United States Government Accountability Office

Report to the Committee on Armed Services, U.S. Senate

April 2015

SPACE ACQUISITIONS

Space Based Infrared System Could Benefit from Technology Insertion Planning

Accessible Version

GAO-15-366

GAO Highlights

Highlights of GAO-15-366, a report to the Committee on Armed Services, U.S. Senate

April 2015

SPACE ACQUISITIONS

Space Based Infrared System Could Benefit from Technology Insertion Planning

Why GAO Did This Study

SBIRS is a key part of DOD's missile warning and defense systems. To replace the first two satellites currently on orbit, the Air Force plans to build two more with the same design as previous satellites. The basic SBIRS design is years old and some of its technology has become obsolete. To address obsolescence issues in the next satellites, the program must replace old technologies with new ones, a process that may be referred to as technology insertion or refresh. A Senate Armed Services Committee report included a provision for GAO to review an Air Force assessment of the feasibility of inserting newer technologies into the planned replacement satellites, SBIRS GEO satellites 5 and 6, and how it intends to address technology insertion issues for future satellite systems.

This report examines (1) the extent to which the Air Force assessed the feasibility of inserting newer technologies into SBIRS GEO satellites 5 and 6 and (2) plans to address obsolescence issues and risk associated with technology insertion for future satellites or systems. GAO identified technology insertion planning guidance and practices, reviewed the Air Force's assessment and plans, and met with DOD and contractor offices.

What GAO Recommends

To improve technology planning, GAO recommends that the Secretary of the Air Force establish a plan as part of the SBIRS follow-on acquisition strategy that identifies obsolescence needs, specific potential technologies, and insertion points. DOD concurred with the recommendation.

View GAO-15-366. For more information, contact Cristina T. Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

The Air Force assessed options for replacing older technologies with newer ones—called technology insertion—in the Space Based Infrared System (SBIRS) geosynchronous earth orbit (GEO) satellites 5 and 6. However, the assessment was limited in the number of options it could practically consider because of timing and minimal early investment in technology planning. The Air Force assessed the feasibility and cost of inserting new digital infrared focal plane technology—used to provide surveillance, tracking, and targeting information for national missile defense and other missions—in place of the current analog focal plane, either with or without changing the related electronics. While technically feasible, neither option was deemed affordable or deliverable when needed. The Air Force estimated that inserting new focal plane technology would result in cost increases and schedule delays ranging from $424 million and 23 months to $859 million and 44 months. The assessment came too late to be useful for SBIRS GEO satellites 5 and 6. It occurred after the Air Force had approved the acquisition strategy and while negotiations were ongoing to procure production of the two satellites. According to the Air Force, implementing changes at that stage would require contract modifications and renegotiations and incur additional cost and schedule growth. Limited prior investment in technology development and planning for insertion also limited the number of feasible options for adding new technology into SBIRS GEO satellites 5 and 6. Department of Defense (DOD) acquisition policy and guidance indicate that such planning is important throughout a system's life cycle, and GAO has reported on leading commercial companies' practice of planning for technology insertion prior to the start of a program. Air Force officials said early technology insertion planning was hampered in part by development challenges, test failures, and technical issues with the satellites, which took priority over research and development efforts.

The current approach to technology insertion for the system or satellites after SBIRS GEO satellites 5 and 6 could leave the program with similar challenges in the future. GAO's work on best practices has found that leading companies conduct strategic planning before technology development begins to help identify needs and technologies. Similarly, the MITRE Corporation—a not-for-profit research and development organization—has highlighted the importance of technology planning to provide guidance for evolving and maturing technologies to address future mission needs. Technology insertion decisions for the future system or satellites are not guided by such planning. Instead, decisions are largely driven by the need to replace obsolete parts as issues arise. Current efforts—such as individual science and technology projects, including those in the Space Modernization Initiative—are limited by lack of direction, focusing on isolated technologies, and therefore are not set up to identify specific insertion points for a desired future system. In addition, the SBIRS program has had little time to develop and demonstrate new technologies that could be inserted into a SBIRS follow-on system. The Air Force is working to develop a technology road map for the next system, according to officials. Given the lack of a clear vision for the path forward and the road map's early development status, it is too soon to determine whether it will be able to identify specific technology and obsolescence needs and insertion points in time for the next system.

Contents

Abbreviations

AFSPC	Air Force Space Command
AOA	analysis of alternatives
CFSP	Core Function Support Plan
CHIRP	Commercially Hosted Infrared Payload
DOD	Department of Defense
DSP	Defense Support Program
GEO	geosynchronous earth orbit
HEO	highly elliptical orbit
SBIRS	Space Based Infrared System
SMI	Space Modernization Initiative

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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Washington, DC 20548

April 3, 2015

The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

In the mid-1990s, the Department of Defense (DOD) selected the Space Based Infrared System (SBIRS) to replace the Defense Support Program (DSP), the preceding missile early-warning system, which is now over four decades old. SBIRS is a key part of DOD's missile warning and defense systems and provides critical functions for protecting the United States and its allies. A combination of two infrared sensors in highly elliptical orbit (HEO) and four satellites in geosynchronous earth orbit (GEO) make up the nominal SBIRS constellation.[1] To replace the first two GEO satellites on orbit by 2020 and 2021, the Air Force developed an acquisition strategy to procure two more SBIRS GEO satellites as derivatives—that is, of the same design aside from limited changes to accommodate obsolete parts—of the fourth GEO satellite being built. DOD approved the acquisition strategy in February 2012. In September 2012, the Air Force awarded a contract for initial nonrecurring engineering and in June 2014 procured the production of the two satellites—GEO satellites 5 and 6—for a total target price of $2.4 billion.[2] The basic SBIRS design is years old—the system has been in development for over 18 years, and some of its technology has already become obsolete. To address obsolescence issues in the next satellites, the program must replace old technologies with newer ones, a process that may be referred to as technology insertion or refresh.

[1]HEO satellites, which linger over a designated area of the earth, can provide polar coverage. A GEO satellite's revolution is synchronized with the earth's rotation giving it a seemingly stationary position above a fixed point on the equator. At an altitude of about 22,300 miles above the equator, four strategically spaced satellites can view the entire globe with the exception of the polar regions.

[2]Following the initial nonrecurring engineering contract, the Air Force awarded an advance procurement contract for additional nonrecurring engineering activities and long lead items in February 2013. In June 2014, the Air Force executed a modification of the advance procurement contract for satellite production.

The Senate Armed Services Committee, in its report accompanying S. 1197, a bill for the National Defense Authorization Act for Fiscal Year 2014, directed the Secretary of the Air Force to assess how the Air Force might insert newer technology in the production of GEO satellites 5 and 6.[3] Specifically, the report directed the Air Force to determine whether it would be feasible to introduce newer focal plane arrays—technology used to provide surveillance, tracking, and targeting information for national missile defense—and other technologies and at what cost. If not feasible, the report also directed the Air Force to clarify how it intends to address future technology insertion issues. The Air Force issued its report, *Space Based Infrared System (SBIRS) Geosynchronous Earth Orbit (GEO) 5/6 Focal Plane Technology Insertion*, in May 2014.

Additionally, the committee included a provision in its report for GAO to review the Air Force's assessment. This report examines (1) the extent to which the Air Force assessed the feasibility of inserting newer technologies into SBIRS GEO satellites 5 and 6 and (2) Air Force plans to address obsolescence issues and ongoing risk associated with technology insertion beyond the GEO satellites 5 and 6 replenishment efforts.

To conduct this work, we reviewed DOD acquisition guidance and prior GAO work on best practices in technology insertion to identify criteria for technology insertion planning.[4] We reviewed the Air Force's report and interviewed DOD officials to determine how new technologies for GEO satellites 5 and 6 were assessed and what plans are in place for future technology insertion. We then evaluated the Air Force plans against the guidance, criteria, and practices for technology insertion planning identified to determine the extent to which the Air Force's plans align with them. The DOD offices whose officials we interviewed included the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics; Office of the Secretary of Defense for Cost Assessment and Program Evaluation; Joint Chiefs of Staff; Executive Agent for Space

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[3]S. Rep. No. 113-44, at 168 (2013).

[4]For the purposes of this report, "technology insertion" includes "technology transition." For example, technology insertion can be considered the process of inserting critical technologies—which have been developed and are ready to transition into a system—into military systems to meet mission needs. It can also include development of software algorithms to exploit data gathered by existing and future sensors. Technology insertion can occur during the development of a system and after it has been deployed.

Staff; Office of the Assistant Secretary of the Air Force (Acquisition); Air Force Space Forces Requirements Division; Air Force Space Operations Division; Air Force Space Command; and Air Force Space and Missile Systems Center, Remote Sensing Systems Directorate. We also reviewed documents from and interviewed officials at Lockheed Martin, the prime contractor for SBIRS, and Northrop Grumman, the SBIRS payload integrator.

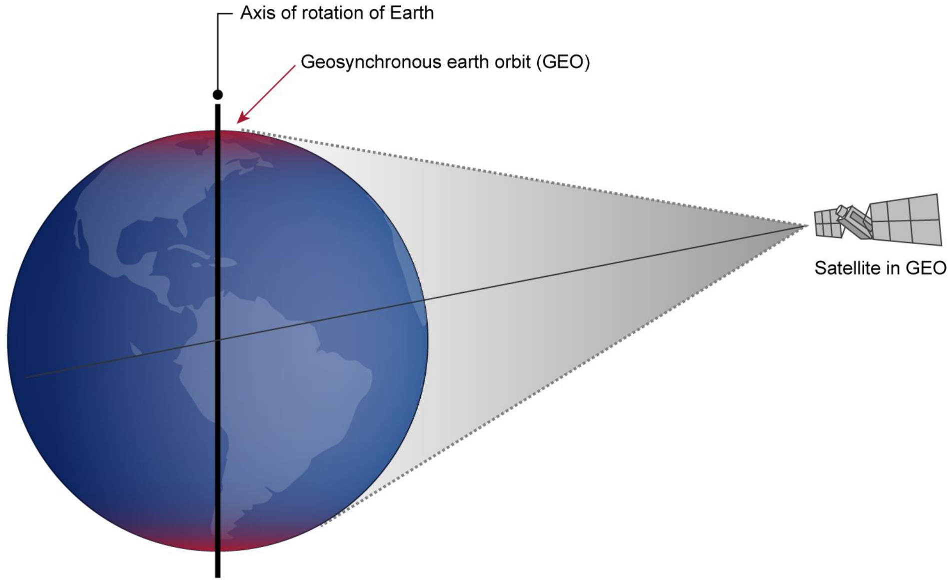
We conducted this performance audit from October 2014 to April 2015 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our objectives.

Background

SBIRS is intended to be a more capable successor to DSP and provide initial warning of a ballistic missile attack on the United States, its deployed forces, or its allies.[5] Once complete, the nominal SBIRS constellation is to consist of two hosted HEO sensors and four GEO satellites. The GEO satellite constellation provides midlatitude coverage and the hosted HEO sensors provide polar coverage for missile warning and defense and other missions. Figure 1 shows the field of view of a single GEO satellite.

[5]The first operational DSP satellite was deployed in 1971. DSP satellites use infrared sensors to detect heat from missile and booster plumes against Earth's background. In addition to missile warning, SBIRS provides capabilities for missile defense, battlespace awareness, and technical intelligence missions.

Figure 1: Example of a Single Geosynchronous Earth Orbit (GEO) Satellite Field of View

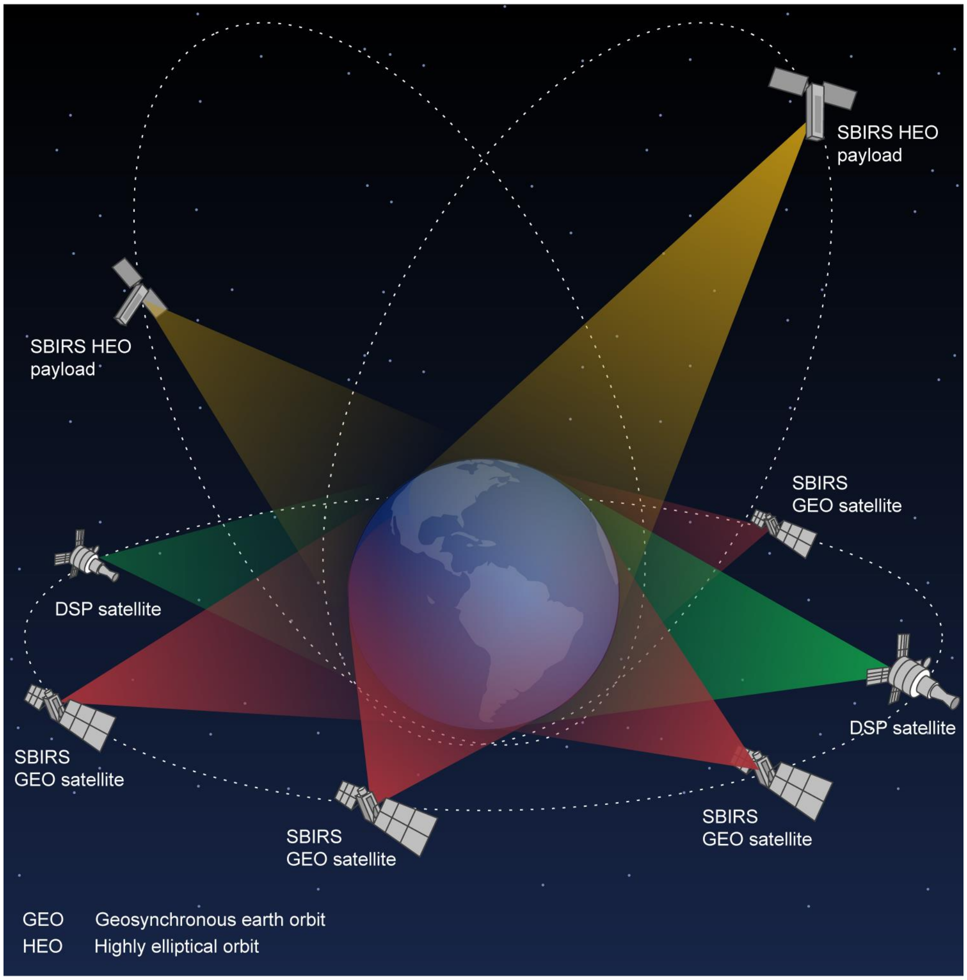


Source: GAO depiction of GEO satellite coverage. | GAO-15-366

Note: This figure is meant for illustrative purposes only to depict the midlatitude coverage of a satellite in GEO, which has a field of view that does not provide polar coverage; the latitudes represented are not precise.

Large, complex satellite systems like SBIRS can take a long time to develop and construct. As a result, they can contain technologies that have become obsolete by the time they are launched. Although two GEO satellites were launched in recent years—the first in May 2011 and the second in March 2013—they had been designed in the late 1990s and primarily use technology from that period. The third and fourth GEO satellites, which have some updates to address parts obsolescence issues, are in production and expected to be initially available for launch in May 2016 for GEO satellite 4, and September 2017 for GEO satellite 3, which will first be stored. Figure 2 depicts a nominal constellation of SBIRS GEO satellites and HEO sensors once SBIRS GEO satellites 3 and 4 are launched and operational, augmented by DSP satellites.

Figure 2: Space Based Infrared System (SBIRS) Constellation with Defense Support Program (DSP) Augmentation (Nominal)



Source: ©2007 Lockheed Martin Corporation. All rights reserved. | GAO-15-366

SBIRS GEO satellites 5 and 6 are needed in 2020 and 2021, respectively, to replenish the first two SBIRS GEO satellites and maintain the SBIRS constellation. In February 2013, the Air Force awarded a fixed-price incentive (firm target) contract for nonrecurring engineering activities and procurement of long lead spacecraft parts for GEO satellites 5 and

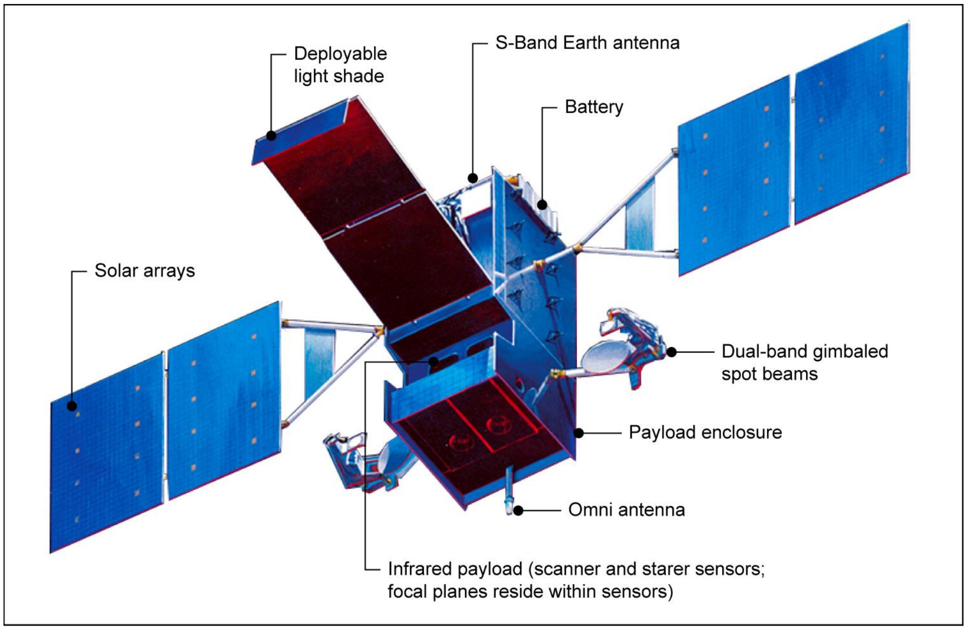
6.[6] The Air Force procured the production of GEO satellites 5 and 6 in June 2014, 1 month after the Air Force's assessment on inserting newer technologies.

In accordance with the acquisition strategy and to reduce risk in meeting need dates, GEO satellites 5 and 6 are to be derivatives of GEO satellite 4, with limited design changes to capitalize on the use of previously procured engineering and parts. According to the Air Force, it plans for limited technology refresh improvements.[7] Several of the subsystems on GEO satellites 5 and 6, including some on the sensors, are being upgraded to address parts obsolescence and essential technology updates. They will also include updates that were incorporated into GEO satellites 3 and 4—approximately 30 percent of these satellites' parts were updated, according to the Air Force's report. Figure 3 depicts the key components of the SBIRS GEO satellite.

[6]A fixed-price incentive (firm target) contract is designed to provide the contractor a profit incentive to control costs. It specifies target cost, a target profit, a price ceiling, and a profit adjustment formula that are negotiated at the outset. The price ceiling is the maximum that may be paid to the contractor, except for adjustments.

[7]DOD's definition of technology refresh is the periodic replacement of both custom-built and commercial-off-the-shelf system components, within a larger DOD weapon system, to ensure continued supportability throughout the weapon system's life cycle.

Figure 3: Key Space Based Infrared System Geosynchronous Earth Orbit Satellite Components



Source: ©2007 Lockheed Martin Corporation. All rights reserved. | GAO-15-366

The Air Force put in place a Space Modernization Initiative (SMI) in fiscal year 2013 in an effort to address the ongoing challenge of inserting mature, updated technology into the SBIRS program while reducing the risk for the next generation of infrared satellites. Through SMI, the Air Force intends to invest in efforts that will help inform future decisions and to explore affordable technology alternatives.

Air Force Assessed the Feasibility of GEO Satellites 5 and 6 Technology Insertion, but Earlier Assessment and Investment in Technology Development and Planning Could Have Improved the Effort

The Air Force assessed the feasibility and cost of incorporating a newer infrared focal plane into the SBIRS GEO satellites 5 and 6 and found that inserting a new focal plane would incur significant cost and schedule increases. The assessment came too late to be useful to GEO satellites 5 and 6, but that might not have been the case if the Air Force had invested in technology development and insertion planning earlier in the program to provide more options for consideration.[8]

The Air Force Met Congressional Requirements to Assess New Focal Plane Technology for GEO Satellites 5 and 6

As directed in the Senate report, the Air Force assessed the feasibility and costs of inserting newer infrared focal plane technologies—sensors that can detect heat from missile launches, for example—into GEO satellites 5 and 6. The Air Force considered one digital focal plane, a staring sensor, in lieu of the current analog focal plane. It identified two plausible options for insertion, and though technically feasible, neither was deemed affordable or deliverable within the replenishment need dates of 2020 and 2021. According to the Air Force report:

- The first option would develop and replace the current analog focal plane assembly with more a modern digital focal plane while minimizing changes to the electronic interfaces. This would not increase system performance; however, the cost would be about $424 million and incur a schedule delay of 23 to 32 months.[9]

[8]In 2014, we reviewed classified details associated with technologies and budgets for overhead persistent infrared technologies. GAO, *Space Acquisitions: Assessment of Overhead Persistent Infrared Technology Report*, GAO-14-287R (Washington, D.C.: Jan. 13, 2014). The overhead persistent infrared mission area is supported by SBIRS and other satellites.

[9]Cost Assessment and Program Evaluation officials told us they did not complete an independent cost estimate because it was not required for the Air Force's assessment.

- The second option would also include replacement of the analog focal plane with a digital focal plane; however, the most significant difference between this option and the first option is the redesign of the signal processor assembly. According to the Air Force, this redesign could maximize the capability of the new digital focal plane by at least 20 percent beyond the current system's requirements by increasing, among other items, target resolution. However, this option—at $859 million—would more than double the cost of the first option, and bring with it a 35- to 44-month schedule delay.

The timing of the Air Force's assessment occurred after the Air Force had already approved the GEO satellites 5 and 6 acquisition strategy and awarded the advance procurement contract to complete nonrecurring engineering activities and procurement of critical parts with long lead times—on February 26, 2012, and February 19, 2013, respectively. In its assessment, the Air Force reported that to implement changes to the infrared focal planes at this stage, the current advanced procurement GEO satellites 5 and 6 contract would have to be modified, which would require renegotiations. In addition, the Air Force noted that at the time of the assessment, the fix-priced production modification had not yet been executed and changes could also have affected the related negotiations. Furthermore, any changes to the design of the satellites at this juncture would most likely have incurred additional cost with resulting schedule slips. For example, Air Force officials stated additional nonrecurring engineering would likely be required to design, build, test, and qualify a new focal plane design and to mitigate impacts to other subsystems on the satellite.

Limited Prior Investment in Technology Development and Planning Efforts Reduced Technology Insertion Options

Because of limited prior investment in research and development and technology insertion planning leading up to the acquisition of GEO satellites 5 and 6, there was only one viable alternative focal plane to be considered.[10] As a result, the Air Force was limited in the number of feasible options for adding new technology to GEO satellites 5 and 6.

Effectively planning and managing technology development—including specifying when, how, and why to insert technologies into a deployed system—can help to increase readiness and improve the potential for

[10]The Air Force assessed the digital staring focal plane at a technology readiness level 5, meaning the technological components were tested in a simulated environment.

reduced costs. We have found that leading commercial companies plan for technology insertion prior to the start of a program, which provides managers time to gain additional knowledge about a technology.[11] DOD policy and guidance indicate that planning for technology insertion and refresh is also important throughout a system's life cycle. Specifically, DOD Instruction 5000.02, January 7, 2015, requires program managers to prepare a Life Cycle Sustainment Plan, and notes that technology advances and plans for follow-on systems may warrant revisions to the plan.[12] In addition, DOD's Defense Acquisition Guidebook advises the use of trade studies to inform system modifications, such as technology insertion or refresh, and the development and implementation of technology refresh schedules.

Very little technology insertion or refresh planning was completed early on in the SBIRS program to address potential obsolescence and find opportunities to insert newer technologies in later stages of the program's life cycle. The SBIRS program was unable to plan for technology upgrades and refresh, according to program officials, because of other issues with the satellites being built. Officials said it was difficult to obtain funding for exploring future technologies at a time when the program was experiencing satellite development problems. As we have reported, the SBIRS program has experienced significant cost growth and schedule delays since its inception, in part because of development challenges, test failures, and technical issues.[13] For example, in 2014 we reported a total cost growth of $14.1 billion over the original program cost estimate, and a delay of roughly 9 years for the first satellite launch.[14] Hence, funding that could have been used for technology development and

[11]GAO, *Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes*, GAO-06-883 (Washington, D.C.: Sept. 14, 2006).

[12]Department of Defense, *Operation of the Defense Acquisition System*, Instruction 5000.02 (Washington, D.C.: Jan. 7, 2015).

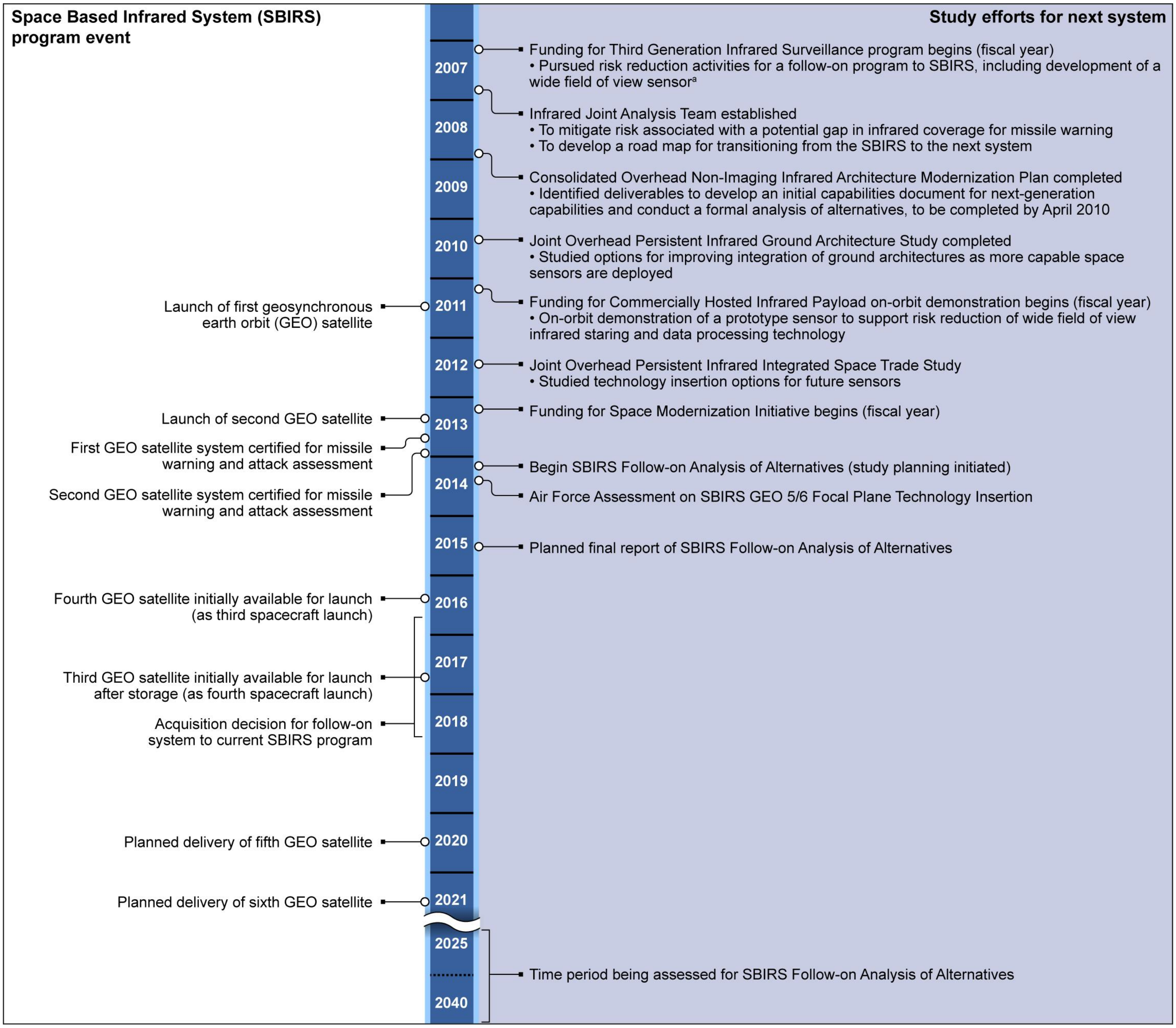
[13]GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-12-400SP (Washington, D.C.: Mar. 29, 2012); *National Defense: Space Based Infrared System High Program and its Alternative*, GAO-07-1088R (Washington, D.C.: Sept. 12, 2007); and *Defense Acquisitions: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns*, GAO-04-48 (Washington, D. C.: Oct. 31, 2003).

[14]GAO, *Space Acquisitions: Acquisition Management Continues to Improve but Challenges Persist for Current and Future Programs*, GAO-14-382T (Washington, D.C.: Mar. 12, 2014).

planning for parts obsolescence or technology insertion to reduce risk was, instead, used to address significant cost and schedule breaches as they arose. Though the SBIRS program started in 1996, efforts to begin studying options for transitioning to the next system did not start until 2007. The program also began to invest in technology development in 2007 with the Third Generation Infrared Surveillance program, which was intended to reduce risk for the development of new sensor technology. The Air Force later incorporated the technology into the Commercially Hosted Infrared Payload (CHIRP), which received funding for an on-orbit demonstration beginning in fiscal year 2011, though it was not used operationally for SBIRS missions. Funding for SMI started in fiscal year 2013.[15] Figure 4 depicts a timeline of key SBIRS program events and efforts to study options for the next system, including technology development investments.

[15]CHIRP tested new infrared sensor technology and demonstrated hosting a government payload on a commercial satellite bus. The demonstration was discontinued in 2013 because of a technical issue and budgetary constraints.

Figure 4: Timeline of Space Based Infrared System (SBIRS) Program Events and Efforts to Study Options for the Next System



Source: GAO analysis of program documentation. | GAO-15-366

[a]Wide field of view sensor technology could allow 100 percent continuous Earth coverage through large format staring arrays.

Beyond assessing the two options—of replacing the current analog focal plane with a more modern digital focal plane, either with or without changes to the electronic interfaces—the Air Force was not in a position to incorporate changes and still maintain the efficiencies planned by buying GEO satellites 5 and 6 together.

Limited Planning May Hinder the Air Force's Ability to Fully Address Technology Insertion Risks in Future Systems

The current approach to technology insertion for SBIRS is not consistent with the best practice of establishing a plan prior to the start of a program that identifies specific technologies to be developed and inserted to achieve a desired end state. The efforts that are under way are limited by lack of direction and time constraints in informing an acquisition decision and technology insertion plan for the follow-on to the current SBIRS program. While the Air Force is working to develop a technology road map for the next system, the effort is still hampered by the lack of a clear vision for the path forward, requiring the Air Force to plan for multiple potential systems. Further, it is too soon to tell whether the road map will be sufficiently developed in time to address future technology insertion needs.

Current Technology Insertion for SBIRS Lacks a Defined Plan

Technology insertion decisions for SBIRS do not systematically follow an established plan. Instead, efforts are more near-term oriented to solve known problems or to take advantage of isolated technologies. A technology insertion plan ideally envisions desired capabilities for a system and then directs investments to develop those capabilities. In its Systems Engineering Guide, the MITRE Corporation—a not-for-profit research and development company—highlights the importance of technology planning to provide guidance for evolving and maturing technologies to address future mission needs.[16] As mentioned above, we have also found that leading commercial companies conduct strategic planning before technology development and plan for technology insertion before a program begins. Such practices enable managers to identify needs and technologies, prioritize resources, and validate that a technology can be integrated.[17]

[16]The MITRE Corporation, "Acquisition Program Planning: Technology Planning," *Systems Engineering Guide* (Bedford, Mass.: 2014).

[17]GAO-06-883.

Currently, technology insertion for SBIRS is largely driven by the need to replace obsolescent parts, that is, parts that are no longer available and need to be rebuilt or redesigned and qualified for the space environment. For example, when a contractor was having difficulty delivering an encoder and decoder system—which assists with pointing control of the sensor—on time, the program office sought another source for the system. In place of a technology insertion plan, Air Force officials have cited SMI as a means for demonstrating developed technologies that could be inserted into future systems. One of the areas under the SMI plan, Evolved SBIRS, focuses on reducing cost and technical risk for replenishments of the current SBIRS satellites and future SBIRS systems, including addressing obsolescence. By simplifying designs and studying ways to reduce the risk of obsolescence, the effort aims to significantly reduce costs if the decision is made to procure a seventh and eighth GEO satellite.

Beyond replacing obsolescent parts, technology insertion efforts for SBIRS are generally ad hoc and focus on isolated technologies. Although Air Force Space Command's (AFSPC) annual integrated planning process identifies technology concepts that could be a part of a future system, it is the program's responsibility to decide which concepts to pursue further, according to officials.[18] Program managers generally initiate technology development ideas and propose them to AFSPC as they arise, at which point they develop into science and technology projects. Air Force officials noted that ongoing technology development efforts are relatively narrow in scope because of resource constraints. For example, another SMI effort, Wide Field of View Testbeds, is focused on demonstrating a prototype wide field of view staring payload that could be inserted either into an evolved program of record or an alternate system, such as a host satellite. Officials said this effort has been limited to testing one focal plane in a relevant space environment, although it would have been beneficial to test others that were available. The Data Exploitation effort, another SMI effort, is focused on ways to further exploit data collected from existing sensors on orbit by advancing on-orbit data collection and analysis and developing algorithms to process data. Given that these efforts aim for varying goals, they are not together intended to

[18]The annual planning process is documented in Core Function Support Plans (CFSP), which recently replaced Core Function Master Plans. Within AFSPC, CFSPs are used to define service-wide investments supporting the space and cyberspace superiority core functions.

plan for a single end system and are not set up to identify the specific technologies required for such a system. Officials acknowledge that the SMI efforts cover different directions to keep options open for the various potential approaches to a future system but anticipate that efforts will become more focused once the SBIRS Follow-on analysis of alternatives (AOA) is completed and a decision is made on the way forward.

Timing Constraints Could Limit the Effectiveness of Ongoing Efforts

SMI efforts are also hampered by time constraints that could limit their usefulness in informing technology insertion decisions for the follow-on system. Air Force officials have stated that an acquisition decision for the follow-on to SBIRS—whether a continuation of the program with next-generation satellites or a different system—will need to be made within the fiscal year 2017-2018 time frame. To inform that decision, any new technologies required for the follow-on will need to be developed enough that the Air Force can be certain they will be ready to transition in time. For example, if the follow-on uses a wide field of view sensor, the Air Force will need to complete significant work—including data exploitation, testing, and demonstrations—to ensure that the sensor is capable of performing the necessary function. Officials said the relevant Wide Field of View Testbeds effort, expected to be active by fiscal year 2017, could potentially meet the decision time frame if it stays on track, though a delay in the AOA or funding decisions could affect the program's ability to keep the effort on schedule. Given the short history of SMI, which started in fiscal year 2013, the SBIRS program has had limited time to develop and demonstrate new technologies that could be inserted into a follow-on.

Going forward, program officials said they are developing a technology road map for each of the different options being considered in the AOA. As the results of the AOA are pending, officials must develop plans for multiple potential paths forward, including those that may involve less mature technology currently. This road map will be modified based on the option selected from the AOA to identify the technologies available and determine when they may be inserted into the follow-on, officials said. Though specific timelines for the final road map are not yet determined, once finalized, the program plans to use it to guide SMI investment plans and to work with the science and technology community on development efforts. It is too early to determine how successful the road map will be in providing a timely plan for inserting technology into the next system. Delays in previous efforts to analyze alternatives and plan for a follow-on suggest similar delays could occur for the ongoing SBIRS Follow-on AOA. Such delays would make it difficult to develop a thorough road map for technology insertion if the program does not know the system for which to plan. In addition, some officials have cited concerns that all segments of the system—particularly the ground system, which provides command and control of the satellites and is already delayed behind the satellites currently on orbit—may not be fully assessed in ongoing analyses and that potential risks could be marginalized or overlooked in a technology insertion plan.

Conclusions

Large and complex satellites like SBIRS take a long time to develop and build, which can make the technology aboard outdated compared to what might be available when the satellites are launched and operated. The Air Force has been focused on building the satellites versus developing new capabilities and, in doing so, has missed opportunities to pursue viable technology options. Establishing a plan for when, how, and why technology improvements should be inserted into a system can be essential to providing capabilities when needed and reducing life cycle costs. Without an early technology insertion plan for SBIRS and the associated technology development, the Air Force was limited to assessing few new technologies, which were too late to be incorporated into GEO satellites 5 and 6 without significant cost and schedule increases. Given the time it took to develop, produce, and launch the SBIRS satellites, spanning over 18 years, a forward-looking approach that develops and inserts technologies within planned schedule windows could be more effective in satisfying mission needs and anticipating future requirements.

Going forward, the Air Force is at risk of being in the same position for the next system that follows the current SBIRS program. Plans to establish more specific technology insertion strategies for potential alternatives could encourage earlier technology development, though these cannot yet be assessed because they are still in development. Without a clear vision of the path forward and a corresponding plan that lays out specific points for addressing potential obsolescence issues, assessing technology readiness, and determining when it is appropriate to insert technology for all segments of the program, the Air Force could be limited in its ability to mitigate technology insertion risk. Further, as the deadline approaches for deciding on a follow-on to SBIRS, the Air Force continues to lose valuable time to develop, demonstrate, and assess new technologies. As a result, it may be forced to continue with the current design for subsequent satellites, potentially requiring more attention to obsolete components and continuing the cycle of limited technology insertion.

Recommendation for Executive Action

To improve technology planning and ensure planning efforts are clearly aligned with the SBIRS follow-on, we recommend that the Secretary of the Air Force establish a technology insertion plan as part of the SBIRS follow-on acquisition strategy that identifies obsolescence needs as well as specific potential technologies and insertion points.

Agency Comments

We provided a draft of this report to DOD for comment. In its written comments, which are reprinted in appendix I, DOD concurred with our recommendation. DOD also provided technical comments which were incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees and the Secretary of Defense. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff any have questions about this report, please contact me at (202) 512-4841 or at chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff members who made key contributions to this report are listed in appendix II.

Cristina T. Chaplain
Director
Acquisition and Sourcing Management

Appendix I: Comments from the Department of Defense

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

OFFICE OF THE UNDER SECRETARY

MAR 26 2015

Ms. Christina Chaplain
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Chaplain,

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-15-366, "SPACE ACQUISITIONS: Space Based Infrared System Could Benefit from Technology Insertion Planning," dated February 26, 2015 (GAO Code 121243). Your staff conducted a thorough study and produced a useful report with which we find much to concur. Comments on the report recommendation are enclosed.

Sincerely,

MARTIN WHELAN
Major General, USAF
Principal Advisor to the Deputy Under Secretary
(Space)

GAO DRAFT REPORT DATED FEBRUARY 26, 2015
GAO-15-366 (GAO CODE 121243)

"SPACE ACQUISITIONS: SPACE BASED INFRARED SYSTEM COULD BENEFIT FROM TECHNOLOGY INSERTION PLANNING"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

RECOMMENDATION: The GAO recommends that the Secretary of the Air Force establish a technology insertion plan, as part of the SBIRS follow-on acquisition strategy, that identifies obsolescence needs as well as specific potential technologies and insertion points.

DoD RESPONSE: Concur.

The scope and focus of technology insertion will be determined based on direction resulting from the SBIRS Follow-on Analysis of Alternatives (AoA) and will be executed through the SBIRS Space Modernization Initiative (SMI).

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, key contributors to this report were Art Gallegos (Assistant Director), Maricela Cherveny, Brenna Guarneros, Bob Swierczek, Hai Tran, Oziel Trevino, and Alyssa Weir.

Appendix III: Accessible Data

Data Table for Figure 4: Timeline of Space Based Infrared System (SBIRS) Program Events and Efforts to Study Options for the Next System

Year	Space Based Infrared System (SBIRS) program event	Study efforts for next system
2007		Funding for Third Generation Infrared Surveillance Program begins (fiscal year) • Pursued risk reduction activities for a follow-on program to SBIRS, including development of a wide field of view sensor[Note A]
		Infrared Joint Analysis Team established • To mitigate risk associated with a potential gap in infrared coverage for missile warning • To develop a road map for transitioning from the SBIRS to the next system
2008		Consolidated Overhead Non-Imaging Infrared Architecture Modernization Plan completed • Identified deliverables to develop an initial capabilities document for next-generation capabilities and conduct a formal analysis of alternatives, to be completed by April 2010
2010		Joint Overhead Persistent Infrared Ground Architecture Study completed • Studied options for improving integration of ground architectures as more capable space sensors are deployed
2011		Funding for Commercially Hosted Infrared Payload on-orbit demonstration begins (fiscal year) • On-orbit demonstration of a prototype sensor to support risk reduction of wide field of view infrared staring and data processing technology
	Launch of first geosynchronous earth orbit (GEO) satellite	
2012		Joint Overhead Persistent Infrared Integrated Space Trade Study • Studied technology insertion options for future sensors
2013	Launch of second GEO satellite	Funding for Space Modernization Initiative begins (fiscal year)
	First GEO satellite system certified for missile warning and attack assessment	
	Second GEO satellite system certified for missile warning and attack assessment	
2014		Begin SBIRS Follow-on Analysis of Alternatives (study planning initiated)
		Air Force Assessment on SBIRS GEO 5/6 Focal Plane Technology Insertion
2015		Planned final report of SBIRS Follow-on Analysis of Alternatives
2016	Fourth GEO satellite initially available for launch (as third spacecraft launch)	
2017	Third GEO satellite initially available for launch after storage (as fourth spacecraft launch)	
2016-2018	Acquisition decision for follow-on system to current SBIRS program	
2020	Planned delivery of fifth GEO satellite	

Year	Space Based Infrared System (SBIRS) program event	Study efforts for next system
2021	Planned delivery of sixth GEO satellite	
2025-2026	Estimated need dates for follow-on system	

Source: GAO analysis of program documentation. GAO-15-366.

[a]Wide field of view sensor technology could allow 100 percent continuous Earth coverage through large format staring arrays.

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