GAO
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Washington, DC 20548

August 2, 2007

The Honorable Bill Nelson
Chairman
The Honorable Jeff Sessions
Ranking Member
Subcommittee on Strategic Forces
Committee on Armed Services
United States Senate

The Honorable Ellen Tauscher
Chairwoman
The Honorable Terry Everett
Ranking Member
Subcommittee on Strategic Forces
Committee on Armed Services
House of Representatives

The Honorable Silvestre Reyes
House of Representatives

Subject: DOD is Making Progress in Adopting Best Practices for the Transformational Satellite Communications System and Space Radar but Still Faces Challenges

The Department of Defense (DOD) is working to achieve information superiority over adversaries and share information seamlessly among disparate weapons systems. Two programs envisioned as a part of this effort are Transformational Satellite Communications System (TSAT) and Space Radar. TSAT is designed to provide rapid worldwide secure communications with air and space systems—including Space Radar—through radio frequency and laser communications links. Space Radar is expected to provide global all-weather intelligence, surveillance, and reconnaissance, particularly in denied areas, for military, national intelligence, and civil users. Both TSAT and Space Radar will require major software development efforts and employ a significant number of experienced staff.

TSAT and Space Radar development efforts are expected to be among the most costly space systems ever developed by DOD. In 2004, TSAT was estimated to have a total life cycle cost of about $16 billion, of which $2.0 billion will have been spent at the end of fiscal year 2007. Space Radar is estimated to have a total life cycle cost from $20 billion to $25 billion, and the program has spent about approximately $464.5 million. TSAT expects to begin product development in fiscal year 2008, and launch the first satellite in the first quarter of fiscal year 2016. Space Radar expects to begin product development in fiscal year 2009 and launch the first satellite in third quarter of fiscal year 2016. The systems are also expected to be among the most complex ever developed, largely because of the challenges associated with integrating critical technologies within the satellites and networking the satellites to other platforms.

You requested that we assess DOD's progress in adopting best practice as both of these programs proceed toward product development. We presented our findings on TSAT and Space Radar in briefings to your staffs in March 2007. This letter summarizes our findings, conclusions, and recommendations. Copies of the briefings are enclosed.

Results in Brief

DOD is making efforts to instill best practices on TSAT and Space Radar. These practices, as GAO has identified over the past decade, are to separate technology discovery from acquisition, follow an incremental path toward meeting user needs, match resources and requirements at program start, and use quantifiable data to make decisions to move to next phases. Collectively, these practices ensure a high level of knowledge is achieved at key junctures in development and that a program does not go forward unless a strong business case on which the program was originally justified continues to hold true.

However, sustaining these efforts could prove challenging. Specifically:

- *Successful organizations we have studied ensure that technologies are mature, that is, proven to work as intended before program start.* In the past DOD has chosen to extend technology invention into the acquisition process, and as a result, programs have experienced technical problems that require large amounts of time and money to fix. By contrast, best practice organizations mature technologies to the point of being tested in a relevant or operational environment before committing to an acquisition program.

  TSAT and Space Radar have made progress in the maturation of technologies, but challenges remain. In a June 2007 update, DOD determined that six of the seven critical technologies for TSAT are at a technology readiness level (TRL) 6 (meaning the technology has been tested in a relevant environment), and the program expects to have the remaining technology at a TRL 6 prior to the preliminary design phase. Space Radar expects to have almost all critical technologies mature to a TRL 6 by program start in June 2009. However, the program currently has five critical technologies assessed to be TRL 3 to TRL 4. This signifies that DOD will need to gain significant knowledge on these technologies to gain sufficient insight into costs and schedule to be well positioned for success by program start. In addition, the program office acknowledges that some of the seven technology risks it has rated as high, including risks related to spectrum, software, and integration with space radar users, will not be fully mitigated prior to program start.

- *Successful organizations defer more ambitious technology efforts to corporate research departments (equivalent to the science and technology [S&T] organization in DOD) until they are ready to be added to future increments.* Our best practice work has shown that a technology development environment is more forgiving and less costly than a delivery-oriented acquisition program environment. Events such as test failures, new discoveries, and time spent attaining knowledge are considered normal in this environment.

  Both programs have deferred more ambitious technology development efforts to the science and technology environment. TSAT, for example, deferred the inclusion of the wide-field of view multi-access communication technology to reduce risk on the program, and is currently contributing about $16.7 million for "off-line" maturation of this technology until opportunities arise for including it as

part of future increments. In addition, it also eliminated multi-access laser communications[1] capabilities from consideration for future increments at this time due to the immaturity level of the technology. Space Radar has deferred lithium-ion batteries, more efficient solar cells, and onboard processing for its first increment, and like TSAT, is contributing toward their development by S&T organizations. At this time, Space Radar has not defined details of an increment beyond the first one.

- *Successful organizations extensively research and define requirements before program start to ensure that they are achievable, given available resources, and that they do not define requirements after starting programs.* In successful programs, negotiations and trade-offs occur before product development is started to ensure that a match exists between customer expectations and developer resources.

  Both programs have also strived to employ best practices to help identify and determine achievability of requirements. In 2006, the TSAT program was restructured into an incremental approach to control risk and increase confidence in the program schedule, putting agreements in place between development partners that organize capabilities into blocks based on technological maturity. For example, TSAT has reached agreements with groups representing the needs of users and warfighters that addresses which requirements will be included in the first and second blocks of the program. Space Radar has also developed an approach to obtain agreement and collaboration among users on program requirements. In an effort to facilitate communication and reach agreement over requirements between program partners within DOD and the Intelligence Community (IC), Space Radar has proactively introduced a variety of working groups that provide the program with a consolidated senior group of participants to validate, coordinate and integrate Space Radar requirements and concepts of operations throughout project development. Nevertheless, the Space Radar development effort has not yet had to fully define program requirements, including key performance parameters. Until all requirements are defined, vetted, and validated, the program office could still face challenges in closing potential gaps between requirements and resources.

- *Successful organizations ensure other resources—primarily funding, time, and people -- can also be matched to requirements before program start.* Funding: Both programs face long-term challenges for funding. As DOD seeks to fund Space Radar and TSAT, it will be (1) undertaking other new, costly efforts, including the Global Positioning System III, the Space Based Surveillance System, and the Alternative Infrared Satellite System; (2) addressing cost overruns associated with legacy programs; and (3) facing increased pressures to ramp up investments in assets designed to protect space systems. In total, these efforts will increase DOD's investment for all major space acquisitions from $6.31 billion to $9.22 billion, or about 46 percent over the next 3 years. More may be needed if technical, software, and other problems on current programs worsen. At the same time, investment needs for other weapon systems are also on the rise, while long-term budget forecasts indicate that considerably fewer dollars will be available for discretionary spending in coming years rather than more. Funding for Space Radar is further complicated by the lack of long-term funding agreements beyond fiscal year 2013, adding uncertainty to DOD's and the intelligence community's ability to afford expensive programs such as Space Radar. To its credit, Space Radar has worked to establish a key funding agreement between DOD and the intelligence community that addresses short-term cost sharing responsibilities. In prior reports, we have stated that as long as too many programs compete for too few dollars in DOD, programs will be incentivized to produce optimistic estimates and suppress bad news. They will view success as securing the next installment of funds versus

[1] Multi-access laser communications technology is to provide simultaneous communications for a number of optical users at very high data rates.

delivering capability within cost and schedule goals. We have recommended that DOD guide its decisions to start space and other weapons acquisition programs with an overall investment strategy that would identify priorities for funding so that space systems that are expected to play a critical role in transformation, such as Space Radar and TSAT, could be priorities along with other legacy and transformational systems. To date, this has not been done for space or for DOD's broader weapons portfolio.

Schedule: Schedules for both programs may also be optimistic. The TSAT program may have underestimated the time for design, integration, and production activities. For example, TSAT embarked on a major software development effort in January 2006 that would build the overall network architecture and provide network management capabilities for TSAT and Advanced Extremely High Frequency satellites, but DOD's Program Analysis & Evaluation office has expressed concern about the overall complexity of the program and the ability of the contractors to write enough software code in one year as is necessary for the program to proceed effectively. In addition, the Space Radar schedule is shorter between program start and initial launch capability than what DOD has achieved for other complex satellite systems. The Space Radar acquisition timeframe from program start to initial launch capability is 86 months, which our analysis shows is shorter than what DOD has achieved or estimated for other complex satellite systems.

Workforce: TSAT also faces further challenges in meeting workforce personnel requirements to manage and oversee the program in the future, such as the impact from future Air Force workforce reductions of 40,000 active duty personnel—positions that the Air Force may not be able to fill with civilians due to budgetary constraints.

Conclusion

Continued efforts by the programs to instill best practices on TSAT and Space Radar are good steps toward addressing acquisition problems, representing significant shifts in thinking about how space systems should be developed. While these steps can help better position these programs for success, they will not work without adhering to commitments to delay milestone decisions or make trade-offs if there are still gaps between requirements and resources. DOD space program and senior officials recognize this and have expressed a commitment to delay program milestones in order to provide the time needed to match resources to requirements, if necessary. However, DOD has not addressed funding pressures that have encouraged premature program starts and too much optimism for past satellite development efforts.

Recommendation for Executive Action

To ensure that TSAT and Space Radar do not succumb to funding pressures within DOD, we recommend that the Secretary of Defense direct the Under Secretary of the Air Force to identify potential gaps between requirements and resources before approving the start of product development and, if necessary, adjust requirements and resources to increase the likelihood of achieving program cost, schedule, and performance goals.

We provided a draft of this letter to DOD for review and comment. DOD concurred with our recommendation and provided technical comments, which were incorporated where appropriate. DOD's letter is reprinted as Appendix I.

Scope and Methodology

To assess DOD's progress in adopting best practices as both of these programs proceed toward product development, we obtained and analyzed pertinent documents from the program offices at the Air Force Space and Missile Systems Center at Los Angeles Air Force Base, California. We reviewed budget documents, risk management plans, and risk handling plans as well as requirements documentation for both TSAT and Space Radar. We also reviewed acquisition strategies, program office and prime contractor schedules, and technology development plans for both programs.

To accomplish our work, we conducted interviews with cognizant and responsible program officials at Space and Missile Systems Center in El Segundo, California, and with Department of Defense officials in Arlington, Virginia. We also met with Air Force Space Command officials at Peterson Air Force Base, Colorado, as well as the Space Radar Integrated Program Office in Chantilly, Virginia. We also visited contractor facilities in California, Colorado, and Maryland.

We conducted our work from July 2006 to March 2007 in accordance with generally accepted government auditing standards.

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We will send copies of the letter to Department of Defense and interested congressional committees. We will also make copies available to others upon request.

Should you or your staff have any questions on matters discussed in this report, please contact me at (202) 512-4841 or chaplainc@gao.gov contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Principal contributors to this report were Art Gallegos, Assistant Director; Josie Sigl; Ann Hobson; Arturo Holguin; Jeff Barron; Rich Horiuchi; Maria Durant; Jackie Wade; Tony Beckham; and Hai Tran.

Cristina Chaplain
Director
Acquisition and Sourcing Management

Enclosure I: Comments from the Department of Defense

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
6000 DEFENSE PENTAGON
WASHINGTON, DC 20301-6000

NETWORKS AND
INFORMATION INTEGRATION

JUL 20 2007

Ms. Christina Chaplain
Director, Acquisition and Sourcing Management
U. S. Government Accountability Office
441 G Street, N.W., Washington, D.C. 20548

Dear Ms. Chaplain,

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) draft report 07-1029R, 'DOD is Making Progress in Adopting Best Practices for the Transformational Satellite Communications System and Space Radar but Still Faces Challenges,' dated June 19, 2007, (GAO Code 120647). The GAO assessment of the Transformational Satellite Communications System and Space Radar programs was informative and provided additional insight into issues the Department was addressing with the Air Force since early 2006. The Department concurs with the GAO recommendation and enclosed is a response.

The principle action officer for this effort is Mr. Frank Myers. He can be contacted at (703) 607-0289 or by email at frank.myers@osd.mil.

Dr. Ronald Jost
Deputy Assistant Secretary of Defense
(C3, Space and Spectrum)

Enclosure:
As stated

GAO DRAFT REPORT JUNE 19, 2007
GAO-07-1029R (GAO CODE 120647)

"DOD IS MAKING PROGRESS IN ADOPTING BEST PRSCTICES FOR THE TRANSFORMATIONAL SATELLITE COMMUNICATIONS SYSTEM AND SPACE RADAR BUT STILL FACES CHALLENGES"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense direct the Under Secretary of the Air Force to identify potential gaps between requirements and resources before approving the start product development, and if necessary, adjust requirements and resources to increase the likelihood of achieving cost, schedule, and performance goals. (Page 8/GAO Draft Report)

DOD RESPONSE: The Department of Defense (DoD) concurs with the GAO recommendation. DoD agrees that requirements and resources need to be synchronized to ensure space acquisition programs succeed. For space programs, DoD, and specifically the Under Secretary of the Air Force, implemented a Back to Basics philosophy that is focused on maturing technology prior to acquisition and delivery capability in smaller but value-added increments through the use of a Block Approach. In this paradigm, each specific capability increment is based on a balance of capability, delivery timeline, technology maturity, risk and budget. Tradeoffs in these areas mitigate any disconnects between requirements and resources as well between requirements and technology. A Block Approach for space acquisition, coupled with a robust Science and Technology program to mature technologies and reduce risk, greatly minimizes the potential for programs to experience significant cost growth and schedule delays.

Enclosure II: Space Radar Briefing Slides

Space Radar

Briefing to Staff of the Subcommittees on Strategic Forces Armed Services Committees

Preliminary Findings

March 13, 2007

1

Briefing Contents

- Background
- Objective
- Preliminary Findings
- Conclusions
- Scope of Work
- Back-Up Slides

2

BACKGROUND

System Description and Capabilities

- Through an integrated program office, the Department of Defense (DOD) and the intelligence community (IC) are collaborating to develop a single common radar system, called Space Radar (SR), to provide global, persistent, all-weather, day and night, intelligence, surveillance and reconnaissance capabilities, particularly in denied areas.
- As envisioned, SR is to consist of a constellation of low earth orbiting satellites, ground systems and communications network, and would generate large volumes of radar data for transmission to ground-, air-, ship-, and space-based platforms.

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BACKGROUND

System Description and Capabilities (cont.)

- The core capabilities of SR are to include:
  - Synthetic aperture radar imaging, surface moving target indication, open ocean surveillance, high-resolution terrain information, and advanced geospatial intelligence.
  - Processing, disseminating, and exploiting collected data to support both national and theater users.

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BACKGROUND

Program Cost and Complexity

- SR could be one of the more expensive and complex space systems DOD has ever tried to develop. According to the program office, system capabilities of the SR constellation will exceed that of any current on-orbit system.

- The Integrated Program Office estimates the cost of developing, producing, and operating the system through 2027 from $20 billion to $25 billion.

- Ground segment processing systems will have to handle the large volumes of data to be produced by the satellites. The program office estimates that the SR ground segment development effort represents one of the most significant challenges to the program and may involve about 5.3 million lines of new and reused software code.

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BACKGROUND

Management and Stakeholders

- Through the Integrated Program Office in Chantilly, VA, the Air Force, National Reconnaissance Organization (NRO), and National Geospatial-Intelligence Agency (NGA) are responsible for space and ground segment development.

- The primary stakeholders are those agencies who will be developing, operating, supporting, and using the products of the SR system to support military warfighting and national intelligence requirements as well as civil objectives, including the military services, combatant commands, combat support agencies, Joint Chiefs of Staff, the IC, and civil agencies.

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BACKGROUND

Program Status

- The development effort is currently in the concept development phase, focusing on technology development and systems engineering activities.
- Product development is scheduled to begin in fiscal year 2009 and the first satellite is scheduled to be ready for launch in fiscal year 2016.
- With recent congressional concerns and funding reductions, the Under Secretary of the Air Force has re-focused the SR acquisition approach.
- Currently 10 satellites are to be developed (9 plus 1 spare however, the definitive number of satellites is still under consideration until key decision point-B (KDP-B), also known as program start.

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BACKGROUND

Knowledge About Requirements and Resources Should Influence Program Start

- Our Best Practices reports show that gaining knowledge about requirements and resources before product development is important for space acquisition success.

- The following steps should occur before acquisition programs are initiated:
  - Fully define and stabilize requirements;
  - Assure other resources will be available (funding, technology, time); and
  - Mature technologies to the point of being tested in a relevant or realistic environment (technology readiness level 6-7) to reduce the likelihood of costly and time-consuming rework during acquisition.

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Objective

- Assess DOD's efforts to gain knowledge of requirements and resources as the Space Radar development efforts proceed toward product development.

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Results in Brief

- Program has strived to close knowledge gaps:
  - Requirements: program has developed tools to get agreement and collaboration among users and development partners.
  - Resources:
    - Program is following incremental acquisition approach which focuses on use of mature technologies and is taking other actions to reduce technical risk.
    - Program has reached agreements, reflected in budget, for cost sharing over the Future Years Defense Program (FYDP).
- Challenges remain:
  - Requirements: Key performance parameters still to be defined.
  - Resources:
    - Program may not have planned enough time for design, integration, and production activities.
    - High-level agreements between DOD and the intelligence community for long term (beyond FYDP) cost sharing and defining management roles and responsibilities have not been finalized.
    - Growth in DOD's space investment portfolio raises questions about its ability to afford expensive development efforts such as SR.

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PRELIMINARY FINDINGS

Program Has Strived to Close Gaps:
Requirements

- Program has developed tools to get agreement and collaboration among users and development partners—at both high and lower levels of management.
  - Requirements and Capabilities Working Group
  - Requirements and Capabilities Group
  - Executive Committee
  - Executive Steering Group
  - Joint Requirements Oversight Council/Mission Requirements Board
- According to the program office, coordination efforts on developing requirements to date have been effective

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PRELIMINARY FINDINGS

Program Has Strived to Close Gaps: Resources – Technology

- Program is to include mature technologies and not push to adopt advanced technologies (such as on-board processing, lithium-ion batteries, and more efficient solar cells) unless they become mature in time for preliminary design review (PDR). Efforts to develop follow-on satellites have yet to be defined.

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PRELIMINARY FINDINGS

Technology Expected to Be Mature at Program Start

Technology	Current TRL	Work to Be Done	Expected TRL At KDP-B
Analog to digital converter	TRL 3	Develop space-qualified advanced analog to digital converter.	TRL 5 [1]
Integrated radio frequency assembly	TRL 4	Integration and demonstration of radar tiles and panels (including panel-mounted electronics), radar electronic unit, and front-end processor. Demonstrate an integrated subscale electronically scanned array antenna over simulated expected environments.	TRL 6
Low earth orbit laser communication terminal	TRL 4	Laser terminal to be demonstrated in low earth orbit simulated environment.	TRL 6
Surface moving target indication processing algorithms	TRL 4	Establish and demonstrate algorithm test beds; expand data repository with relevant synthetic/collected data; validate performance against stressing, full-scale datasets.	TRL 6
Open ocean surveillance processing algorithms	TRL 3	Performance of open ocean surveillance processing algorithms to be demonstrated using test bed aircraft, synthetic, and other data to validate performance predictions.	TRL 6

[1] Note: The program office is coordinating plans for demonstrating the maturity of the advanced analog to digital converter. It has established an initial test program but needs to resolve whether or not testing is required at a higher level of assembly to meet the standard for demonstrating technology maturity at KDP-B.

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PRELIMINARY FINDINGS

Technology Expected to be Mature at Program Start (cont.)

- Current technology readiness levels (TRL) of critical technologies are low–TRL 3 to TRL 4.
- With one exception, the program office expects to have mature critical technologies–TRL 6–at KDP-B (initiation of product development). Concept definition contracts do not stipulate maturing technologies to TRL 6 but require the demonstration of "appropriate" technology maturity for a KDP-B technology maturity assessment.
- Section 2366a of Title 10, United States Code, stipulates that a major defense acquisition program may not receive KDP-B approval until the milestone decision authority certifies that, among other things, the technology in the program has been demonstrated in a relevant environment. According to the program office, this requirement can be satisfied with TRL 6.

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PRELIMINARY FINDINGS

Program Has Strived to Close Gaps: Resources – Technology

- Technical risk:
  - Program has proactively identified and categorized risks and developed plans to address them.
  - Program established a software division at the same level as other major divisions within the program office to elevate the visibility of software development and oversight.

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PRELIMINARY FINDINGS

Program Has Strived to Close Gaps: Resources – Cost Sharing

- According to the program office, a short-term agreement through fiscal year 2013 has been established and used for developing the fiscal year 2008 budget estimates. NRO Military Intelligence Program is to fund the SR program at least through FY13 (Air Force provided funding prior to FY08).

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PRELIMINARY FINDINGS

Challenges Remain – Requirements

- Key performance parameters still to be defined and most requirement performance specifications remain to be finalized or determined.

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PRELIMINARY FINDINGS

Challenges Remain – Program May Not Have Planned Enough Time

- GAO analysis shows acquisition time-frame from program start (KDP B) to initial launch capability (ILC) for SR is shorter than what DOD has achieved or estimated for other complex satellite systems.
- GAO analysis also shows the time period between preliminary design review (PDR) and critical design review (CDR) for SR is shorter than other major space programs.
- PDR determines whether preliminary designs are complete and if the program is prepared to start detailed design and test procedure development. CDR assesses the systems final design and according to GAO best practices, at least 90% of engineering drawings should be completed to provide tangible evidence that the design is stable.

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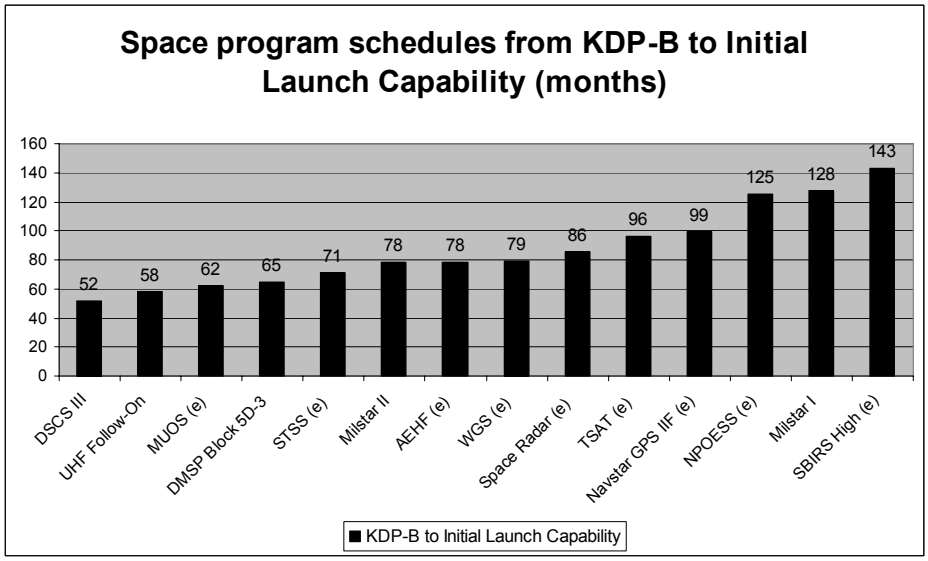
PRELIMINARY FINDINGS

Comparison of Months Between Program Milestones



Note: All programs with *(e)* denotation used current estimated dates for Initial Launch Capability.

Source: GAO analysis of DOD data

LEGEND

DSCS – Defense Satellite Communications System

UHF – Ultra High Frequency

MUOS – Mobile User Objective System

DMSP – Defense Meteorological Satellites Program

STSS – Space Tracking and Surveillance System

AEHF – Advanced Extremely High Frequency

WGS – Wideband Global Satellite Communications

TSAT – Transformation Satellite Communications System

GPS – Global Positioning System

NPOESS – National Polar-orbiting Operational Environmental Satellite System

SBIRS – Space Based Infrared System

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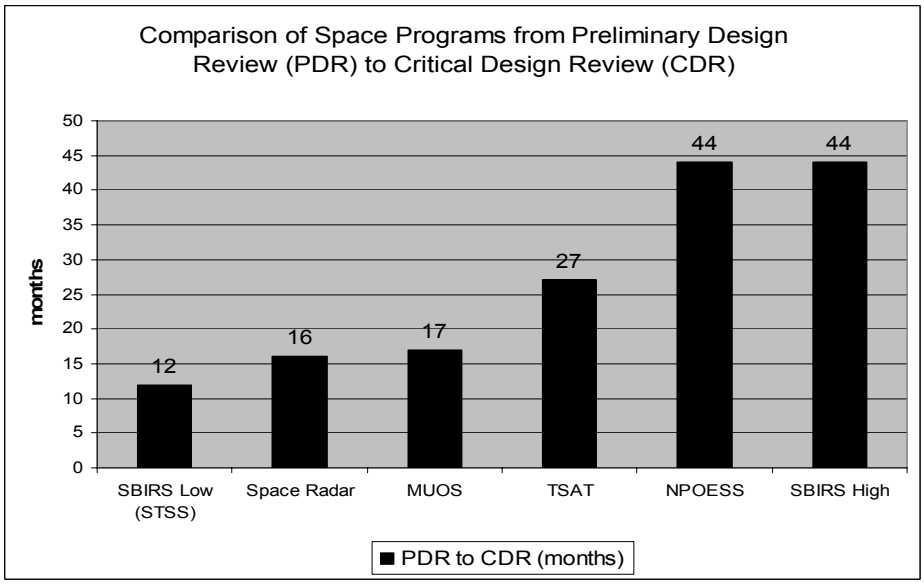
PRELIMINARY FINDINGS

Comparison of Months Between Program Milestones (cont.)



LEGEND

SBIRS – Space Based Infrared System

STSS – Space Tracking and Surveillance System

MUOS – Mobile User Objective System

NPOESS – National Polar-orbiting Operational Environmental Satellite System

TSAT – Transformation Satellite Communications System

Source: GAO analysis of DOD data

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PRELIMINARY FINDINGS

Challenges Remain – Program May Not Have Planned Enough Time

- Program office officials believe the timeframe is conservative because unlike other programs, they are conducting extensive up-front systems engineering, technology development efforts, and requirements analyses during Phase A. They also stated that the initial launch date is established through systems engineering analyses and a funding availability assessment.

- We agree that the Phase A efforts are reducing risk and have been shown to reduce development time when employed by successful organizations.

- However, the SR development effort is perhaps more complex than other space system acquisitions when considering software and other development activities. E.g., software effort alone expected to be among most complex to date.

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PRELIMINARY FINDINGS

Challenges Remain: Key risks need to be mitigated

- Program has rated 7 risks as high, including risks related to spectrum, software, and integration with space radar users. Program office acknowledges that some of these risks can not be fully mitigated prior to KDP-B.

Likelihood of Occurrence	Near certainty					1
	Highly likely				1	4
	Possible					1
	Unlikely					
	Remote					
		Low	Medium-low	Medium	Medium-high	High
	Severity of Consequence					

Legend: Low risk; Medium Risk; High risk

Source: Space Radar Integrated Program Office

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PRELIMINARY FINDINGS

Examples of top risks of the development effort

Risk and Consequence of Occurrence
If: Program office does not take the necessary steps to understand the periodicity and magnitude of interference on other spectrum users and communicate this risk to prime contractors/payload developer. **Then:** Radar payload performance and mission utility will be reduced.
If: Program office does not take the necessary steps to understand the periodicity and magnitude of interference from other spectrum users and communicate this risk to prime contractors/payload developer. **Then:** Mission performance will be inadequate.
If: Horizontally integrated tasking, processing, exploitation, and dissemination end-to-end requirements are not defined and allocated to Space Radar partner agencies 6 months prior to system design review. **Then:** Horizontal integration goals may not be achieved resulting in performance degradation or cost growth and schedule slippage due to redesign.
If: Integration and testing of the prototype payload panel reveals characteristics that will not meet Space Radar mission requirements or other impacts. **Then:** Significant Changes to panel design may be required, impacting the payload integration and testing schedule.
If: Program office software acquisition process is inadequate for providing SR functionality that will require extensive development by multiple parties and integration of complex software on a schedule that is known to be aggressive. (According to the program office, software in general and large, complex space system software in particular have a history of not meeting schedule, cost, and functionality requirements.) **Then:** Cost increase and schedule slippage and/or functionality, ranging from minor through Nunn-McCurdy breach to possible program failure may occur.

[a]Due to security classification, not all top risks of the development effort are listed.

Source: SR Integrated Program Office

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PRELIMINARY FINDINGS

Challenges Remain: Key Risks Need to be Mitigated

- The program office states that it can adequately address these risks because it has or will have sufficient numbers of systems engineers and detailed risk mitigation plans in place. We acknowledge the program's attention to risk mitigation and efforts to bring on systems engineers but do not have evidence to show how its risk mitigation measures go beyond other acquisitions efforts, which were not successful in addressing similar risks.

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PRELIMINARY FINDINGS

Challenges Remain – Agreements Need to be Finalized: Cost sharing

- Long-term cost-share agreement (beyond FYDP) between DOD and the intelligence community has not been established.
  - In January 2005, the Secretary of Defense and the Director of Central Intelligence committed to share the cost in developing an SR capability.
  - A formal agreement that includes a time period beyond fiscal year 2013 has yet to be signed.
  - Program office expects a cost-sharing agreement to be signed in Spring of 2007.
- Given recent changes in leadership (e.g., Secretary of Defense, Under Secretary for Intelligence, Director of National Intelligence) and the varied interests and missions of the SR development partners, it is important that commitments to cost sharing be formalized soon.

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PRELIMINARY FINDINGS

Challenges Remain – Agreements Need to be Finalized: Roles and Responsibilities

- Memorandum of agreement between DOD and IC drafted to define management and oversight roles and responsibilities, including defining the milestone decision authority has not been finalized.
  - According to the DOD officials, the memorandum of agreement is to be finalized within 30 days.

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PRELIMINARY FINDINGS

Challenges Remain - Program Affordability

- Growth in DOD's space investment portfolio raises questions about its ability to afford expensive programs such as SR.
  - DOD's investment for all major space acquisitions for space from 2006 through 2009 is expected to increase about 46 percent, from $6.31 billion to $9.22 billion.
  - Space Radar is being undertaken at the same time as other major, costly efforts, including Transformational Satellite Communications System, Global Positioning System III, Alternative Infrared Satellite System.
  - In addition to these new programs, DOD is still addressing cost overruns associated with legacy programs like Space Based Infrared Systems High. Moreover, it is likely that DOD will be pressured to increase funding space protection/control. DOD has not developed an overall investment strategy for its portfolio of space programs or conducted affordability assessments which would help prioritize space radar against other space and non-space investments.

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Conclusions

- Our best practices work shows that a knowledge-based process can enable decision makers to be reasonably certain about their programs and make informed investment decisions. SR is working toward closing gaps between requirements and resources and has adopted our recommended practices for negotiating requirements and maturing technologies. However, if gaps remain at product development between requirements and resources, SR must be prepared to conduct trade-off analyses or defer milestones to increase the likelihood of achieving program cost and schedule goals.

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Scope of Work

- Key documents reviewed:
  - SR requirements documentation (Initial Capabilities Document and current versions of the Capabilities Development Document and Concept of Operations)
  - Risk Management Plan and risk handling plans
  - System Acquisition Strategy
  - SR KDP-A Technology Readiness Assessment
  - Program office and prime contractor schedules and technology development plans
  - National Security Space Acquisition Policy
  - Selected Acquisition Reports for major DOD space acquisitions

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Scope of Work (cont.)

Locations for interviews and documentation:

- Air Force
  - Space Radar Integrated Program Office, Chantilly, VA and Los Angeles Air Force Base
  - Air Force Space Command, Peterson Air Force Base, CO
  - Air Force National Security Space Office, Fairfax, VA
  - Office of the Under Secretary of the Air Force, Washington, DC
- Other Defense
  - Office of the Secretary of Defense, Program Analysis and Evaluation, Arlington, VA
  - Office of the Joint Chiefs of Staff (J-2 and J-8), Arlington, VA
  - Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, Arlington, VA

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Scope of Work (cont.)

- Other Defense (cont.)
  - Office of the Under Secretary of Defense for Intelligence, Arlington, VA
  - Office of the Deputy Under Secretary of Defense for Science and Technology, Arlington, VA
  - Institute for Defense Analyses, Alexandria, VA
  - National Geospatial Intelligence Agency, Chantilly, VA
  - U.S. Strategic Command, Offutt Air Force Base, NE
- SR Contractors
  - Northrop Grumman Electronic Systems, Baltimore, MD
  - Northrop Grumman Space Technology, Redondo Beach, CA
  - Lockheed Martin Space Systems Company, Littleton, CO
- Other
  - Congressional Budget Office

We conducted our work from August 2006 to February 2007 in accordance with generally accepted government auditing standards.

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Enclosure III: Transformational Satellite Communications System (TSAT)

Transformational Satellite Communications System (TSAT)

Briefing to Congressional Committee Staff

March 13, 2007

Briefing Contents

- Objective
- Background
- GAO Findings
- Conclusions
- Scope and Methodology

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Background

Importance of TSAT

DOD is transforming its military capabilities. As part of this effort, it plans to:

- achieve information superiority over adversaries, and
- share information seamlessly among disparate weapons systems.

One of the key transformation initiatives is the Global Information Grid (GIG), a collection of programs and initiatives modeled after the Internet that is aimed at building a secure information network for enhanced rapid decision making.

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Background

Importance of TSAT

The Transformational Satellite Communications System (TSAT), the space-borne element of the GIG, is designed to provide more rapid world-wide secure communications with other systems using radio frequency and laser (lasercom) crosslinks.

- For example, in less than a second, TSAT could disseminate a radar image from a Global Hawk that would take Milstar 12 minutes and the Advanced Extremely High Frequency (AEHF) systems 2 minutes to disseminate.

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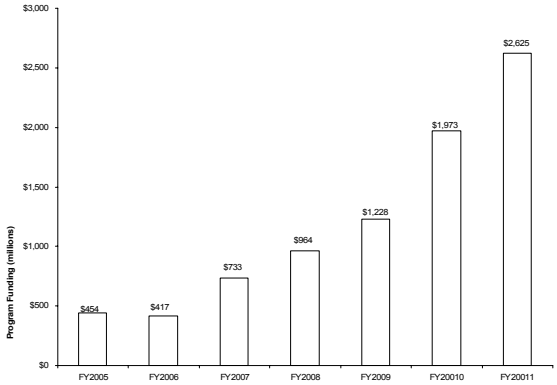
Background

Cost, Funding & Schedule

In January 2004, the program's total life cycle cost was estimated at almost $16 billion. A new cost estimate will not be developed until the program moves into the system development and demonstration phase.

TSAT Annual Funding Profile
For Fiscal Years 2005 to 2011



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Background

Cost, Funding & Schedule

- The program has spent about $2.1billion since its inception. The funding estimate for FY 07 is almost $733 million.
- Entry into the system development and demonstration phase is scheduled for the first quarter of FY 2008.
- Initial launch is scheduled for first quarter, fiscal year 2016.
- DOD and the Air Force reduced the FY 08 TSAT budget request by about $573 million. The Air Force has also moved the first launch from FY 15 to FY 16.

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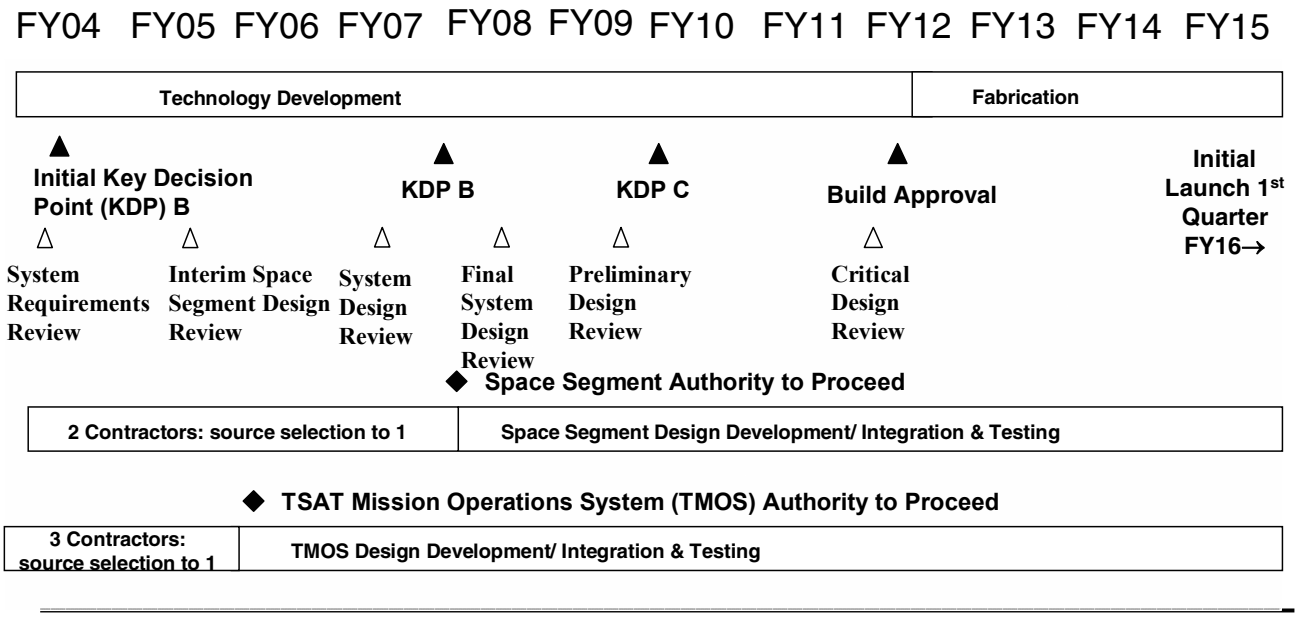
Background

Acquisition Schedule



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Background

Incremental Block Approach

As GAO reported last year, DOD restructured the TSAT program to better position it to gain critical knowledge before it enters the preliminary design phase.

Before TSAT moves to product development:

- all critical technologies must be mature, and
- system design review (SDR) must be complete prior to seeking preliminary design phase approval.

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Background

Incremental Block Approach

Through a “block” acquisition approach, the program is to:

- control risk through flexibility by scaling the capabilities initially delivered in the first block;
- meet the goal of maintaining scheduled deployment; and
- provide the ability to add additional capabilities in subsequent blocks.

Since the last GAO report, the program has specified what technologies will be included in TSAT Blocks 1 and 2.

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Objective

Assess DOD's efforts to gain knowledge of requirements and resources as the TSAT program proceeds toward product development.

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Results in Brief

- TSAT program has continued to gain knowledge about requirements and technologies:
  - Reflected agreements on requirements in specifying future blocks.
  - Made progress in technology maturation activities during FY 2006 and the first quarter of FY 2007, and continues to focus on maturing its key subsystem technologies to a technology readiness level (TRL) 6.

- Challenges remain in matching other resources:
  - Technology:
    - Early tests have revealed challenges in laser communication
    - Limited scalability analyses raises integration risks
  - Time: Program may not have planned enough time for activities involved with networking TSAT to other DOD systems
  - People: Program is not able to fill critical technical positions

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Preliminary Findings

Program Has Strived to Close Gaps: Requirements

- After restructuring, program worked with users and other stakeholders to reflect agreements on requirements in its plans for the subsequent increment, or block, of TSAT.

- Note on broader DOD requirements: Even with TSAT and other DOD satellites assets, gaps between bandwidth needs and resources are expected to continue to grow, requiring continued dependence on commercial bandwidth. Moreover, systems such as Space Radar, may not be able to rely on TSAT. More data provided in backup slides.

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Preliminary Findings

Program Has Strived to Close Gaps: Maturing Technology

- TSAT continues to focus on maturing its key subsystem technologies to a technology readiness level (TRL) 6. Systems tested at this level are considered to be sufficiently mature and have been tested in a relevant environment.

- According to the program office, in FY 07, the three technologies not already at TRL-6 remain on track to achieve TRL-6, prior to the preliminary design phase.

- The final test analysis for Phase II testing will not be available until the end of the third quarter of FY 07.

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Preliminary Findings

Program Has Strived to Close Gaps: Maturing Technology

Critical Technologies	Technology Readiness Level (TRL)	Purpose
Communication-on-the move antenna (COTM)	6	Enables high capacity data communications to small terminals (e.g., one foot antennas).
Packet Processing Payload	6	Converts incoming radio signals into digital data for delivery to the correct Internet-like address..
Information Assurance – Transmission Security	6	Protects transmissions from jamming and interception.
Information Assurance – Space High Assurance Internet Protocol Encryptor (HAIPE)	6	Facilitates security between network nodes.
Bandwidth Efficient Modulation (XDR+)	5	Allows higher capacity protected communications.
Dynamic Bandwidth Resource Allocation (DBRA)	5	Adjusts on-orbit resource allocations more efficiently, which will allow more users to be serviced simultaneously.
Single-access Laser Communications	5	Provides a high bandwidth medium to transmit huge amounts of data between satellites.

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PRELIMINARY FINDINGS

Challenges Remain: Early tests have revealed challenges in laser communication

Phase I testing involved two major components: Next Generation Processor Router (NGPR) and lasercom. The program office is satisfied with Phase I test results and is proceeding with Phase II tests.

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Preliminary Findings

Challenges Remain: Limited Scalability Testing Adds Risk

- As GAO previously reported in 2006, assessing scalability is an integral part of technology development testing.
  - Scalability analysis during the technology development phase can be used to demonstrate whether a satellite can support thousands of users, including those connected via communications-on-the-move technology in a theater of operations.
- According to TSAT officials, scalability analysis to date has been focused on functionality at a very small scale (5-10 users).
- Conducting detailed scalability analysis during the current phase could reduce risk during subsequent integration effort, which is the most risky phase of a satellite program.

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Preliminary Findings

Challenges Remain: Program Faces Inherent Integration Risks

- According to an official from the Office of Program Analysis & Evaluation (PA&E), although the TSAT program is making strides in maturing the critical technologies, these new technologies must still be integrated into a single space communications system making the TSAT development effort inherently risky.

- GAO has previously reported on the inherent risks of integration. To ensure program success, it is important that all significant testing issues be resolved before DOD authorizes the program to enter the formal acquisition process.

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FINDINGS

Software Development Schedule Optimistic

A TMOS cost-plus award fee contract valued at over $2.0 billion was awarded to Lockheed Martin Integrated Systems and Solutions in January 2006 to:

- develop the overall network architecture; and
- provide network management capabilities for TSAT and AEHF satellites.
  - TMOS involves a major software development effort and is to provide, among other things, communications mission planning, policy management, external network coordination, and situational awareness/common operational picture in a secure environment.

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Preliminary Findings

Challenges Remain: Program may not have planned enough time for networking activities

TMOS delivery schedule may be optimistic.

- PA&E has expressed concern about the overall complexity of the TSAT program and that the TMOS program is optimistic in the amount of software code that can be written in a year.

- DOD and the Air Force reduced the FY 08 TSAT budget request by about $573 million. The Air Force has also moved the first launch from FY 15 to FY 16.

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PRELIMINARY FINDINGS

Challenges Remain: Program is not able to fill critical technical positions

- Over the next five years, the Air Force is to experience a projected decrease of 40,000 active duty positions. TSAT program expects to be impacted.
  - The program office lacks the authorization to meet its government personnel needs due to the workforce reductions. The program office does not expect to receive the number of personnel requested for FY 2008.
  - Program officials said they will need additional government personnel to carry out oversight and management functions in the long-run.

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Preliminary Findings

Challenges Remain: Program is not able to fill critical technical positions

Program Office Resources

- From FY 06 to FY 07, the program's budget increased by 77 percent, while program office military and civilian staff increased by 14 percent.
- In addition to the 76 staff for FY 06, the program office currently employs over 100 full-time equivalents from federally funded research development center (FFRDC) (primarily Aerospace Corporation).

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PRELIMINARY FINDINGS

Challenges Remain: Program is not able to fill critical technical positions

- The program office is currently developing a workforce plan intended to identify the necessary government personnel for the program.
  - Based on prior GAO reports, a workforce plan should include five key elements:
    - involve management, employees, and stakeholders;
    - analyze critical skill and competency gaps between current and future workforce needs;
    - develop strategies to fill identified gaps;
    - build capabilities to address requirements; and
    - monitor and evaluate progress towards achieving strategic goals.

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Conclusions

- Our best practices work shows that a knowledge-based process can enable decision makers to be reasonably certain about their programs and make informed investment decisions. TSAT is continuing to work toward closing gaps between requirements and resources and has adopted our recommended practices for maturing technologies. However, if gaps remain at product development between requirements and resources, TSAT must be prepared to conduct trade-off analyses or defer milestones to increase the likelihood of achieving program cost and schedule goals.

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Scope of Work

•Key documents analyzed:

- Risk Management Plan and risk handling plans
- System TSAT requirements documentation (Block Delivery Plan)
- Acquisition Strategy
- Program office and prime contractor schedules and technology development plans
- National Security Space Acquisition Policy
- DOD Funding Estimate Reports

We conducted our work between July 2006 and March 2007 in accordance with generally accepted government auditing standards.

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