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GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES

Additional Action Needed to Incorporate Lessons Learned from Other Satellite Programs

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GAO-06-1129T

September 29, 2006

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Highlights

Highlights of GAO-06-1129T, a testimony before the Committee on Science, House of Representatives

Why GAO Did This Study

The National Oceanic and Atmospheric Administration (NOAA) plans to procure the next generation of geostationary operational environmental satellites, called the Geostationary Operational Environmental Satellites-R series (GOES-R). This new series is considered critical to the United States' ability to maintain the continuity of data required for weather forecasting through the year 2028.

GAO was asked to summarize and update its report previously issued to the Subcommittee on Environment, Technology, and Standards—*Geostationary Operational Environmental Satellites: Steps Remain in Incorporating Lessons Learned from Other Satellite Programs*, GAO-06-993 (Washington, D.C.: Sept. 6, 2006). This report (1) determines the status of and plans for the GOES-R series procurement, and (2) identifies and evaluates the actions that the program management team is taking to ensure that past problems experienced in procuring other satellite programs are not repeated.

What GAO Recommends

In our report, we make recommendations to the Secretary of Commerce to improve NOAA's ability to effectively manage the GOES-R procurement. In written comments, the Department of Commerce agreed with the recommendations and identified plans for implementing them.

www.gao.gov/cgi-bin/getrpt?GAO-06-1129T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact David Powner at (202) 512-9286 or pownerd@gao.gov.

What GAO Found

At the time of our review, NOAA was nearing the end of the preliminary design phase of its GOES-R system—which was estimated to cost $6.2 billion and scheduled to have the first satellite ready for launch in 2012. It expected to award a contract in August 2007 to develop this system. However, recent analyses of the GOES-R program cost—which in May 2006 the program office estimated could reach $11.4 billion—have led the agency to consider reducing the scope of requirements for the satellite series. Since our report was issued, NOAA officials told GAO that the agency has made a decision to reduce the scope of the program to a minimum of two satellites and to reduce the complexity of the program by canceling a technically complex instrument.

NOAA has taken steps to implement lessons learned from past satellite programs, but more remains to be done. Prior satellite programs—including a prior GOES series, a polar-orbiting environmental satellite series, and various military satellite programs—often experienced technical challenges, cost overruns, and schedule delays. Key lessons from these programs include the need to (1) establish realistic cost and schedule estimates, (2) ensure sufficient technical readiness of the system's components prior to key decisions, (3) provide sufficient management at government and contractor levels, and (4) perform adequate senior executive oversight to ensure mission success. NOAA has established plans to address these lessons by conducting independent cost estimates, performing preliminary studies of key technologies, placing resident government offices at key contractor locations, and establishing a senior executive oversight committee. However, many steps remain to fully address these lessons (see table). Until it completes these activities, NOAA faces an increased risk that the GOES-R program will repeat the increased cost, schedule delays, and performance shortfalls that have plagued past procurements.

Key Lessons Learned and the Activities Taken or Remaining to Fully Address Them

Lesson learned	Actions taken or under way	Actions remaining
Establish realistic cost and schedule estimates	• Obtaining multiple independent cost estimates • Conducting risk analysis of schedule estimates	• Ensuring objectivity when reconciling alternative estimates
Ensure sufficient technical readiness of the system's components prior to critical decisions	• Conducted preliminary studies of key technologies and components	• Ensuring sufficient technical maturity before proceeding to production
Provide sufficient management of contractors and subcontractors	• Increased presence at contractor sites • Plan to increase number of system engineers • Plan to hire three specialists in earned value	• Assessing the number of earned value specialists needed commensurate with increased acquisition activities
Perform effective executive-level oversight	• NOAA's program management council meets regularly to oversee project	

Source: GAO analysis.

Mr. Chairman and Members of the Committee:

We appreciate the opportunity to participate in today's hearing on the planned Geostationary Operational Environmental Satellites-R (GOES-R) program. The GOES-R series is to replace the current series of satellites which will likely begin to reach the end of their useful lives in approximately 2012. This new series is expected to mark the first major technological advance in GOES instrumentation since 1994. It is also considered critical to the United States' ability to maintain the continuity of data required for weather forecasting through the year 2028.

As requested, our testimony summarizes and updates a report we previously issued to your subcommittee that (1) determines the status of and plans for the GOES-R series procurement, and (2) identifies and evaluates the actions that the program management team is taking to ensure that past problems experienced in procuring other satellite programs are not repeated.[1] In preparing for this testimony, we relied on our work supporting the accompanying report. That report contains a detailed overview of our scope and methodology. All the work on which this testimony is based was performed in accordance with generally accepted government auditing standards.

Results in Brief

The National Oceanic and Atmospheric Administration (NOAA) is nearing the end of the preliminary design phase of its GOES-R system, which was initially estimated to cost $6.2 billion and scheduled to have the first satellite ready for launch in 2012. At the time of our review, NOAA had issued contracts for the preliminary design of the overall GOES-R system to three vendors and expected to award a contract to one of these vendors in August 2007 to develop the satellites. In addition, to reduce the risks associated with developing new instruments, NOAA issued contracts for the

[1]GAO, *Geostationary Operational Environmental Satellites: Steps Remain in Incorporating Lessons Learned from Other Satellite Programs*, GAO-06-993 (Washington, D.C.: Sept. 6, 2006).

early development of two instruments and for the preliminary designs of three other instruments. The agency plans to turn these instrument contracts over to the vendor that is awarded the contract for the overall GOES-R program. However, recent analyses of the GOES-R program cost—which in May 2006 the program office estimated could reach $11.4 billion—have led the agency to consider reducing the scope of requirements for the satellite series. At the time of our review, NOAA officials estimated that a decision on the future scope and direction of the program could be made by the end of September 2006. Since then, NOAA officials told us that the agency has made a decision to reduce the scope and complexity of the GOES-R program by reducing the number of satellites and canceling a technically complex instrument.

NOAA has taken steps to implement lessons learned from past satellite programs, but more remains to be done. Prior satellite programs—including a prior GOES series, a polar-orbiting environmental satellite series, and various military satellite programs—often experience technical challenges, cost overruns, and schedule delays. Key lessons from these programs include the need to (1) establish realistic cost and schedule estimates, (2) ensure sufficient technical readiness of the system's components prior to key decisions, (3) provide sufficient management at government and contractor levels, and (4) perform adequate senior executive oversight to ensure mission success. NOAA has established plans to address these lessons by conducting independent cost estimates, performing preliminary studies of key technologies, placing resident government offices at key contractor locations, and establishing a senior executive oversight committee. However, many steps remain to fully address these lessons. Specifically, NOAA has not yet developed a process to evaluate and reconcile the independent and government cost estimates. In addition, NOAA has not yet determined how it will ensure that a sufficient level of technical maturity will be achieved in time for an upcoming decision milestone, nor has it determined the appropriate level of resources it needs to adequately track and oversee the

program using earned value management.[2] Until it completes these activities, NOAA faces an increased risk that the GOES-R program will repeat the increased cost, schedule delays, and performance shortfalls that have plagued past procurements.

To improve NOAA's ability to effectively manage the GOES-R procurement, in our accompanying report,[3] we made recommendations to the Secretary of Commerce to direct its NOAA Program Management Council to establish a process for objectively evaluating and reconciling the government and independent life cycle cost estimates once the program requirements are finalized; to establish a team of system engineering experts to perform a comprehensive review of the Advanced Baseline Imager instrument to determine the level of technical maturity achieved on the instrument before moving the instrument into production; and to seek assistance in determining the appropriate levels of resources needed at the program office to adequately track and oversee the contractor's earned value management data. In written comments, the Department of Commerce agreed with our recommendations and provided information on its plans to implement our recommendations.

Background

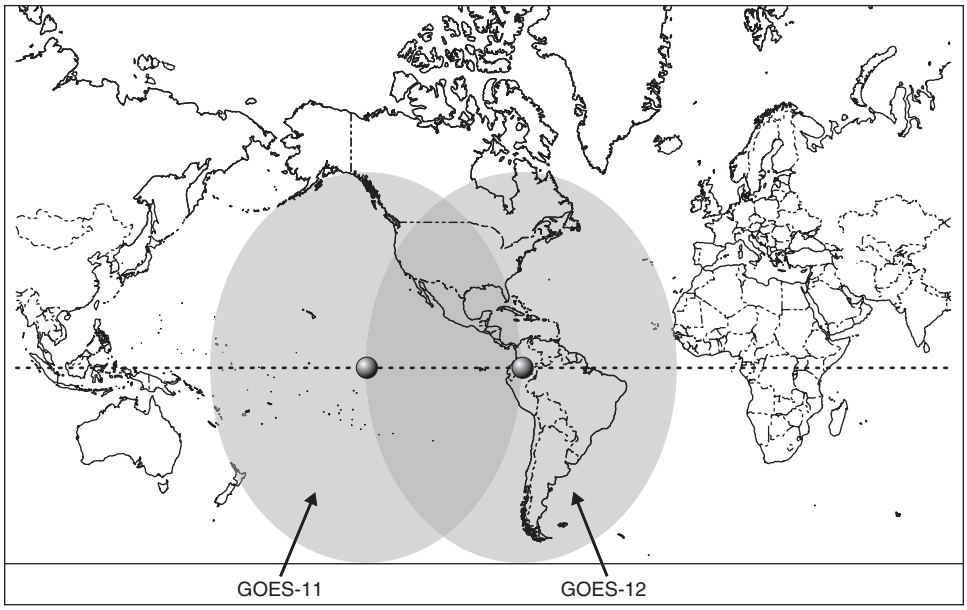
Since the 1960s, geostationary and polar-orbiting environmental satellites have been used by the United States to provide meteorological data for weather observation, research, and forecasting. NOAA's National Environmental Satellite Data and Information Service (NESDIS) is responsible for managing the civilian geostationary and polar-orbiting satellite systems as two separate programs, called GOES and the Polar Operational Environmental Satellites, respectively.

[2]Earned value management is a method that compares the value of work accomplished during a given period with that of the work expected in that period.

[3]GAO-06-993.

Unlike polar-orbiting satellites, which constantly circle the earth in a relatively low polar orbit, geostationary satellites can maintain a constant view of the earth from a high orbit of about 22,300 miles in space. NOAA operates GOES as a two-satellite system that is primarily focused on the United States (see fig. 1). These satellites are uniquely positioned to provide timely environmental data to meteorologists and their audiences on the earth's atmosphere, its surface, cloud cover, and the space environment. They also observe the development of hazardous weather, such as hurricanes and severe thunderstorms, and track their movement and intensity to reduce or avoid major losses of property and life. Furthermore, the satellites' ability to provide broad, continuously updated coverage of atmospheric conditions over land and oceans is important to NOAA's weather forecasting operations.

Figure 1: Approximate GOES Geographic Coverage



Sources: NOAA (data), Map Resources (map).

To provide continuous satellite coverage, NOAA acquires several satellites at a time as part of a series and launches new satellites every few years (see table 1).

Table 1: Summary of the Procurement History of GOES

Series name	Procurement duration[a]	Satellites
Original GOES[b]	1970–1987	1, 2, 3, 4, 5, 6, 7
GOES I-M	1985–2001	8, 9, 10, 11, 12
GOES-N	1998–2011	13, O, P, Q[c]
GOES-R	2007–2020	R, S, T, U

Source: GAO analysis of NOAA data.

[a]Duration includes time from contract award to final satellite launch.

[b]The procurement of these satellites consisted of four separate contracts for (1) two early prototype satellites and GOES-1, (2) GOES-2 and -3, (3) GOES-4 through -6, and (4) GOES-G (failed on launch) and GOES-7.

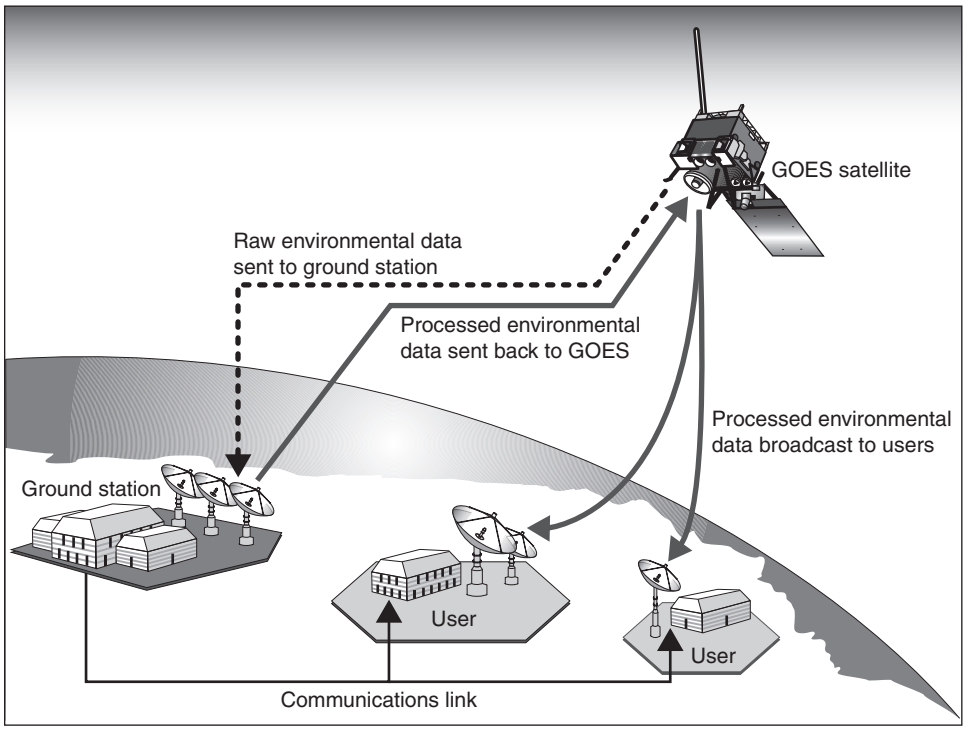
[c]NOAA decided not to exercise the option for this satellite.

Three satellites—GOES-11, GOES-12, and GOES-13—are currently in orbit. Both GOES-11 and GOES-12 are operational satellites, while GOES-13 is in an on-orbit storage mode. It is a backup for the other two satellites should they experience any degradation in service. The others in the series, GOES-O and GOES-P, are planned for launch over the next few years.[4] NOAA is also planning a future generation of satellites, known as the GOES-R series, which are planned for launch beginning in 2012.

Each of the operational geostationary satellites continuously transmits raw environmental data to NOAA ground stations. The data are processed at these ground stations and transmitted back to the satellite for broadcast to primary weather services both in the United States and around the world, including the global research community. Raw and processed data are also distributed to users via ground stations through other communication channels, such as dedicated private communication lines and the Internet. Figure 2 depicts a generic data relay pattern from the geostationary satellites to the ground stations and commercial terminals.

[4]Satellites in a series are identified by letters of the alphabet when they are on the ground and by numbers once they are in orbit.

Figure 2: Generic GOES Data Relay Pattern



Source: GAO analysis of NOAA data.

GOES-R Program—An Overview

NOAA is planning for the GOES-R program to improve on the technology of prior GOES series, in terms of both system and instrument improvements. The system improvements are expected to fulfill more demanding user requirements and to provide more rapid information updates. Table 2 highlights key system-related improvements GOES-R is expected to make to the geostationary satellite program.

Table 2: Summary of Key GOES-R System Improvements

Key feature	GOES-N (current)	GOES-R
Total products	41	~152
Downlink rate of raw data collected by instruments (from satellite to ground stations)	2.6 Mbps	132 Mbps
Broadcast rate of processed GOES data (from satellite to users)	2.1 Mbps	17–24 Mbps

Key feature	GOES-N (current)	GOES-R
Raw data storage (the length of time that raw data will be stored at ground stations)	0 days	30 days

Source: GAO analysis of NOAA data.

The instruments on the GOES-R series are expected to increase the clarity and precision of the observed environmental data. NOAA plans to acquire five different types of instruments. The program office considered two of the instruments—the Advanced Baseline Imager and the Hyperspectral Environmental Suite—to be most critical because they would provide data for key weather products.[5] Table 3 summarizes the originally planned instruments and their expected capabilities.

[5]After our report was issued on September 6, 2006, NOAA officials told us that the agency has decided to cancel its plans for the development of the Hyperspectral Environmental Suite but expects to explore options that will ensure continuity of data provided by the current GOES series.

Table 3: Expected GOES-R Series Instruments, as of June 2006

Planned instrument	Description
Advanced Baseline Imager	Expected to provide variable area imagery and radiometric information of the earth's surface, atmosphere, and cloud cover. Key features include • monitoring and tracking severe weather, • providing images of clouds to support forecasts, and • providing higher resolution, faster coverage, and broader coverage simultaneously.
Hyperspectral Environmental Suite	Expected to provide information about the earth's surface to aid in the prediction of weather and climate monitoring. Key features include • providing atmospheric moisture and temperature profiles to support forecasts and climate monitoring, • monitoring coastal regions for ecosystem health, water quality, coastal erosion, and harmful algal blooms, and • providing higher resolution and faster coverage.
Space Environmental In-Situ Suite	Expected to provide information on space weather to aid in the prediction of particle precipitation, which causes disturbance and disruption of radio communications and navigation systems. Key features include • measuring magnetic fields and charged particles, • providing improved heavy ion detection, adding low energy electrons and protons, and • enabling early warnings for satellite and power grid operation, telecom services, astronauts, and airlines.
Solar Imaging Suite	Expected to provide coverage of the entire dynamic range of solar X-ray features, from coronal holes to X-class flares, as well as estimate the measure of temperature and emissions. Key features include • providing images of the sun and measuring solar output to monitor solar storms and • providing improved imager capability.
Geostationary Lightning Mapper	Expected to continuously monitor lightning activity over the United States and provide a more complete dataset than previously possible. Key features include • detecting lightning strikes as an indicator of severe storms and • providing a new capability to GOES that only previously existed on polar satellites.

Source: GAO analysis of NOAA data.

GOES-R Program Office Structure

The program management structure for the GOES-R program differs from past GOES programs. Prior to the GOES-R series, NOAA was responsible for program funding, procurement of the ground elements, and on-orbit operation of the satellites, while NASA was responsible for the procurement of the spacecraft, instruments, and launch services. NOAA officials stated that this approach limited the agency's insight and management involvement in the procurement of major elements of the system.

Alternatively, under the GOES-R management structure, NOAA has responsibility for the procurement and operation of the overall system—including spacecraft, instruments, and launch services. NASA is responsible for the procurement of the individual instruments until they are transferred to the overall GOES-R system contractor for completion and integration onto the spacecraft. Additionally, to take advantage of NASA's acquisition experience and technical expertise, NOAA located the GOES-R program office at NASA's Goddard Space Flight Center. It also designated key program management positions to be filled with NASA personnel. These positions include the deputy system program director role for advanced instrument and technology infusion, the project manager for the flight portion of the system, and the deputy project manager for the ground and operations portion of the system. NOAA officials explained that they changed the management structure for the GOES-R program in order to streamline oversight and fiduciary responsibilities, but that they still plan to rely on NASA's expertise in space system acquisitions.

Satellite Programs Often Experience Technical Problems, Cost Overruns, and Schedule Delays

Satellite programs are often technically complex and risky undertakings, and as a result, they often experience technical problems, cost overruns, and schedule delays. We and others have reported on a historical pattern of repeated missteps in the procurement of major satellite systems, including the National Polar-orbiting Operational Environmental Satellite System (NPOESS), the GOES I-M series, the Space Based Infrared System High Program (SBIRS-High), and the Advanced Extremely High Frequency Satellite System (AEHF).[6] Table 4 lists key problems experienced with these programs.

[6]GAO, *Defense Acquisitions: Space System Acquisition Risks and Keys to Addressing Them*, GAO-06-776R (Washington, D.C.: June 1, 2006); *Polar-orbiting Operational Environmental Satellites: Cost Increases Trigger Review and Place Program's Direction on Hold*, GAO-06-573T (Washington, D.C.: Mar. 30, 2006); *Polar-orbiting Operational Environmental Satellites: Technical Problems, Cost Increases, and Schedule Delays Trigger Need for Difficult Trade-off Decisions*, GAO-06-249T (Washington, D.C.: Nov. 16, 2005); *Polar-orbiting Environmental Satellites: Information on Program Cost and Schedule Changes*, GAO-04-1054 (Washington, D.C.: Sept. 30, 2004); *Defense Acquisitions: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns*, GAO-04-48 (Washington, D.C.: Oct. 31, 2003); *Military Space Operations: Common Problems and Their Effects on Satellite and Related Acquisitions*, GAO-03-825R (Washington, D.C.: June 2, 2003); *Defense Acquisitions: Assessments of Major Weapon Programs*, GAO-03-476 (Washington, D.C.: May 15, 2003); *Weather Satellites: Action Needed to Resolve Status of the U.S. Geostationary Satellite Program*, GAO/NSIAD-91-252 (Washington, D.C.: July 24, 1991). Defense Science Board/Air Force Scientific Advisory Board Joint Task Force, *Report on the Acquisition of National Security Space Programs* (May 2003).

Table 4: Key Problems Experienced on Selected Major Space Systems

Problem	NPOESS	GOES I-M	SBIRS–High	AEHF
Insufficient technical readiness prior to critical decision points				
Inadequate preliminary studies prior to the decision to award a development contract	X	X	X	
Insufficient technical maturity prior to the decision to move to production	X	X	X	X
Unrealistic cost and schedule estimates				
Optimistic assumptions including:				
• savings from heritage systems	X	X	X	
• readiness of technology maturity	X	X	X	X
• constant and available industrial base			X	
• no weight growth	X		X	X
• no requirements growth				X
• savings from lot buys versus single-unit purchase			X	
• overly aggressive schedule	X	X	X	X
Poor program and contractor management				
Quality and subcontractor issues	X	X	X	X
Inadequate systems engineering capabilities	X	X	X	X
Inadequate earned value management capabilities	X		X	X
Insufficient management reserve	X			X
Ineffective contract award fee structure	X	X	X	
Poor senior executive level oversight				
Infrequent meetings	X			
Inability to make timely decisions	X			
Other				
Unstable funding stream	X		X	X
Unstable requirements			X	X

Source: GAO analysis of NOAA and DOD data.

GOES-R Procurement Activities Are Under Way, but System Requirements and Cost Estimates Are Changing

At the time of our review, NOAA was nearing the end of the preliminary design phase on its GOES-R program and planned to award a contract for the system's development in August 2007. However, because of concerns with potential cost growth, NOAA's plans for the GOES-R procurement are changing. To date, NOAA has issued contracts for the preliminary design of the overall GOES-R system to three vendors and expects to award a contract to one of these vendors to develop the system. In addition, to reduce the risks associated with developing new instruments, NASA has issued

contracts for the early development of two instruments and for the preliminary designs of three other instruments.[7] The agency plans to award these contracts and then turn them over to the contractor responsible for the overall GOES-R program. However, this approach is under review and NOAA may wait until the instruments are fully developed before turning them over to the system contractor. Table 5 provides a summary of the status of contracts for the GOES-R program.

Table 5: Status of GOES-R Program Contracts, as of September 6, 2006

Contract item	Date contract was awarded for design	Planned date contract will be awarded for development
Instruments		
Advanced Baseline Imager	May 2001	September 2004 (actual)
Space Environmental In-Situ Suite	December 2004	August 2006 (actual)
Solar Imaging Suite	September 2004	September 2006
Hyperspectral Environmental Suite	June 2004	June 2007
Geostationary Lightning Mapper	February 2006	August 2007
GOES-R System		
Acquisition and Operations	October 2005	August 2007

Source: NOAA.

According to program documentation provided to the Office of Management and Budget in 2005, the official life cycle cost estimate for GOES-R was approximately $6.2 billion (see table 6). However, program officials reported that this estimate was over 2 years old and under review.

[7]The development contract for the Space Environmental In-Situ Suite instrument was issued after we completed our review.

Table 6: GOES-R Program Life Cycle Cost Estimate, as of June 2006

Major cost category	Dollars in millions
System level	$533
Space segment	2,494
Ground segments	729
Launch segment	686
Operations and support	1,147
Government program office	637
Total	**$6,226**

Source: NOAA.

At the time of our review, NOAA was planning to launch the first GOES-R series satellite in September 2012.[8] The development of the schedule for launching the satellites was driven by a requirement that the satellites be available to back up the last remaining GOES satellites (GOES-O and GOES-P) should anything go wrong during the planned launches of these satellites. Table 7 provides a summary of the planned launch schedule for the originally planned GOES-R series.

Table 7: GOES-R Program Schedule, as of September 6, 2006

Milestone	Planned date
GOES-O launch[a]	April 2008
GOES-P launch[a]	October 2009[b]
GOES-R satellite available for launch	September 2012
GOES-S satellite available for launch	April 2014
GOES-T satellite available for launch	October 2015
GOES-U satellite available for launch	April 2017
End of operations and maintenance	2028

Source: NOAA.

[a]GOES-O and GOES-P are not part of the GOES-R series program. Their launch dates are provided because of their relevance to the GOES-R series satellite schedules.

[b]Because GOES satellites have been operating longer than expected, NOAA is considering moving the planned launch of the GOES-P satellite to July 2011.

[8]After our report was issued on September 6, 2006, NOAA officials told us that the planned launch schedule was being delayed. The expected launch of the first GOES-R series satellite is now planned for December 2014.

However, NOAA's plans for the GOES-R procurement are changing because of concerns with potential cost growth. Given its experiences with cost growth on the NPOESS acquisition, NOAA asked program officials to recalculate the total cost of the estimated $6.2 billion GOES-R program. In May 2006, program officials estimated that the life cycle cost could reach $11.4 billion. The agency then requested that the program identify options for reducing the scope of requirements for the satellite series. Program officials reported that there were over 10 viable options under consideration, including options for removing one or more of the planned instruments. The program office also reevaluated its planned acquisition schedule based on the potential program options. Specifically, program officials stated that if there was a decision to make a major change in system requirements, they would likely extend the preliminary design phase, delay the decision to proceed into the development and production phase, and delay the contract award date. At the time of our review, NOAA officials estimated that a decision on the future scope and direction of the program could be made by the end of September 2006.

Recent NOAA Decision on the Direction and Scope of the GOES-R Program

In mid-September 2006, NOAA officials reported that a decision on the future scope and direction of GOES-R had been made—and involved a reduction in the number of satellites and in planned program capabilities, a revised life cycle cost estimate, and the delay of key programmatic milestones. Specifically, NOAA reduced the minimum number of satellites to two. In addition, plans for developing the Hyperspectral Environmental Suite—which was once considered a critical instrument by the agency—were cancelled. Instead, the program office is exploring options that will ensure continuity of sounding data currently provided by the current GOES series.[9] NOAA officials reported that the cost of the restructured program is not known, but some anticipate it will be

[9]The Hyperspectral Environmental Suite was intended to be the successor to the sounder instrument onboard the current GOES series. The sounder measures radiated energy at different depths (altitudes) and also records surface and cloud-top temperatures and ozone distribution.

close to the original program estimate of $6.2 billion. The contract award for the GOES-R system has been pushed out to May 2008. Finally, the planned launch date of the first satellite in the GOES-R series has been delayed until December 2014.

The GOES-R Program Office Has Taken Steps to Address Past Lessons Learned, but Significant Actions Remain

NOAA has taken steps to apply lessons learned from problems encountered on other satellite programs to the GOES-R procurement. Key lessons include (1) establishing realistic cost and schedule estimates, (2) ensuring sufficient technical readiness of the system's components prior to key decisions, (3) providing sufficient management at government and contractor levels, and (4) performing adequate senior executive oversight to ensure mission success. NOAA has established plans designed to mitigate the problems faced in past acquisitions; however, many activities remain to fully address these lessons. Until it completes these activities, NOAA faces an increased risk that the GOES-R program will repeat the increased cost, schedule delays, and performance shortfalls that have plagued past procurements.

Efforts to Improve Reliability of Cost and Schedule Estimates are Under Way, but Key Steps Remain in Reconciling Cost Estimates

We and others have reported that space system acquisitions are strongly biased to produce unrealistically low cost and schedule estimates in the acquisition process.[10] Our past work on military space acquisitions has indicated that during program formulation, the competition to win funding is intense and has led program sponsors to minimize their program cost estimates. NOAA programs face similar unrealistic estimates. For example, the total development cost of the GOES I-M acquisition was over three times

[10]GAO, *Space Acquisitions: Stronger Development Practices and Investment Planning Needed to Address Continuing Problems*, GAO-05-891T (Washington, D.C.: July 12, 2005). Defense Science Board/Air Force Scientific Advisory Board Joint Task Force, *Report on the Acquisition of National Security Space Programs* (May 2003).

greater than planned, escalating from $640 million to $2 billion. Additionally, the delivery of the first satellite was delayed by 5 years.

NOAA has several efforts under way to improve the reliability of its cost and schedule estimates for the GOES-R program. NOAA's Chief Financial Officer has contracted with a cost-estimating firm to complete an independent cost estimate, while the GOES-R program office has hired a support contractor to assist with its internal program cost estimating. The program office is re-assessing its estimates based on preliminary information from the three vendors contracted to develop preliminary designs for the overall GOES-R system. Once the program office and independent cost estimates are completed, program officials intend to compare them and to develop a revised programmatic cost estimate that will be used in its decision on whether to proceed into system development and production. In addition, NOAA has planned for an independent review team—consisting of former senior industry and government space acquisition experts—to provide an assessment of the program office and independent cost estimates for this decision milestone. To improve its schedule reliability, the program office is currently conducting a schedule risk analysis in order to estimate the amount of adequate reserve funds and schedule margin needed to deal with unexpected problems and setbacks. Finally, the NOAA Observing System Council[11] submitted a prioritized list of GOES-R system requirements to the Commerce Undersecretary for approval. This list is expected to allow the program office to act quickly in deleting lower priority requirements in the event of severe technical challenges or shifting funding streams.

While NOAA acknowledges the need to establish realistic cost and schedule estimates, several hurdles remain. As discussed earlier, the agency was considering—during the time of our review—reducing the requirements for the GOES-R program to mitigate the increased cost estimates for the program. Prior to this decision, the agency's

[11]NOAA's Observing System Council is the principal advisory council for NOAA's earth observation and data management activities. It includes members from each NOAA line office, other relevant councils, and program offices. The Assistant Administrator for Satellite and Information Services and the Assistant Administrator for Weather Services serve as the co-chairs of the council.

efforts to establish realistic cost estimates could not be fully effective in addressing this lesson. In addition, NOAA suspended the work being performed by its independent cost estimator. Now that the program scope and direction is being further defined, it will be important for the agency to restart this work. Further, the agency has not yet developed a process to evaluate and reconcile the independent and program office cost estimates once final program decisions are made. Without this process, the agency may lack the objectivity necessary to counter the optimism of program sponsors and is more likely to move forward with an unreliable estimate. Until it completes this activity, NOAA faces an increased risk that the GOES-R program will repeat the cost increases and schedule delays that have plagued past procurements.

Preliminary Studies Are Under Way, but Steps Remain in Determining Components' Technical Maturity

Space programs often experience unforeseen technical problems in the development of critical components as a result of having insufficient knowledge of the components and their supporting technologies prior to key decision points. One key decision point is when an agency decides on whether the component is sufficiently ready to proceed from a preliminary study phase into a development phase; this decision point results in the award of the development contract. Another key decision point occurs during the development phase when an agency decides whether the component is ready to proceed from design into production (also called the critical design review). Without sufficient technical readiness at these milestones, agencies could proceed into development contracts on components that are not well understood and enter into the production phase of development with technologies that are not yet mature.

In 1997, NOAA began preliminary studies on technologies that could be used on the GOES-R instruments. These studies target existing technologies and assessed how they could be expanded for GOES-R. The program office is also conducting detailed trade-off studies on the integrated system to improve its ability to make decisions that balance performance, affordability, risk, and schedule. For instance, the program office is analyzing the potential architectures for the GOES-R constellation of satellites—the quantity and configuration of satellites, including how the instruments will be distributed over

these satellites. These studies are expected to allow for a more mature definition of the system specifications.

NOAA has also developed plans to have an independent review team assess project status on an annual basis once the overall system contract has been awarded. In particular, this team will review technical, programmatic, and management areas; identify any outstanding risks; and recommend corrective actions. This measure is designed to ensure that sufficient technical readiness has been reached prior to the critical design review milestone. The program office's ongoing studies and plans are expected to provide greater insight into the technical requirements for key system components and to mitigate the risk of unforeseen problems in later acquisition phases.

However, the progress currently being made on a key instrument currently under development—the Advanced Baseline Imager—has experienced technical problems and could be an indication of more problems to come in the future. These problems relate to, among other things, the design complexity of the instrument's detectors and electronics. As a result, the contractor is experiencing negative cost and schedule performance trends. As of May 2006, the contractor incurred a total cost overrun of almost $6 million with the instrument's development only 28 percent complete. In addition, from June 2005 to May 2006, it was unable to complete approximately $3.3 million worth of work. Unless risk mitigation actions are aggressively pursued to reverse these trends, we project the cost overrun at completion to be about $23 million.

While NOAA expects to make a decision on whether to move the instrument into production (a milestone called the critical design review) in January 2007, the contractor's current performance raises questions as to whether the instrument designs will be sufficiently mature by that time. Further, the agency does not have a process to validate the level of technical maturity achieved on this instrument or to determine whether the contractor has implemented sound management and process engineering to ensure that the appropriate level of technical readiness can be achieved prior to the decision milestone. Until it does so, NOAA risks making a poor decision based on inaccurate or insufficient information—which could lead

to unforeseen technical problems in the development of this instrument.

Efforts to Strengthen Government and Contractor Management are Under Way, but Significant Work on Program Controls Remain

In the past, we have reported on poor performance in the management of satellite acquisitions.[12] The key drivers of poor management included inadequate systems engineering and earned value management[13] capabilities, unsuitable allocation of contract award fees, inadequate levels of management reserve, and inefficient decision-making and reporting structure within the program office.

NOAA has taken numerous steps to restructure its management approach on the GOES-R procurement in an effort to improve performance and to avoid past mistakes. These steps include:

- The program office revised its staffing profile to provide for government staff to be located on-site at prime contractor and key subcontractor locations.
- The program office plans to increase the number of resident systems engineers from 31 to 54 to provide adequate government oversight of the contractor's system engineering, including verification and validation of engineering designs at key decision points (such as the critical design review milestone).
- The program office has better defined the role and responsibilities of the program scientist, the individual who is expected to maintain an independent voice with regard to scientific matters and advise the program manager on related technical issues and risks.

[12]GAO-06-573T, GAO-06-249T, GAO/NSIAD-91-252, *Defense Acquisitions: DOD Has Paid Billions in Award and Incentive Fees Regardless of Acquisition Outcomes*, GAO-06-66 (Washington, D.C.: Dec. 19, 2005), and *Weather Satellites: Cost Growth and Development Delays Jeopardize U.S. Forecasting Ability*, GAO/NSIAD-89-169 (Washington, D.C.: June 30, 1989).

[13]Earned value management is a method, used by DOD for several decades, to track a contractor's progress in meeting project deliverables. It compares the value of work accomplished during a given period with that of the work expected in that period. Differences from expectations are measured in both cost and schedule variances.

- The program office also intends to add three resident specialists in earned value management to monitor contractor cost and schedule performance.
- NOAA has work under way to develop the GOES-R contract award fee structure and the award fee review board that is consistent with our recent findings, the Commerce Inspector General's findings, and other best practices, such as designating a non-program executive as the fee-determining official to ensure objectivity in the allocation of award fees.
- NOAA and NASA have implemented a more integrated management approach that is designed to draw on NASA's expertise in satellite acquisitions and increase NOAA's involvement on all major components of the acquisition.
- The program office reported that it intended to establish a management reserve of 25 percent consistent with the recommendations of the Defense Science Board Report on Acquisition of National Security Space Programs.[14]

While these steps should provide more robust government oversight and independent analysis capabilities, more work remains to be done to fully address this lesson. Specifically, the program office has not determined the appropriate level of resources it needs to adequately track and oversee the program and the planned addition of three earned value management specialists may not be enough as acquisition activities increase. By contrast, after its recent problems and in response to the independent review team findings, NPOESS program officials plan to add 10 program staff dedicated to earned value, cost, and schedule analysis. An insufficient level of established capabilities in earned value management places the GOES-R program office at risk of making poor decisions based on inaccurate and potentially misleading information. Finally, while NOAA officials believe that assuming sole responsibility for the acquisition of GOES-R will improve their ability to manage the program effectively, this change also elevates NOAA's risk for mission success. Specifically, NOAA is taking on its first major system acquisition and an increased risk due to its lack of

[14]Defense Science Board/Air Force Scientific Advisory Board Joint Task Force, *Report on the Acquisition of National Security Space Programs* (May 2003).

experience. Until it fully addresses the lesson of ensuring an appropriate level of resources to oversee its contractor, NOAA faces an increased risk that the GOES-R program will repeat the management and contractor performance shortfalls that have plagued past procurements.

NOAA Has Established a Senior Executive Committee to Perform Oversight Role

We and others have reported on NOAA's significant deficiencies in its senior executive oversight of NPOESS.[15] The lack of timely decisions and regular involvement of senior executive management was a critical factor in the program's rapid cost and schedule growth.

NOAA formed its program management council in response to the lack of adequate senior executive oversight on NPOESS. In particular, this council is expected to provide regular reviews and assessments of selected NOAA programs and projects—the first of which is the GOES-R program. The council is headed by the NOAA Deputy Undersecretary and includes senior officials from Commerce and NASA. The council is expected to hold meetings to discuss GOES-R program status on a monthly basis and to approve the program's entry into subsequent acquisition phases at key decision milestones—including contract award and critical design reviews, among others. Since its establishment in January 2006, the council has met regularly and has established a mechanism for tracking action items to closure.

The establishment of the NOAA Program Management Council is a positive action that should support the agency's senior-level governance of the GOES-R program. In moving forward, it is important that this council continue to meet on a regular basis and exercise diligence in questioning the data presented to it and making difficult decisions. In particular, it will be essential that the results of all preliminary studies and independent assessments on technical maturity of the system and its components be reviewed by this

[15]GAO-06-573T; Department of Commerce Office of Inspector General, *Poor Management Oversight and Ineffective Incentives Leave NPOESS Program Well Over Budget and Behind Schedule*, OIG-17794-6-0001 (May 8, 2006).

council so that an informed decision can be made about the level of technical complexity it is taking on when proceeding past these key decision milestones. In light of the recent uncertainty regarding the future scope and cost of the GOES-R program, the council's governance will be critical in making those difficult decisions in a timely manner.

Implementation of GAO Recommendations Should Improve NOAA's Efforts to Implement Lessons Learned

To improve NOAA's ability to effectively manage the GOES-R procurement, in our accompanying report,[16] we recommended that the Secretary direct its NOAA Program Management Council to take the following three actions:

- Once the scope of the program has been finalized, establish a process for objectively evaluating and reconciling the government and independent life cycle cost estimates.
- Perform a comprehensive review of the Advanced Baseline Imager, using system engineering experts, to determine the level of technical maturity achieved on the instrument, to assess whether the contractor has implemented sound management and process engineering, and to assert that the technology is sufficiently mature before moving the instrument into production.
- Seek assistance from an independent review team to determine the appropriate level of resources needed at the program office to adequately track and oversee the contractor's earned value management. Among other things, the program office should be able to perform a comprehensive integrated baseline review after system development contract award, provide surveillance of contractor earned value management systems, and perform project scheduling analyses and cost estimates.

[16] GAO-06-993.

In written comments, Commerce agreed with our recommendations and provided information on its plans to implement our recommendations. In particular, Commerce intends to establish a process for evaluating and reconciling the various cost estimates and to analyze this process and the results with an independent review team comprised of recognized satellite acquisition experts. The agency is also planning to have this independent review team provide assessments of the Advanced Baseline Imager's technical maturity and the adequacy of the program management's staffing plans.

In summary, the procurement of the next series of geostationary environmental satellites—called the GOES-R series—is at a critical juncture. Recent concerns about the potential for cost growth on the GOES-R procurement have led the agency to reduce the scope of requirements for the satellite series. According to NOAA officials, the current plans call for acquiring 2 satellites and moving away from a technically complex new instrument in favor of existing technologies. While reducing the technical complexity of the system prior to contract award and defining an affordable program are sound business practices, it will be important for NOAA to balance these actions with the agencies' long term need for improving geostationary satellites over time.

While NOAA is positioning itself to improve the acquisition of this system by incorporating the lessons learned from other satellite procurements including the need to establish realistic cost estimates, ensure sufficient government and contractor management, and obtain effective executive oversight, further steps remain to fully address selected lessons and thereby mitigate program risks. Specifically, NOAA has not yet developed a process to evaluate and reconcile the independent and government cost estimates. In addition, NOAA has not yet determined how it will ensure that a sufficient level of technical maturity will be achieved in time for an upcoming decision milestone or determined the appropriate level of resources it needs to adequately track and oversee the program using earned value management. Moreover,

problems that are frequently experienced on major satellite acquisitions, including insufficient technical maturity, overly aggressive schedules, inadequate systems engineering capabilities, and insufficient management reserve will need to be closely monitored throughout this critical acquisition's life cycle. To NOAA's credit, it has begun to develop plans for implementing our recommendations. These plans include, among other things, establishing a process to evaluate and reconcile the various cost estimates and obtaining assessments from an independent review team on the technical maturity of a key instrument in development and the adequacy of the program management's staffing plans. However, until it addresses these lessons, NOAA faces an increased risk that the GOES-R program will repeat the increased cost, schedule delays, and performance shortfalls that have plagued past procurements.

Mr. Chairman, this concludes my statement. I would be happy to answer any questions that you or members of the committee may have at this time.

If you have any questions on matters discussed in this testimony, please contact me at (202) 512-9286 or by e-mail at pownerd@gao.gov. Other key contributors to this testimony include Carol Cha, Neil Doherty, Nancy Glover, Kush Malhotra, Colleen Phillips, and Karen Richey.

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