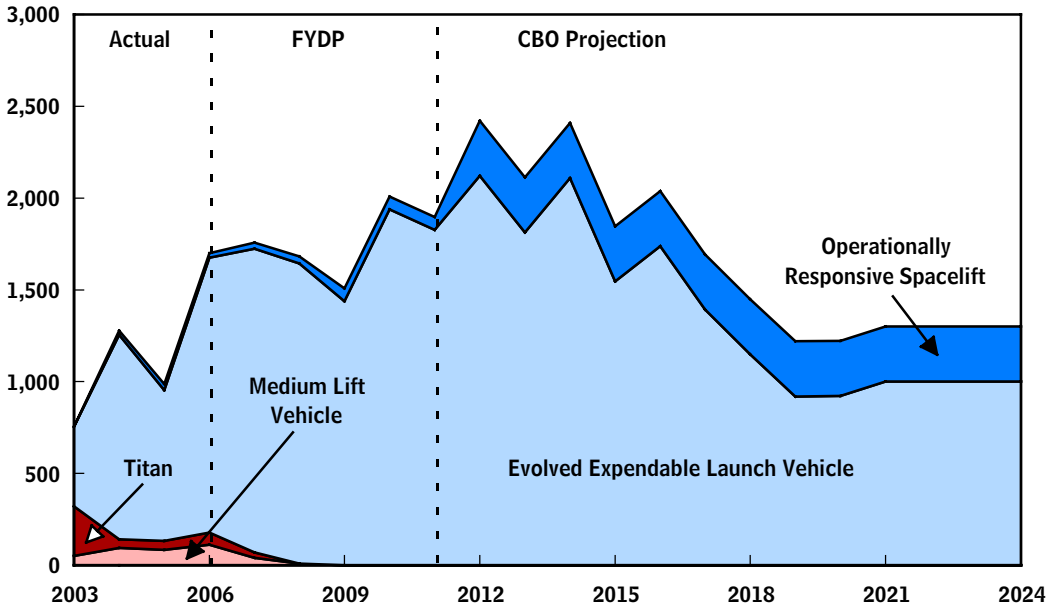
The plans in the 2006 FYDP imply total funding needs of about $28 billion for the EELV program through 2024, CBO projects (see Figure 10). Judging from the launch requirements of the various satellite constellations discussed earlier in this report, CBO projects that an average of six to seven EELV launches will be needed each year through 2024 (see Figure 11).[13] CBO assumed that beyond 2018, at least five EELV

13. That projected launch schedule excludes classified launches by the National Reconnaissance Office as well as any satellite constellations that may be launched by the Missile Defense Agency. MDA is considering a Space Tracking and Surveillance System constellation that would consist of six to nine satellites for tracking missile launches, with a first launch in about 2012. The agency is also considering a space-based constellation of boost-phase interceptors for missile defense for the 2015-2020 time frame; that constellation could consist of more than 100 satellites.

Figure 10.

Investment in Space Launch Vehicles

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Notes: FYDP = 2006 Future Years Defense Program.

CBO's projection assumes that five Evolved Expendable Launch Vehicles are purchased each year and that the Operationally Responsive Spacelift program does not reach the procurement stage until after 2024.

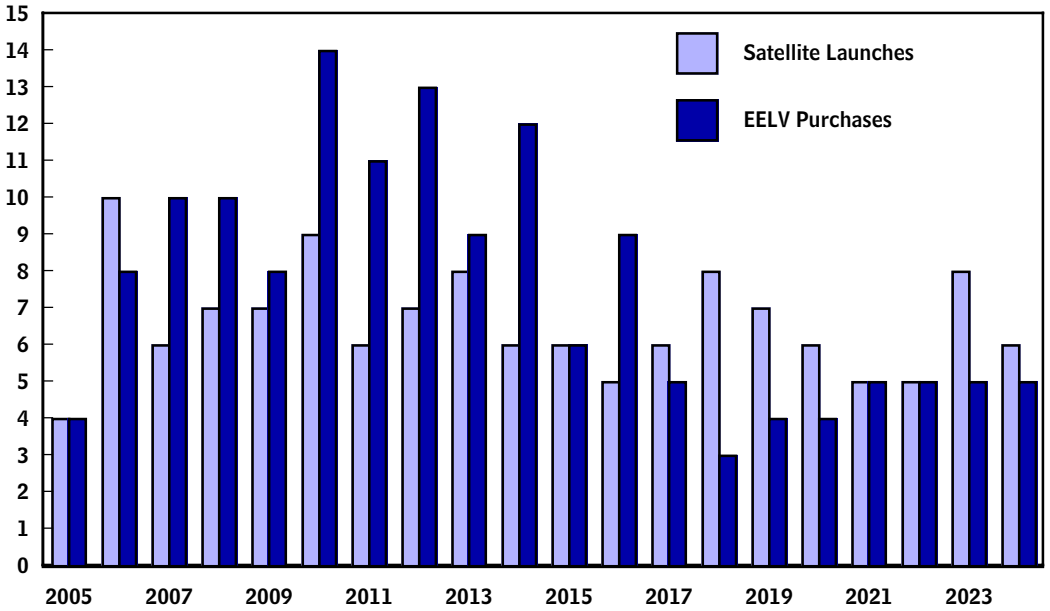
launches per year would be funded. The 2006 FYDP also envisions several more years' worth of funding for two older launch programs that are winding down: the Titan and Medium Launch Vehicle (Delta II) programs.

Other Programs

DoD's other major plans for investment in unclassified space programs relate to the areas of space control, force application, and space support other than launches. Unclassified space-control programs focus on developing ground- and space-based sensors to enhance situational awareness in space and on improving capabilities to protect U.S. space assets from enemy attack. Such programs include Spacetrack, which is developing radar and optical sensors (such as the Optical Deep Space Imager), and the Space-Based Surveillance System and other ground systems, which are designed to track objects in space. Other space-control programs—such as the Rapid Attack Identification, Detection, and Reporting System and the Counter Communications System—focus on developing technology to disrupt, deny, degrade, or destroy an enemy's space systems. Under the 2006 FYDP, RDT&E funding for space-

Figure 11.

Projected Launch Manifest for the Evolved Expendable Launch Vehicle



Source: Congressional Budget Office based on data from the Department of Defense.

Note: CBO projects that a total of 132 military satellites will be launched over the 2005-2024 period (excluding launches by the National Reconnaissance Office and the Missile Defense Agency) and that a total of 150 Evolved Expendable Launch Vehicles will be bought during that period.

control programs would increase from $195 million in 2006 to $768 million in 2011. CBO's long-term projection assumes a constant level of funding for those activities through 2024.

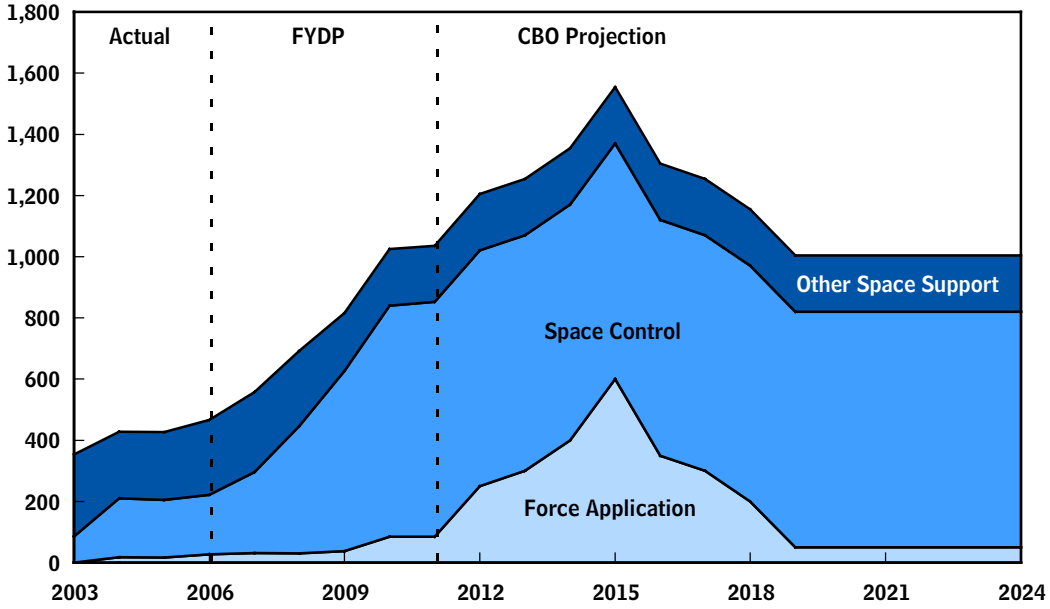
Force-application programs include an initiative to develop the Common Aero Vehicle (CAV)—a conventional warhead that would be launched from an intercontinental ballistic missile (ICBM) or ultimately from an orbiting space platform—as part of the Force Application and Launch from Continental United States (or FALCON) program being run jointly by the Air Force and the Defense Advanced Research Projects Agency. The 2006 FYDP envisions total funding of less than $100 million per year for those programs through 2011. CBO's projection assumes the limited deployment of 40 CAV-equipped ICBMs in about 2015, at which point the demand for investment resources would peak at $600 million (see Figure 12).

In the category of space support, satellite-control programs provide global communications systems to control satellites (the Air Force's Satellite Control Network is one example), and launch-range programs focus on improving infrastructure at DoD's

Figure 12.

Investment in Other Major Unclassified Military Space Programs

(Millions of 2006 dollars)



Source: Congressional Budget Office based on data from the Department of Defense.

Notes: FYDP = 2006 Future Years Defense Program.

Other space support excludes investment in space launch vehicles, which is shown in Figure 10.

two launch sites, the Eastern Range at Cape Canaveral Air Force Station and the Western Range at Vandenberg Air Force Base. Under the 2006 FYDP and CBO's long-term projection, annual investment funding for those activities would average about $180 million through 2024. Part of those resources would go toward modernizing the Launch and Test Range System, which provides tracking, telemetry, flight safety, and other support for space launches and ballistic missile tests.