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Subcommittee, Committee on Armed
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SPACE ACQUISITIONS

Stronger Development
Practices and Investment
Planning Needed to Address
Continuing Problems

Statement of Robert E. Levin, Director,
Acquisition and Sourcing Management





Highlights of [GAO-05-891T](#), a report to Strategic Forces Subcommittee of the Committee on Armed Services, U.S. House of Representatives

Why GAO Did This Study

GAO was asked to testify on problems relating to the Department of Defense's (DOD) space system acquisitions. In doing so, we drew on our previous reports related to the causes of acquisition problems, underlying incentives and pressures, and potential solutions.

What GAO Recommends

DOD has attempted to address its problems in space system acquisitions. However, our reports have recommended that DOD adopt practices that would:

- Separate technology development from an acquisition program;
- Employ evolutionary approaches that pursue incremental increases in capability; and
- Guide program start decisions with investment strategies that identify (1) overall capabilities and how to achieve them, that is, what role space will play versus other air-, sea-, and land-based assets and (2) priorities for funding.

www.gao.gov/cgi-bin/getrpt?GAO-05-891T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Robert E. Levin at (202) 512-4841 or levinr@gao.gov.

DOD SPACE ACQUISITIONS

Stronger Development Practices and Investment Planning Needed to Address Continuing Problems

What GAO Found

Our work on the acquisition of space-based capabilities over the last several years has been conducted on two levels. First, we have reviewed most of the major space system acquisitions to determine their status at different points in time. The results are discouraging—systems cost more and take much longer to acquire than promised when initially approved. In some cases, the justification or business case for the system when initially approved is far different from the current status, so DOD has had to re-assess the need to acquire that particular system and the soundness of its acquisition strategy.

Second, we have analyzed the common and causal factors for these poor acquisition outcomes. Overall, we have found that DOD has been unable to match resources (technology, time, money) to requirements before beginning individual programs, setting the stage for technical and other problems, which lead to cost and schedule increases. Specifically:

- Requirements for what the satellite needed to do and how well it must perform are not adequately defined at the beginning of a program or are changed significantly once the program has begun.
- Technologies are not mature enough to be included in product development.
- Cost estimates are unreliable—largely because requirements have not been fully defined and because programs start with many unknowns about technologies.

We also have reported on cross-cutting factors that make it more difficult for DOD to achieve a match between resources and requirements for space acquisitions. These include: a diverse array of organizations with competing interests; a desire to satisfy all requirements in a single step, regardless of the design or technology challenge; and a tendency for acquisition programs to take on technology development that should occur within the S&T environment. On a broader scale, DOD starts more programs than it can afford in the long run, forcing programs to underestimate costs and over promise capability. As a result, there is pressure to suppress bad news about programs, which could endanger funding and support, as well as to skip testing because of its high cost.

One key to success is closing the gaps between available technologies and customer needs before beginning an acquisition program. This puts programs in a better position to succeed because they can focus on design, system integration, and manufacturing. DOD has recently revised its space acquisition policy, in part to attain more knowledge about technologies before starting an acquisition program. However, we remain concerned that the policy still allows programs to begin before demonstrating technologies in an operational or simulated environment.

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss DOD's efforts to acquire space-based capabilities. In fiscal year 2006 alone, DOD plans to spend almost \$20 billion to develop and procure satellites and other space systems. Our work on the acquisition of space-based capabilities over the last several years has been conducted on two levels. First, we have reviewed most of the major space system acquisitions to determine their status at different points in time. The results are discouraging—systems cost more and take much longer to acquire than promised when initially approved. In some cases, the justification or business case for the system when initially approved is far different from the current status, so DOD has had to reassess the need to acquire that particular system and the soundness of its acquisition strategy. Second, we have analyzed space system acquisitions to identify the common and causal factors for these poor outcomes. Overall, we have found that DOD has been unable to match resources (technology, time, and money) to requirements before beginning individual programs, setting the stage for technical and other problems, which lead to cost and schedule increases. Moreover, on a broader scale, DOD starts more programs than it can afford, creating a set of incentives and pressures that invariably have negative effects on individual programs and the larger investment portfolio. Our recommendations have been focused on getting modifications to the space acquisition policy to ensure that decisions are more knowledge-based and holding decision makers accountable. Here the results are mixed. We have seen some positive changes to the policy, such as a greater emphasis on attaining knowledge about technologies, but we remain concerned that the policy still allows programs to begin before those technologies are actually demonstrated in an operational or simulated environment.

My testimony today describes the condition we have found in our system-focused reviews and lays out the problems across systems and the changes that need to be made if DOD is to break the cycle of acquisition problems. Let me start by recognizing that developing satellites is a very complex task and one which does differ from other military systems. However, we have not been convinced that those differences merit distinction in how system development and production are approached. Nor should those differences ever excuse the Department from achieving the outcomes it promises when requesting and receiving funding.

Problems Affecting Space System Acquisitions Persist

For decades, space acquisition programs have been encountering large cost increases and schedule delays. As a result, DOD has been unable to deliver capabilities as promised. This past year alone, for example, costs have continued to climb on the Space Based Infrared System High (SBIRS-High) program—triggering another Nunn-McCurdy¹ review and certification of the program and pushing DOD’s investment in this critical missile warning system to over \$9.9 billion, from the initial \$3.9 billion estimate made 9 years ago. At the same time, programs focused on developing new communications satellites are facing cost increases and schedule delays, the National Polar-orbiting Operational Environmental Satellite System has been restructured and is facing cost increases and schedule delays, and unit cost increases for launch vehicles have now increased by 81 percent since 2002 due to erroneous assumptions about the commercial launch market upon which the program’s business case was based.

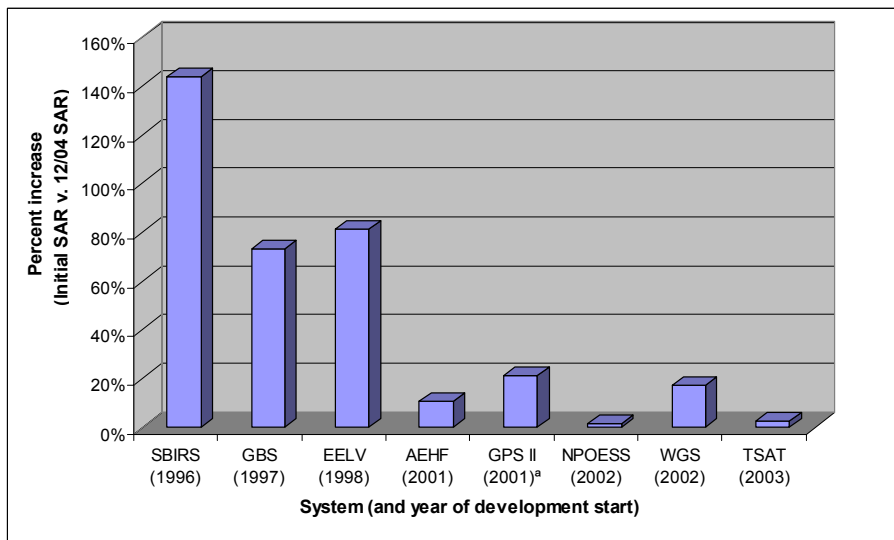
Taken together, these problems have had a dramatic impact on DOD’s overall space portfolio. DOD has had to shift scarce resources to poorly performing programs and has pushed off starting a new version of the Global Positioning System (forcing costs to increase for the current version under development). Cost increases have also kept DOD from investing more in science and technology efforts that support space. We reported recently, for example, that funding for testing of space technologies has declined in recent years. It is also important to note that, for some programs, DOD is spending considerable sums of money—in addition to what was planned or long after it had originally anticipated—thus posing additional pressures on its overall investment portfolio. DOD originally planned to complete expenditures for SBIRS-High in fiscal year 2006, for example, but currently it plans to spend about \$3.4 billion in fiscal years 2007 through 2013.

At the same time DOD is facing these problems, it is attempting to undertake new efforts—including the Transformational Satellite Communications System (TSAT) program and Space Radar program—which are expected to be among the most expensive and complex ever, and which DOD is heavily relying on in its efforts to fundamentally transform how military operations are conducted. In fact, many other weapon systems will be interfaced with these satellites and highly dependent on them for their own success.

¹ 10 U.S.C § 2433.

Figure 1 shows the percent increase in total cost from the initial estimate to its most recent, for current major space system acquisitions. Systems that have incurred particularly significant cost increases include the SBIRS-High and the Global Broadcasting System. In addition, relatively newer programs such as the Evolved Expendable Launch Vehicle (EELV), Advanced Extremely High Frequency (AEHF) satellite and the Wideband Gapfiller communication satellites have also been experiencing cost increases. In general, the longer a system has been in development, the greater the amount of its cost growth. In addition, nearly all of the programs have also experienced significant schedule delays as well.

Figure 1: Percent Increase in Program Cost from Initial Estimate to the Current Estimate (for major space system acquisitions underway)

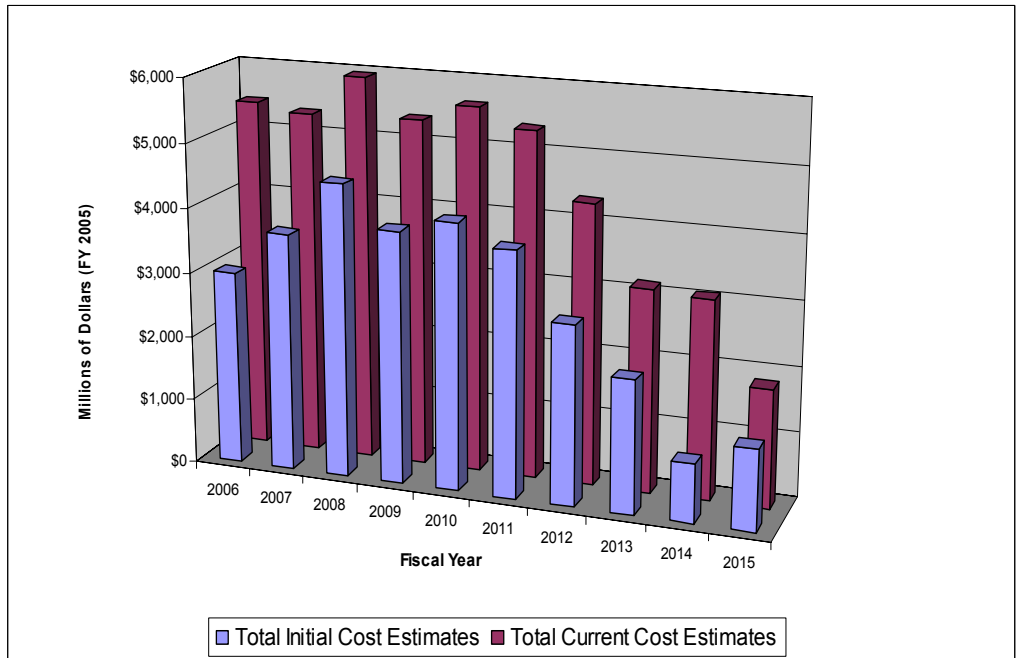


Source: Department of Defense's Selected Acquisition Reports.

*GPS II Modernization Program.

As figure 2 illustrates, there is a vast difference between DOD's budgeting plans and the reality of the cost of its space systems. Over the next 10 years, space systems, each year, on average, will cost DOD in excess of \$1.5 billion more than it had originally planned. Moreover, the sum of the percentage cost increases represents an additional \$20 billion over the combined lives of the programs above. This means there is \$1.5 billion less that DOD has to spend on other priorities annually and tens of billions less available for DOD's overall weapons portfolio over time. It is not clear how DOD's budget will accommodate these additional costs.

Figure 2: Comparison between Original Cost Estimates and Current Cost Estimates for Major Space Systems Acquisitions Underway



Source: Department of Defense's Selected Acquisition Reports.

In Table 1 below, we highlight recent findings from our reports. As the table notes, many programs are still addressing past mistakes in acquisition approaches and contractor oversight as well as technical, design, and manufacturing problems.

Table 1: Highlights of Recent Findings

Program	Recent Findings
Advanced Extremely High Frequency Satellites (AEHF)	Unit cost has increased by more than 50 percent. In 2004, the program experienced cost increases of more than 15 percent, which required a Nunn-McCurdy notification to Congress. Schedule slippages for launching this communication system have now stretched to over 3 years. Our reports have attributed cost increases most recently to production problems and changing security requirements. Earlier cost increases were attributed, in part, to a rush to start the program, changing requirements, and a lack of funding to support an overly optimistic schedule.
Evolved Expendable Launch Vehicle (EELV)	Unit cost increases (for launch vehicles) have increased by 81 percent. In 2004, this program experienced cost increases of more than 25 percent, which triggered statutory requirements to reassess and recertify the program. Our reports have found that a chief reason for cost increases is a decline in the commercial launch market upon which the program's business case was based as well as a reduction in anticipated launches. Recently, the two primary contractors—Boeing Launch Services, Inc. and Lockheed Martin Space Systems Company—agreed to form a joint venture to combine production, engineering, test, and launch operations for U.S. government launches. It is argued that this will help reduce costs while enabling the government to retain two launch systems.
Mobile User Objective System (MUOS)	This is a relatively new effort: No significant cost increases or schedule delays are reported. However, we reported this year that early procurement of long lead items before achieving a stable design for this Navy communications system could lead to cost increases and the program's development schedule remains compressed—posing risks should software development or other technical or design problems be encountered.
Navstar Global Positioning System II (GPS II)	Total costs of the GPS II modernization program have increased by over 20 percent. This is largely due to DOD's decision to delay the start of the follow-on GPS III program. Specifically, the delay will require DOD to buy additional GPS IIF satellites—so far at least 7 more than the program had planned. The launch of the first IIR-M satellite has been delayed at least 7 months due to production problems.
National Polar-orbiting Operational Environmental Satellite System (NPOESS)	Costs have increased by roughly 10 percent due to changes to the contract, increased program management costs, and increased funds needed to mitigate risks. The program office reported that the increases include costs associated with extending the development schedule and increased sensor costs.

Program	Recent Findings
Space Based Infrared System High (SBIRS-High)	This missile warning program has experienced schedule slips of at least 6 years and cost increases that have triggered legislative requirements to reassess and recertify the program several times—most recently this spring. While DOD’s total program cost estimate was about \$3.9 billion, it is now \$9.9 billion—nearly a 150 percent unit cost increase. Our reviews have attributed past problems to an acquisition approach that decreased oversight of contractors, technology challenges, and software development problems. DOD is currently reexamining this program, potential alternatives, and cost estimates.
Space Tracking and Surveillance System (STSS)	This is a relatively new effort: No major reported cost increases or schedule delays. The initial increment of this program, which started in 2002, is composed of two demonstration satellites that were built under the previous Space Based Infrared System-Low (SBIRS-Low) program. SBIRS-Low had incurred cost increases and schedule delays and other problems that were so severe, DOD abandoned the effort. The STSS program has experienced system quality and system engineering problems with the payload, however, the program office still expects early delivery and launch of the satellites.
Space Radar	This is a relatively new effort with no reported cost increases or schedule delays. We reported last year that DOD was not on a path that would enable it to accumulate knowledge and had not formalized agreement on requirements needed to start this technically complex and potentially very costly effort. Congress directed DOD to keep space radar efforts in technology development so that it would accumulate critical knowledge. In January 2005, DOD restructured this effort, focusing on developing smaller, demonstrator satellites, strengthening its partnership with the intelligence community, and revising its acquisition strategy.
Transformational Satellite Communications System (TSAT)	This is a relatively new effort focused on developing much more robust communication satellites. It entered the formal acquisition phase in 2004 with only one of seven critical technologies mature. Due to concerns about the risks such an approach poses, Congress reduced funds and directed that the program focus on technology development before proceeding further with acquisition activities. Although the program started the acquisition program and established its acquisition program baseline with immature critical technologies, the program director told us that the system development contract will not be awarded until critical technologies are mature.

Program	Recent Findings
Wideband Gapfiller Satellites (WGS)	Costs have increased since 2000 and DOD now anticipates buying two additional satellites. The launch of the first satellite has been delayed by almost 2 years. This program involves the purchase of commercial communications satellites for DOD purposes. However, we reported that the program encountered design, integration, and manufacturing problems due largely to the fact that the program was not able to leverage expertise from the commercial sector. This was because there was less than anticipated demand for the commercial satellite. Conflicts in scheduling for the launch pad also contributed to the schedule delay.

Source: GAO analysis of DOD data and previous GAO reports.

Causes of Space System Acquisition Problems

We have analyzed the range of space-based acquisitions over the last several years to identify the common and causal factors for these poor acquisition outcomes. Overall, we have found that DOD has been unable to match resources (technology, time, and money) to requirements before beginning individual programs, setting the stage for technical and other problems, which lead to cost and schedule increases. Moreover, on a broader scale, DOD starts more programs than it can afford, creating a set of incentives and pressures that invariably have negative effects on individual programs and the larger investment portfolio.

Match Between Resources and Requirements Seldom Achieved at the Start of Acquisition Program

Our past work has shown that space programs have typically not achieved a match between requirements and resources at program start. In other words, the programs did not have the level of knowledge needed to assure that they could be completed within expected cost and schedule estimates.

Specifically:

- Requirements for what the satellite needed to do and how well it must perform are not adequately defined at the beginning of a program or are changed significantly once the program has begun.
- Technologies are not mature enough to be included in product development.

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- Cost estimates are unreliable—largely because requirements have not been fully defined and because programs start with many unknowns about technologies.

There are a range of other resource gaps that DOD faces when it begins new space acquisitions. For example, we have reported on deficiencies within the space acquisition workforce, contracting strategies that support acquisitions, contractor capabilities, as well as funding available for testing of space technologies. Nevertheless, unstable requirements and immature technologies are the most significant contributors to cost and schedule increases, and not just for space acquisitions but all DOD weapons acquisitions.

We also have reported on cross-cutting factors that make it more difficult for DOD to achieve a match between resources and requirements for space acquisitions. First, space systems may suffer from more requirements pressures than other weapon systems because there is usually a very broad constituency—contractors, military services, civilian users, administrations, and Congress—behind each satellite program. This creates challenges in making tough tradeoff decisions. The Global Positioning System, for example, not only serves military users but also serves civilians, supports various key economic sectors such as transportation and communications, and is used by allies. As a result, when starting these new systems, space program managers can expect to be inundated with competing demands—not just among military users—but also among civilian and industry users.

Second, space acquisition programs have historically attempted to satisfy all requirements in a single step, regardless of the design challenge or the maturity of technologies to achieve the full capability. There is a variety of reasons for this, including a desire to include the most advanced technologies onboard satellites, particularly in view of the length of time it takes to develop space systems. However, this approach invariably increases the technology challenges facing programs, and thus, the risk that costly problems will be encountered.

Third, there is a tendency among space system acquisition programs to take on technology development that should occur within the science and technology (S&T) environment. Reasons for this include the greater ability to secure funding for costly technology development within an acquisition program versus a science and technology program, a belief among the acquisition community that labs in charge of developing space technologies do not adequately understand their needs, as well as

communication gaps between the S&T and acquisition communities. Nevertheless, our work has continually shown that allowing technology development to carry over into product development increases the risk that significant problems will be discovered late in development. Addressing such problems may require more time, money, and effort to fix because they may require more extensive retrofitting and redesign as well as testing. Moreover, when there are many unknowns about critical technologies, a program cannot reliably estimate what resources will be needed to complete a program—leaving DOD and the Congress in a position of committing to large investments without knowing how much they will truly cost or how long it will actually take for capabilities to be delivered.

DOD Starts More Programs than It Can Afford in the Long Run

There is a widespread belief among DOD and other officials involved with space programs that DOD starts more programs than it can afford in the long run, forcing programs to underestimate costs and over-promise capability and creating a host of negative incentives and pressures. Specifically, officials we have spoken with cited the following.

- Because programs are funded annually and priorities have not been established, competition for funding continues over time, forcing programs to view success as the ability to secure the next installment rather than the end goal of delivering capabilities when and as promised.
- Concurrently, when faced with lower budgets, senior executives within the Office of the Secretary of Defense and the Air Force would rather make across-the-board cuts to all space programs than hard decisions as to which ones to keep and which ones to cancel or cut back.
- Having to continually “sell” a program creates incentives to suppress bad news about a program’s status and avoid activities that uncover bad news.
- When combined with the high cost of launching demonstrators into space, the competition for funding often encourages programs to avoid testing technologies in space before acquisition programs are started.

Our previous reports have found that these pressures are long-standing and common to weapon acquisitions, not just space acquisitions. The competition within DOD to win funding and get approval to start a new program is intense, creating strong incentives to make a weapon system stand out from existing or alternative systems. Moreover, overall DOD funding constraints put a high priority on appearing affordable, making it

important for program sponsors to provide cost estimates that will fit within the funding constraints. Instead of forcing trade-offs, challenging performance requirements—when coupled with other constraints, such as cost or the weight of the satellite—can drive product developers to pursue exotic solutions and technologies that, in theory, can do it all.

Keys to Overcoming Space Acquisition Problems

Our work has shown that fundamental changes are necessary to stem cost and schedule increases and enable DOD to field new capabilities more efficiently and effectively. The following actions, in particular, would assure that DOD can match resources to requirements before its starts new programs and that it has an investment strategy in place that would prevent it from starting more programs than it can afford.

Specifically, to better match resources to requirements, DOD should do the following.

- Implement processes and policies that stabilize requirements. Our reports over the years as well as many DOD studies have pointed to a need to stabilize requirements for all weapons system development. In response, the Office of the Secretary of Defense has taken steps to strengthen requirements setting department-wide, principally by establishing its new Joint Capabilities Integration and Development System (JCIDS). JCIDS is focused on achieving greater across-the-board agreement up front on what capabilities need to be achieved and how they are to be achieved. Because this system is relatively new, it is too early to determine whether it is addressing requirements setting problems within DOD. The Air Force has also taken measures to strengthen requirements setting for key systems such as SBIRS-High and Space Radar, including instituting high-level boards to approve of new requirements and processes that ensure the right officials are involved. However, we reported on Space Radar in July 2004 that even these changes were not ensuring that the intelligence community—a major stakeholder in Space Radar—was in agreement with requirements and that all stakeholders would be held accountable for their agreements. DOD is now working on strengthening its partnership within the Space Radar program to avoid this problem.
- Separate technology development from acquisition. We have previously reported that DOD’s practice of taking on technology development concurrently with product development stands in sharp contrast to that followed by successful programs and the approach recommended by DOD’s acquisition policy for weapon systems. Successful programs will not commit to undertaking product development unless they have a high confidence that they have achieved a match between what the customer

wants and what the program can deliver. Technologies that are not mature continue to be developed in an environment that is focused solely on technology development. Another key to success is employing the technique of systems engineering to close the gaps between available technologies and customer needs before committing to new product development. This puts programs in a better position to succeed because they can focus on design, system integration, and manufacturing. DOD has made some efforts to address this problem. For example, it has recently revised its space acquisition policy, in part to encourage programs to attain more knowledge about technologies before starting. It has developed a strategy for space S&T to help strengthen partnerships between the acquisition and S&T communities and assure they are working toward common goals. It has strengthened its systems engineering capabilities. Department-wide, DOD has expanded the authorities of its Director of Defense Research and Engineering (DDR&E) to help keep technology development out of acquisition programs and within the S&T communities. However, we remain concerned that these measures will not be sufficient. The space acquisition policy, for example, still allows programs to begin before demonstrating technologies in an operational or simulated environment. Moreover, DOD is still approving new programs like TSAT even when many of their critical technologies are still immature. In fact, in our 2005 department-wide assessment of selected major weapon programs, we found that only 15 percent of the programs we assessed began system development having demonstrated all of their technologies mature.

- Adopt an evolutionary development approach for its space systems, that is, pursue incremental increases in capability versus significant leaps. Our examinations of best practices have found that this approach can decrease time and cost for development because it closes gaps in unknowns. DOD's space acquisition policy states its preference for evolutionary development, and DOD pursued evolutionary approaches in the past with GPS. But, more often, it has attempted to achieve significant leaps in capability in one step. Moreover, DOD officials have told us that they are pursuing evolutionary development for space systems, when, in fact, they are beginning programs by challenging program managers to achieve significant leaps in capability with the intention of abandoning those efforts later in the development cycle should too many problems be encountered. This is not a true evolutionary approach, as it still leaves DOD facing increased technical challenges at the beginning of a program and thus, increased risks, and it raises expectations on the part of stakeholders who may be unwilling to accept less capability later on.

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- Address other resource shortfalls. As noted earlier, our reports have identified other resource gaps that should be addressed by DOD. For example, DOD S&T officials cited shortages of staff with science and engineering backgrounds and had more concerns about the future since their workforces were reaching retirement age. Officials who oversee programs cited deficiencies in the program manager workforce—particularly when it comes to experience and knowledge in dealing with contractors. In addition, funding for testing space technologies has decreased, cost to launch experiments have increased, and opportunities for testing have been reduced with the loss of the space shuttle, which had been partially used for DOD-related technology experiments. DOD concurred with our recommendation that it develop plans for addressing these shortages. The Congress has also called on DOD to strengthen its efforts to revitalize its space workforce, and we are undertaking a review for your committee on progress being made by the DOD.

DOD should also guide its decisions to start acquisition programs with an overall investment strategy. Our recent reports on space and other weapon systems have suggested that having a department-wide investment strategy for weapon systems would help reduce pressures facing acquisition programs. For space in particular, a strategy would help DOD rebalance its investments in acquisition programs as it continues to contend with cost increases from its programs. Moreover, it would also help DOD balance investments between S&T and acquisition. This is particularly important since DOD is undertaking a range of initiatives—collectively known as operationally responsive space—designed to facilitate evolutionary development, more testing of technologies before acquisition, and ultimately, enable DOD to deliver space-based capabilities to the warfighter much faster and cheaper.

Critical components of an investment strategy would include identifying overall capabilities and how to achieve them, that is, what role space will play versus other air-, sea-, and land-based assets; identifying priorities for funding; and implementing mechanisms that would enforce the strategy. While DOD has made revisions to its requirements-setting and budgeting processes to strengthen investment planning, it is unclear as to how these changes will be implemented over time and whether they can serve as a foundation for direction of space S&T and acquisition investments.

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In conclusion, there is no question that space acquisition programs are encountering cost increases and schedule delays that are having negative

effects—both in terms of DOD’s ability to deliver current capabilities as well as its ability to deliver future capabilities. Many of these problems are rooted in past mistakes and their impact will be felt for years to come. Nevertheless, it is exceedingly important that DOD takes whatever midcourse corrections it can and ensures it has a foundation in place that puts acquisition programs on a better path, particularly since DOD is counting on its future space programs to play an increasingly critical role in national security and military operations. At this juncture, DOD must still adopt practices that better match resources to requirements before starting its acquisition programs and decide exactly what role space will play in achieving future desired capabilities and what programs merit the highest priorities. At the same time, DOD must continue its efforts to assure it has the right resources to carry out increasingly technically challenging programs—including workforce, funds for testing, less costly and more responsive launch systems, and standardized components—and that it continue to seek ways to deliver capability much more efficiently and effectively. All of these changes will not be easy to undertake. They require significant shifts in thinking about how space systems should be developed; changes in incentives and perceptions; as well as further policy and process changes. As a result, these efforts will require strong and sustained commitment from senior executives and encouragement from the Congress.

Mr. Chairman and Members of the Subcommittee, this concludes my statement. I would be happy to respond to any questions that you or other members of the Subcommittee may have.

Scope and Methodology

In preparing for this testimony, we relied on previously issued GAO reports on assessments of individual space programs, incentives and pressures that drive space system acquisition problems, common problems affecting space system acquisitions, space science and technology, and DOD’s space acquisition policy, as well as our reports on best practices for weapon systems development. We also analyzed DOD’s Selected Acquisition Reports to assess cost increases and investment trends. We conducted our review between June 23 and July 12, 2005 in accordance with generally accepted government auditing standards.

Contacts and Acknowledgments

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