United States Government Accountability Office

GAO

Report to Congressional Committees

September 2010

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES

Improvements Needed in Continuity Planning and Involvement of Key Users

GAO-10-799

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Improvements Needed in Continuity Planning and Involvement of Key Users

GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-10-799, a report to congressional committees

Why GAO Did This Study

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), with the aid of the National Aeronautics and Space Administration (NASA), is to procure the next generation of geostationary operational environmental satellites, called Geostationary Operational Environmental Satellite-R (GOES-R) series. 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 2015. 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 (1) determine the status of the GOES-R acquisition; (2) evaluate whether NOAA has established adequate contingency plans in the event of delays; and (3) assess NOAA's efforts to identify GOES data users, prioritize their data needs, and communicate with them about the program's status. To do so, GAO analyzed contractor and program data and interviewed officials from NOAA, NASA, and other federal agencies that rely on GOES data.

What GAO Recommends

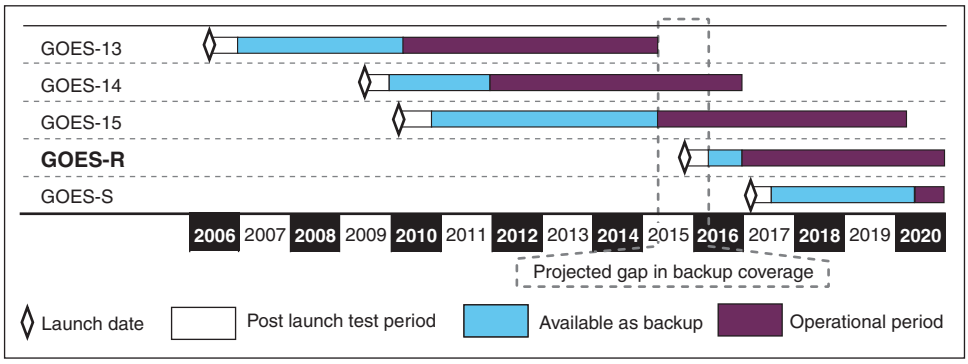
GAO is recommending that NOAA address weaknesses in its continuity plans and improve its processes for involving other federal agencies. In commenting on a draft of this report, the Secretary of Commerce agreed with GAO's recommendations and identified plans for implementing them.

To view the full product, including the scope and methodology, click on GAO-10-799. For more information, contact David A. Powner, (202) 512-9286, pownerd@gao.gov.

What GAO Found

NOAA has made progress on the GOES-R acquisition, but key instruments have experienced challenges and important milestones have been delayed. The GOES-R program awarded key contracts for its flight and ground projects, and these are in development. However, two instruments have experienced technical issues that led to contract cost increases, and significant work remains on other development efforts. In addition, since 2006, the launch dates of the first two satellites in the series have been delayed by about 3 years. As a result, NOAA may not be able to meet its policy of having a backup satellite in orbit at all times, which could lead to a gap in coverage if GOES-14 or GOES-15 fails prematurely (see graphic).

Potential Gap in GOES Coverage



Source: GAO analysis of NOAA data.

Even though there may be a gap in backup coverage, NOAA has not established adequate continuity plans for its geostationary satellites. To its credit, NOAA has established a policy to always have a backup satellite available and high-level plans if that policy is not met. Specifically, in the event of a satellite failure with no backup available, NOAA plans to reduce to a single satellite and, if available, rely on a satellite from an international partner. However, NOAA does not have plans that include processes, procedures, and resources needed to transition to a single or an international satellite. Without such plans, NOAA faces an increased risk that users will lose access to critical data.

While NOAA has identified GOES data users and involved internal users in developing and prioritizing the GOES-R requirements, it has not adequately involved other federal users that rely on GOES data. Specifically, NOAA's processes for developing and prioritizing satellite requirements do not include documented input from other federal agencies. Further, since 2006, the GOES-R program has undergone significant changes (such as the removal of certain satellite data products), but these have not been communicated to federal agencies. Until improvements are made in NOAA's processes for involving key federal users, these users may not be able to meet mission requirements.

Contents

Abbreviations

GOES-R	Geostationary Operational Environmental Satellite-R series
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service

GAO
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United States Government Accountability Office
Washington, DC 20548

September 1, 2010

The Honorable Bart Gordon
Chairman
The Honorable Ralph Hall
Ranking Member
Committee on Science and Technology
House of Representatives

The Honorable Brad Miller
Chairman
The Honorable Paul Broun, Jr.
Ranking Member
Subcommittee on Investigations and Oversight
Committee on Science and Technology
House of Representatives

Operational geostationary environmental satellites play a critical role in our nation's weather forecasting. These satellites—which are managed by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA)—provide critical information on atmospheric, oceanic, climatic, and solar conditions that help meteorologists observe and predict global and local weather events. They also provide a means to identify severe storm conditions, such as hurricanes and tornadoes, and to track the movement and intensity of these storms once they develop.

NOAA, with the aid of the National Aeronautics and Space Administration (NASA), is procuring the next generation of geostationary satellites, called the Geostationary Operational Environmental Satellite-R (GOES-R) series. 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 2015. 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.

This report responds to your request that we review NOAA's management of the GOES-R program. Specifically, we were asked to (1) determine the status of the GOES-R acquisition, including cost, schedule, and performance trends; (2) evaluate whether NOAA has established adequate contingency plans in the event of delays; and (3) assess NOAA's efforts to

identify GOES data users, prioritize their data needs, and communicate with them about the program's status.

To determine GOES-R acquisition status, we evaluated program documents, including acquisition plans, contractor performance reports on development efforts, and executive briefings. To evaluate whether NOAA has established contingency plans, we compared NOAA's contingency planning documentation to federal requirements and industry best practices and also met with key GOES data users to determine the potential impact of NOAA's plans on their data needs. To determine the adequacy of NOAA's efforts to identify GOES users, prioritize their data needs, and communicate program status, we compared relevant program documents, including acquisition plans, user requirements, and GOES user group meeting minutes, to industry best practices. We also interviewed key users of GOES data to determine whether NOAA's efforts to prioritize their data needs and communicate program status and changes were adequate.

We conducted this performance audit from October 2009 to September 2010, 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 audit objectives. Appendix I contains further details on our objectives, scope, and methodology.

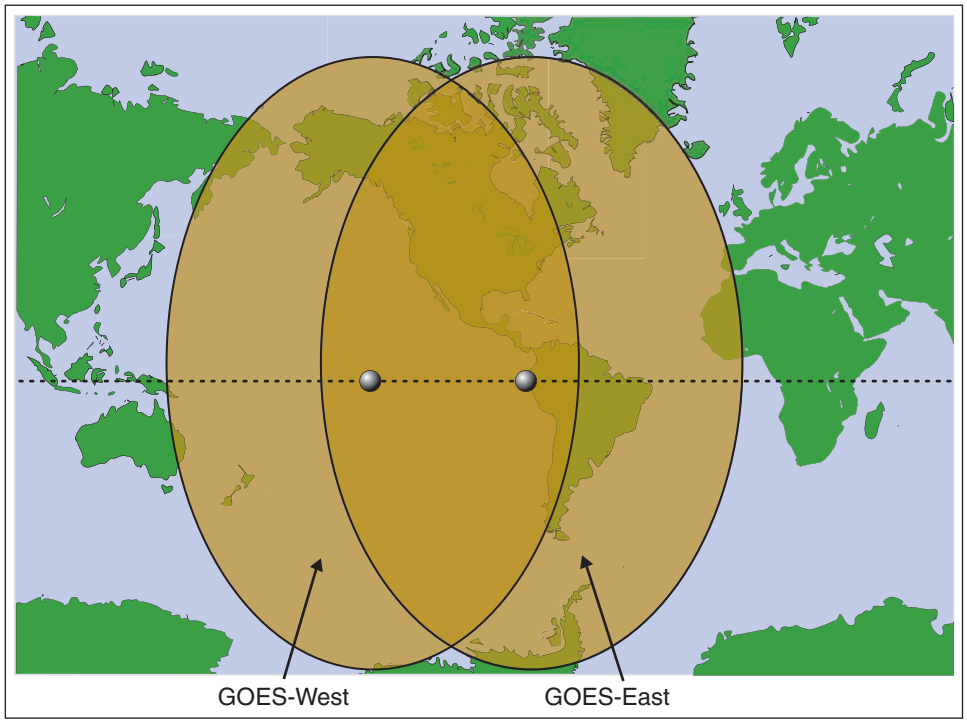
Background

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 operational geostationary and polar-orbiting satellite systems as two separate programs, called GOES and the Polar-orbiting Operational Environmental Satellites, respectively.

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 about the earth's atmosphere, surface, cloud cover, and the space environment to meteorologists and their

audiences. 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), MapArt (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).[1] NOAA's policy is to have two operational satellites and one backup satellite in orbit at all times.

[1]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.

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	1998-2010	13, 14, 15, Q[c]
GOES-R	2008-2017	R, S

Source: GAO analysis of NOAA data.

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

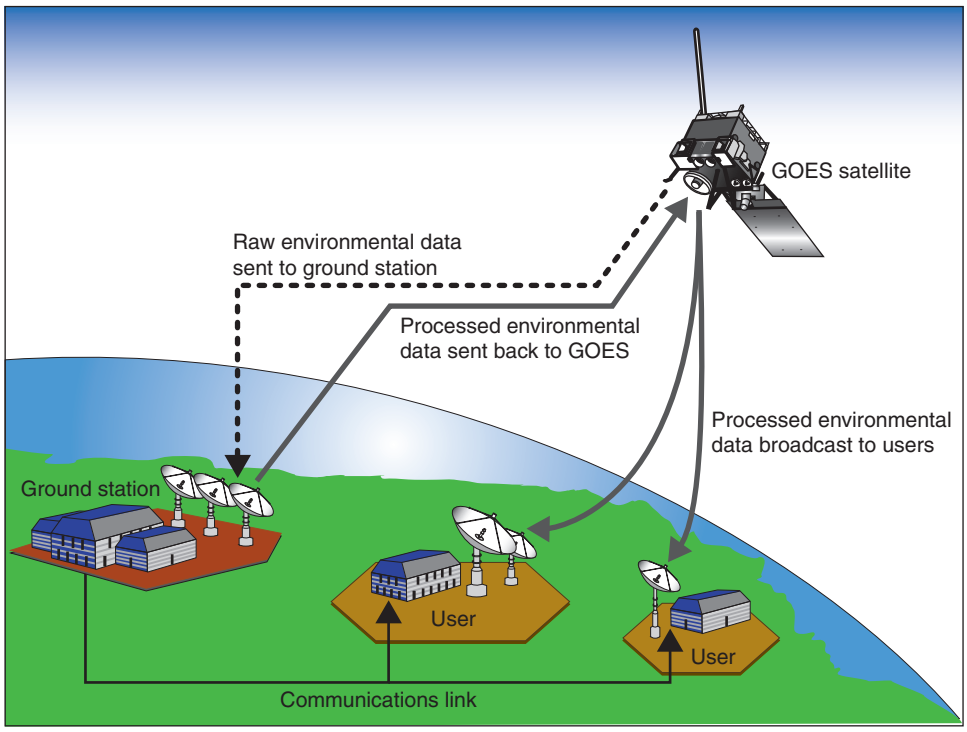
[b]The procurement of these satellites consisted of four separate contracts for (1) two early prototype satellites and GOES-1, (2) GOES-2 and -3, (3) GOES-4 through -6, and (4) GOES-G (failed on launch) and GOES-7.

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

Five GOES satellites—GOES-11, GOES-12, GOES-13, GOES-14, and GOES-15—are currently in orbit. Both GOES-11 and GOES-13 are operational satellites, with GOES-11 covering the west and GOES-13 the east. GOES-14 is currently a backup for the other two satellites should they experience any degradation in service. The final satellite in the series, GOES-15, is undergoing a post-launch test period until October 2010, at which time it will also be put in on-orbit storage mode. GOES-12 is at the end of its service life, but is being used to provide coverage of South America. The GOES-R series is the next generation of satellites that NOAA is planning; the satellites are planned for launch beginning in 2015.

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 and the global research community in the United States and abroad. 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.

Figure 2: Generic GOES Data Relay Pattern



Source: GAO analysis of NOAA data.

Overview of the GOES-R Program

NOAA plans for the GOES-R program to improve on the technology of prior series, in terms of both system and instrument improvements. The system improvements are expected to fulfill more demanding user requirements by updating the satellite data more often and providing satellite products to users more quickly. The instrument improvements are expected to significantly increase the clarity and precision of the observed environmental data. NOAA originally planned to acquire six different types of instruments. Furthermore, two of these instruments—the Advanced Baseline Imager and the Hyperspectral Environmental Suite—were considered to be the most critical because they would provide data for key weather products. Table 2 summarizes the originally planned instruments and their expected capabilities.

Table 2: Originally Planned GOES-R Series Instruments, as of August 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[a]	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 of the rapidly evolving pre-storm convective environment to support forecasts and warnings of high-impact weather phenomena; • monitoring coastal regions for ecosystem health, water quality, coastal erosion, and harmful algal blooms; and • providing higher resolution and faster coverage.
Geostationary Lightning Mapper	Expected to continuously monitor total lightning (in-cloud and cloud-to-ground) activity over the United States and adjacent oceans and to provide a more complete dataset than previously possible. Key features include • detecting lightning activity as an indicator of severe storms and convective weather hazard impacts to aviation, and • providing a new capability to GOES for long-term mapping of total lightning that only previously existed on NASA low-earth-orbiting research satellites.
Magnetometer	Expected to provide information on the general level of geomagnetic activity, monitor current systems in space, and permit detection of magnetopause crossings, sudden storm commencements, and substorms.
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[b]	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.

Source: GAO analysis of NOAA data.

[a]The Hyperspectral Environmental Suite was cancelled in September 2006.

[b]The Solar Imaging Suite was divided into two separate acquisitions, the Solar Ultraviolet Imager and the Extreme Ultraviolet/X-Ray Irradiance Sensor.

However, in September 2006, NOAA decided to reduce the scope and technical complexity of the GOES-R program because of expectations that total costs, which were originally estimated to be $6.2 billion, could reach $11.4 billion.[2] Specifically, NOAA reduced the minimum number of satellites from four to two, cancelled plans for developing the Hyperspectral Environmental Suite (which reduced the number of planned satellite products from 81 to 68), and divided the Solar Imaging Suite into two separate acquisitions. In light of the cancellation of the Hyperspectral Environmental Suite, NOAA decided to use the planned Advanced Baseline Imager to develop certain satellite data products that were originally to be produced by this instrument. The agency estimated that the revised program would cost $7 billion.

Subsequently, NOAA made several other important decisions about the cost and scope of the GOES-R program.[3] In May 2007, NOAA had an independent cost estimate completed for the GOES-R program. After reconciling the program office's cost estimate of $7 billion with the independent cost estimate of about $9 billion, the agency established a new program cost estimate of $7.67 billion. This was an increase of $670 million from the previous estimate. Further, in November 2007, to mitigate the risk that costs would rise, program officials decided to remove selected program requirements from the baseline program and treat them as contract options that could be exercised if funds allow. These requirements include the number of products to be distributed, the time to deliver the remaining products (product latency), and how often these products are updated with new satellite data (refresh rate). For example, program officials eliminated the requirement to develop and distribute 34 of the 68 envisioned products, including aircraft icing threat, turbulence,

[2]GAO, *Geostationary Operational Environmental Satellites: Additional Action Needed to Incorporate Lessons Learned from Other Satellite Programs*, GAO-06-1129T (Washington, D.C.: Sept. 29, 2006) and *Geostationary Operational Environmental Satellites: Steps Remain in Incorporating Lessons Learned from Other Satellite Programs*, GAO-06-993 (Washington, D.C.: Sept. 6, 2006).

[3]GAO, *Geostationary Operational Environmental Satellites: Acquisition Has Increased Costs, Reduced Capabilities, and Delayed Schedules*, GAO-09-596T (Washington, D.C.: Apr. 23, 2009);*Geostationary Operational Environmental Satellites: Acquisition Is Under Way, but Improvements Needed in Management and Oversight*, GAO-09-323 (Washington, D.C.: Apr. 2, 2009*); Geostationary Operational Environmental Satellites: Further Actions Needed to Effectively Manage Risks*, GAO-08-183T (Washington, D.C.: Oct. 23, 2007); and *Geostationary Operational Environmental Satellites: Progress Has Been Made, but Improvements Are Needed to Effectively Manage Risks*, GAO-08-18 (Washington, D.C.: Oct. 23, 2007).

and visibility. Program officials included the restoration of the products, latency, and refresh rates as options in the ground system contract that could be acquired at a later time. Program officials later reduced the number of products that could be restored as a contract option (called option 2) from 34 to 31 because they determined that two products were no longer feasible and two others could be combined into a single product. See table 3 below for an overview of key changes to the GOES-R program.

Table 3: Key Changes to the GOES-R Program

	Baseline program, as of August 2006	Revised program, as of September 2006	Current program
Number of satellites	4	2	2
Instruments	2 critical instruments: • Advanced Baseline Imager • Hyperspectral Environmental Suite 4 noncritical instruments/suites: • Geostationary Lightning Mapper • Magnetometer • Space Environmental In-Situ Suite • Solar Imaging Suite (which included the Solar Ultraviolet Imager, and Extreme Ultraviolet/ X-Ray Irradiance Sensor)	1 critical instrument: • Advanced Baseline Imager 5 noncritical instruments/suites: • Geostationary Lightning Mapper • Magnetometer • Space Environmental In-Situ Suite • Solar Ultraviolet Imager • Extreme Ultraviolet/X-Ray Irradiance Sensor	1 critical instrument: • Advanced Baseline Imager 5 noncritical instruments/suites: • Geostationary Lightning Mapper • Magnetometer • Space Environmental In-Situ Suite • Solar Ultraviolet Imager • Extreme Ultraviolet/X-Ray Irradiance Sensor
Number of satellite products	81	68	34 baseline 31 optional
Life-cycle cost estimate (in then year dollars)	$6.2 billion–$11.4 billion (through 2034)	$7 billion (through 2028)	$7.67 billion (through 2028)

Source: GAO analysis of NOAA data.

Acquisition Strategy

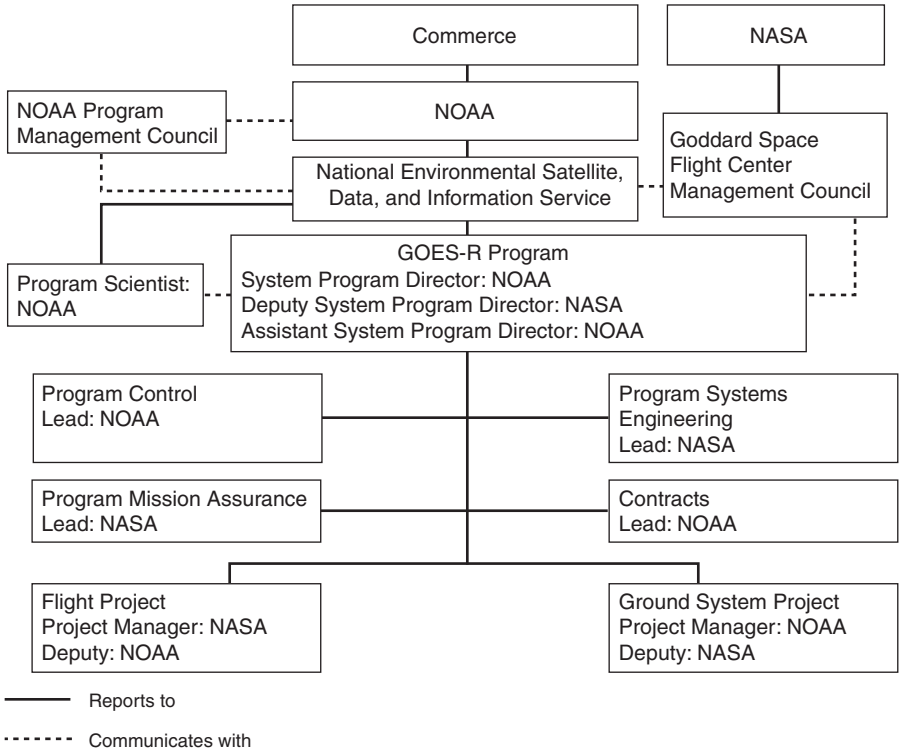
NOAA's original acquisition strategy was to award contracts for concept development of the GOES-R system to several vendors who would subsequently compete to be the single prime contractor responsible for overall system development and production. In keeping with this strategy, NOAA awarded contracts for concept development of the overall GOES-R system to three vendors in October 2005. However, in March 2007, NOAA revised its acquisition strategy for the development contract. In response to recommendations by independent advisors, the agency decided to separate the overall system development and production contract into two separate contracts—the spacecraft and ground system contracts.

In addition, to reduce the risks associated with developing technically advanced instruments, NASA awarded contracts for concept development for five of the planned instruments. NASA subsequently awarded development contracts for five instruments and, upon completion and approval by NASA, these instruments will be provided to the prime contractor responsible for the spacecraft of the GOES-R program. NASA will then work with the spacecraft contractor to integrate and test these instruments. The sixth instrument, the Magnetometer, is to be developed as part of the spacecraft contract.

Program Office Structure

NOAA is solely responsible for GOES-R program funding and overall mission success. However, since it relies on NASA's acquisition experience and technical expertise to help ensure the success of its programs, NOAA implemented an integrated program management structure with NASA for the GOES-R program (see fig. 3). NOAA also located the program office at NASA's Goddard Space Flight Center. Within the program office, there are two project offices that manage key components of the GOES-R system. These are called the flight and ground system project offices. The Flight Project Office, managed by NASA, is responsible for awarding and managing the spacecraft contract and delivering flight-ready instruments to the spacecraft. The Ground System Project Office, managed by NOAA, oversees the Core Ground System contract and satellite data product development and distribution.

Figure 3: GOES-R Program Office Structure and Staffing



Source: NOAA.

Prior Report Noted Challenges with Instrument Development and Recommended Steps to Improve Management and Oversight

In April 2009, we reported that a key instrument had experienced technical challenges that led to cost overruns and schedule delays.[4] Specifically, the Advanced Baseline Imager experienced problems with the quality of components in the focal plane module, mirrors, and telescope. As of November 2008, the contractor had incurred a cost overrun of approximately $30 million and delayed $11 million worth of work. In addition, we found that the contractors for both the Advanced Baseline Imager and the Geostationary Lightning Mapper programs had not documented all of the reasons for cost and schedule variances in certain cost reports. At the time, we recommended that NOAA improve its ability to oversee contractor performance by ensuring that the reasons for cost and schedule variances are fully disclosed and documented. Over the past

[4]GAO-09-323.

year, NOAA has improved its ability to oversee contractor performance by, for example, ensuring that the reasons for cost and schedule variances are fully documented in contractor monthly variance reports.

In that same report, we also found that NOAA had delayed key GOES-R program milestones, including the launch of the first satellite, which was delayed from December 2014 to April 2015. Program officials attributed these delays to providing more stringent oversight before releasing the request for proposals for the spacecraft and ground system, additional time needed to evaluate the contract proposals, and funding reductions in fiscal year 2008. We reported that, as a result of these delays, NOAA may not be able to meet its policy of having a backup satellite in orbit at all times. Specifically, in 2015, NOAA expected to have two operational satellites in orbit, but it would not have a backup satellite in place until GOES-R is launched. As a result, any further delays in the launch of the first satellite in the GOES-R program would increase the risk of gaps in satellite coverage.

GOES-R Is in Development, but Delays in Key Program Milestones Have Endangered Satellite Continuity

The GOES-R program has continued to make progress in the development of its major projects, but key instruments have experienced technical issues and significant work remains to be completed. Further, key program milestones, including the launch dates for the first two satellites in the series, have been further delayed. As a result, NOAA may not be able to meet its policy of having a backup satellite in orbit at all times, which could lead to a gap in satellite coverage if an existing satellite fails prematurely.

Progress Continues to Be Made on GOES-R Procurement, but Much Work Remains to Be Completed on the Flight and Ground Projects

NOAA and NASA have made progress on the procurement of its two major projects—the flight project and the ground project. The flight project includes contracts for the development of the five key instruments and spacecraft[5] while the ground project includes contracts for the development of key systems needed for the on-orbit operation of the satellites, receipt and processing of information, and distribution of satellite data products to users.

[5]A sixth instrument, the Magnetometer, is planned to be developed as part of the spacecraft contract.

For the flight project, between September 2004 and December 2008, the GOES-R program awarded contracts for the five key instruments and spacecraft. The contractors are making progress in completing key milestones in developing these components. However, due to bid protests of the award of the spacecraft contract in December 2008, work on the contract did not begin until August 2009. As a result of these delays, NOAA later approved a 6-month delay in the launch date for the first satellite (GOES-R), from April 2015 to October 2015, and the second satellite (GOES-S), from August 2016 to February 2017. Program officials stated that the estimated program life-cycle cost estimate remains steady at $7.67 billion. Table 4 describes the development contracts for the flight project, including their contract award date, and their cost and schedule estimates.

Table 4: Description of Flight Project Development Efforts, as of June 2010

Flight project component	Description	Contract award date	Scheduled completion date	Original contract cost (excludes award fees)
Instruments				
Advanced Baseline Imager	Expected to provide variable area imagery and radiometric information of the Earth's surface, atmosphere, and cloud cover.	Sept. 2004	June 2012	$255 million
Space Environmental In-Situ Suite	Expected to provide information on space weather to aid in the prediction of disturbances and disruptions of radio communications and navigation systems.	Aug. 2006	June 2012	$51 million
Extreme Ultraviolet/X-Ray Irradiance Sensor	Expected to provide real-time measurement of solar activity in the Extreme Ultraviolet and X-ray spectrum.	Aug. 2007	June 2012	$55 million
Solar Ultraviolet Imager	Expected to observe the sun's ultraviolet emissions and provide early detection and location of flares and coronal mass ejections.	Sept. 2007	Oct. 2012	$112 million
Geostationary Lightning Mapper	Expected to continuously monitor lightning activity over the United States and adjacent oceans.	Dec. 2007	Sept. 2012	$58 million
Spacecraft	Expected to provide the platform for instruments and communication systems. The spacecraft contract also includes development of the sixth instrument, the Magnetometer, which is expected to measure the magnitude and direction of the Earth's magnetic field.	Dec. 2008	Sept. 2015	$691 million

Source: GAO analysis of NOAA data.

For the ground project, a contract for one of three key subcomponents, the Core Ground System, was awarded in May 2009, and contracts for the two other subcomponents are planned to be awarded in July 2010. The Core Ground System is of critical importance because it provides for command and control and ground processing capabilities for GOES-R

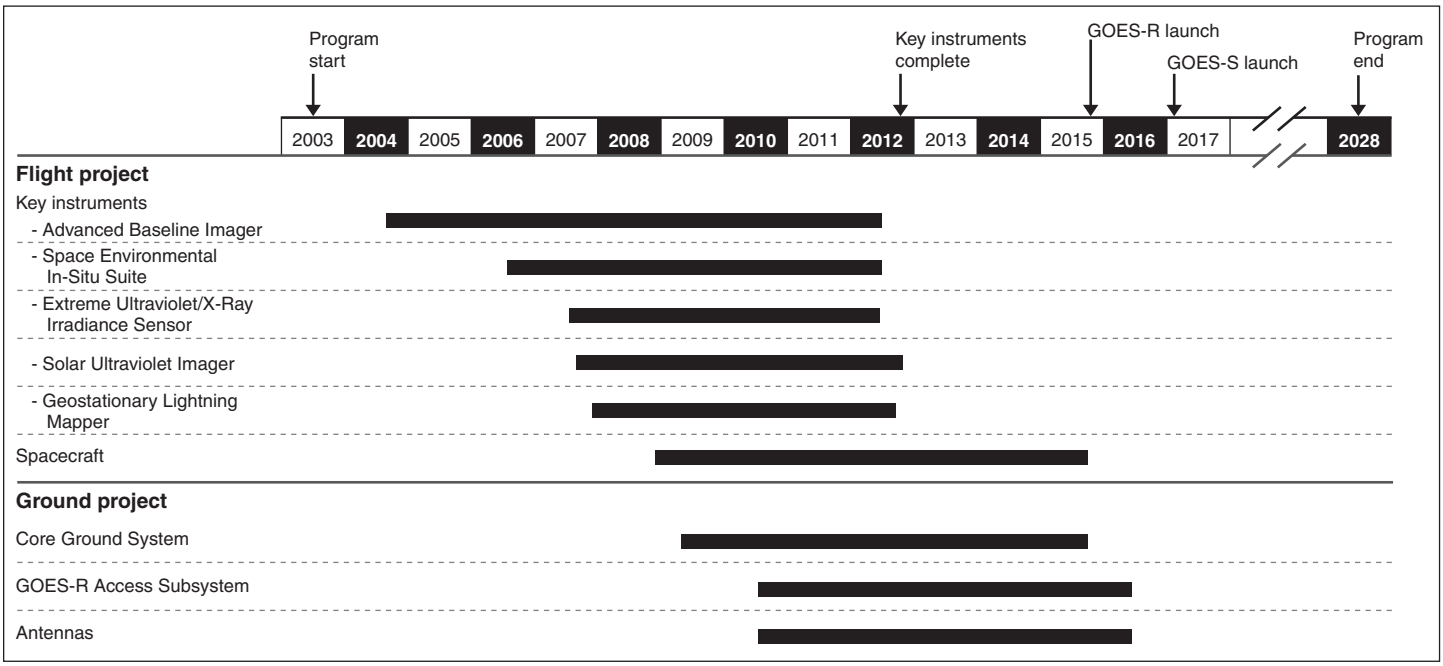
satellites and instruments. Table 5 describes the development contracts for the ground project, including their contract award date, and their cost and schedule estimates, while figure 4 depicts the schedule for both the overall GOES-R program as well as the flight and ground projects.

Table 5: Description of Ground Project Development Efforts, as of June 2010

Ground project component	Description	Contract award date	Scheduled completion date	Original contract cost (excludes award fees)
Core Ground System	Expected to (1) provide command and control of GOES-R satellites and instruments, (2) receive and process information from the instruments and spacecraft, and (3) distribute satellite data products to users.	May 2009	Sept. 2015	$615 million
GOES-R Access Subsystem	Expected to provide ingestion of data and distribution for GOES-R products and data to authorized users. When completed, this subsystem will be integrated into the Core Ground System.	Planned July 2010	Planned June 2016	n/a
Antennas	Expected to provide six new antenna stations and modify four existing antennas to receive GOES-R data. The antenna contract is also expected to include the construction of related infrastructure, software development for control systems, and maintenance.	Planned July 2010	Planned June 2016	n/a

Source: GAO analysis of NOAA data.

Figure 4: Planned Schedule for GOES-R Program and Key Development Efforts, as of June 2010



Source: GAO analysis of NOAA data.

Flight Project—Progress Made, but Two Instruments Have Experienced Technical Challenges

The GOES-R program has continued to make progress on the development of the spacecraft and five key instruments. After starting work on the spacecraft contract in August 2009, the contractor worked to establish the initial cost and schedule baseline and completed a key program milestone intended to demonstrate that the spacecraft concept meets mission requirements. The contractor is currently conducting preliminary design activities and plans to assess the readiness of the program to proceed with detailed design activities in January 2011. In addition, three instruments, the Extreme Ultraviolet/X-Ray Irradiance Sensor, the Solar Ultraviolet Imager, and the Space Environmental In-Situ Suite have recently completed critical design reviews. Completion of this review is intended to demonstrate that the instruments' detailed design is appropriate to support proceeding to full-scale fabrication, assembly, integration, and testing.

Two other instruments—the Advanced Baseline Imager and the Geostationary Lightning Mapper—have experienced significant technical issues, which have resulted in cost increases and schedule delays to the contractors' performance baselines. The Advanced Baseline Imager program has experienced technical issues primarily related to

underestimating the design and development complexity of two components—the focal planes and telescope, which led to cost increases and delays in developing the prototype model. As a result, in September 2009, the program office rebaselined the cost and schedule targets of the Advanced Baseline Imager program.[6] This increased contract costs from the most recent estimate of $375 million to $537 million, an increase of $162 million, and delayed the completion of the prototype model from March 2010 to December 2010. Program officials reported that the rebaseline did not affect the instrument's completion date and that they have sufficient contingency reserves to address the cost overruns experienced to date, meaning that these system-specific cost overruns will not affect the overall GOES-R program's cost.[7] The program is currently testing the prototype model and plans to conduct an updated critical design review in January 2011 to validate any required design changes as a result of testing.[8]

The Geostationary Lightning Mapper experienced technical issues primarily related to underestimating the design complexity of the instrument, as well as an architecture change that significantly increased the electronics design and fabrication cost. As a result, in March 2010, the program office rebaselined the cost and schedule targets of the Geostationary Lightning Mapper program, which increased contract costs from $71 million to $157 million, an increase of about $86 million, and delayed the contract completion from June 2012 to September 2012—a 3-month delay.[9] According to GOES-R program officials, contingency funds are available to cover these changes and they will not affect the overall cost or schedule of the GOES-R program. In addition, the program replaced the development of a prototype model with an engineering development unit, which requires less rigorous development procedures and testing requirements. For example, the planned engineering

[6]This is the Advanced Baseline Imager program's third rebaseline. The program office rebaselined the cost and schedule of the program in February 2007 and rebaselined the program schedule again in March 2008. In addition, contract costs increased from $255 million to $375 million—a total increase of about $120 million—in part, because of the February 2007 rebaseline and other contract modifications.

[7]As of May 2010, the GOES-R program office reported that the flight project had contingency reserves of approximately $455 million.

[8]The first critical design review for this instrument occurred in February 2007.

[9]Contract costs increased from $58 million to $71 million—a total increase of about $13 million, as a result of contract modifications negotiated, in part, to reduce program risk.

development unit is not required to undergo comprehensive environmental testing to validate that the instrument will meet mission objectives in the launch and space environment. According to GOES-R program officials, this decision was made to reduce program risk because the schedule for development of the prototype model and production model would have otherwise overlapped—thus reducing the inherent benefits of a prototype model. However, the lack of a prototype model increases the risk that design issues that would have been identified during more comprehensive testing will surface in the production model, when it is too late to make changes.

The status and program-identified risk level of each of the components of the flight project is described in table 6.

Table 6: Status of Flight Project, as of June 2010

Component	Status	Program-identified risk level
Instruments		
Advanced Baseline Imager	This instrument was rebaselined in September 2009 due to continued technical issues related to underestimating the design and development complexity of two components—the focal planes and telescope. Currently, the program is testing a prototype model, which is planned to be completed in October 2010. An updated critical design review is planned for December 2010. This instrument is to be delivered for integration on the spacecraft by June 2012.	Cost: low Schedule: medium Technical: low
Space Environmental In-Situ Suite	This instrument completed a critical design review in June 2010 and is currently conducting development and testing activities. This instrument is to be delivered for integration on the spacecraft by June 2012.	Cost: low Schedule: low Technical: low
Extreme Ultraviolet/X-Ray Irradiance Sensor	This instrument completed a critical design review in November 2009 and is currently conducting development and testing activities. This instrument is to be delivered for integration on the spacecraft by June 2012.	Cost: low Schedule: low Technical: low
Solar Ultraviolet Imager	This instrument completed a critical design review in December 2009 and is conducting development and testing activities. This instrument is to be delivered for integration on the spacecraft by October 2012.	Cost: low Schedule: low Technical: low
Geostationary Lightning Mapper	This instrument was rebaselined in March 2010 due to technical issues related to underestimating the design complexity of the instrument. Currently, the program is conducting development and testing activities. A critical design review is planned for November 2010. This instrument is to be delivered for integration on the spacecraft by September 2012.	Cost: low Schedule: medium Technical: medium
Spacecraft	Due to protests of the contract award, the start of the spacecraft contract was delayed 8 months to August 2009. Subsequently, the contractor worked to establish the initial cost and schedule baseline and completed a key program milestone intended to demonstrate that the spacecraft concept meets mission requirements. A preliminary design review for the spacecraft is planned for January 2011. The spacecraft is planned to be completed by September 2015.	Cost: low Schedule: low Technical: low

Sources: NOAA and NASA data.

Our analysis of contractor-provided earned value management data[10] showed that most components of the flight project were on track between May 2009 and April 2010. Specifically, contractors for three instruments—the Extreme Ultraviolet/X-Ray Irradiance Sensor, the Space Environmental In-Situ Suite, and the Solar Ultraviolet Imager—and the spacecraft are generally meeting cost and schedule targets. The other two instruments, the Advanced Baseline Imager and the Geostationary Lightning Mapper, are meeting their revised cost and schedule targets since completing their rebaselining efforts in September 2009 and March 2010, respectively.

Ground Project—Development Is Under Way, but Important Work Remains to Be Done

Development of the ground project is under way. After awarding the contract for the Core Ground System in May 2009, the contractor has been conducting system definition activities and plans to conduct a preliminary design review in February 2011 to assess the readiness of the program to proceed with detailed design activities.

However, the awards of two additional ground project contracts have been delayed and important work remains to be completed. For example, contract award for the GOES-R Access Subsystem has slipped 6 months, from January 2010 to July 2010. These delays were due, in part, to delays in releasing the request for proposals. Award of the antennas contract has also been delayed by 3 months. Both contracts are critical to ensuring that GOES-R data are received, stored, and distributed to users. The status and program-identified risk level of each of the components of the ground project is described in table 7.

[10]Earned value management integrates the investment scope of work with schedule and cost elements for investment planning and control. The method compares the value of work accomplished during a given period with that of work expected in the period. Differences in expectations are measured in both cost and schedule variances. The Office of Management and Budget requires agencies to use earned value management as part of their performance-based management system for any investment under development or with system improvements under way.

Table 7: Status of Ground Project, as of June 2010

Component	Status	Program-identified risk level
Core Ground System	After the contract award for this system in May 2009, the contractor has been conducting system definition activities and plans to conduct a preliminary design review in February 2011. A critical design review is planned for September 2011.	Cost: low Schedule: low Technical: low
GOES-R Access Subsystem	Originally planned for award in January 2010, this contract is scheduled to be awarded in July 2010—a delay of about 6 months. These delays were due, in part, to delays in releasing the request for proposals. The GOES-R Access Subsystem is planned for completion in June 2016.	Cost: low Schedule: low Technical: low
Antennas	This contract was originally planned for award in April 2010 but has been delayed to July 2010. According to program officials, these delays are due, in part, to delays in developing the system's requirements and releasing the request for proposals. GOES-R antennas are expected to be completed by June 2016.	Cost: low Schedule: low Technical: low

Sources: NOAA and NASA data.

Our analysis of contractor-provided earned value management data for the Core Ground System indicates that cost and schedule performance were generally on track between June 2009 and April 2010. Between these dates, the contractor for the Core Ground System completed work slightly under budget.

Continued Delays in Launch Dates Put the Continuity of Satellite Operations at Risk

Over the last few years, NOAA has delayed the satellite launch dates several times. We previously reported that, since 2006, the launch of the first satellite had been delayed from September 2012 to April 2015—a slip of more than 30 months.[11] These delays were due, in part, to delays in releasing the requests for proposals for the spacecraft and Core Ground System and additional time needed to evaluate the contract proposals. Since our last report, NOAA further delayed key GOES-R program milestones by 6 months, including the dates when the first two satellites in the series would be available for launch. These recent delays were due to bid protests of the award of the spacecraft contract in December 2008, which delayed the start of work until August 2009. In order to allow sufficient time for the 72-month development cycle required for the spacecraft, NOAA approved a 6-month delay in the launch dates for the first two satellites in the series. Table 8 identifies the delays in the satellite launch dates over time.

[11]GAO-06-993, GAO-08-18, and GAO-09-323.

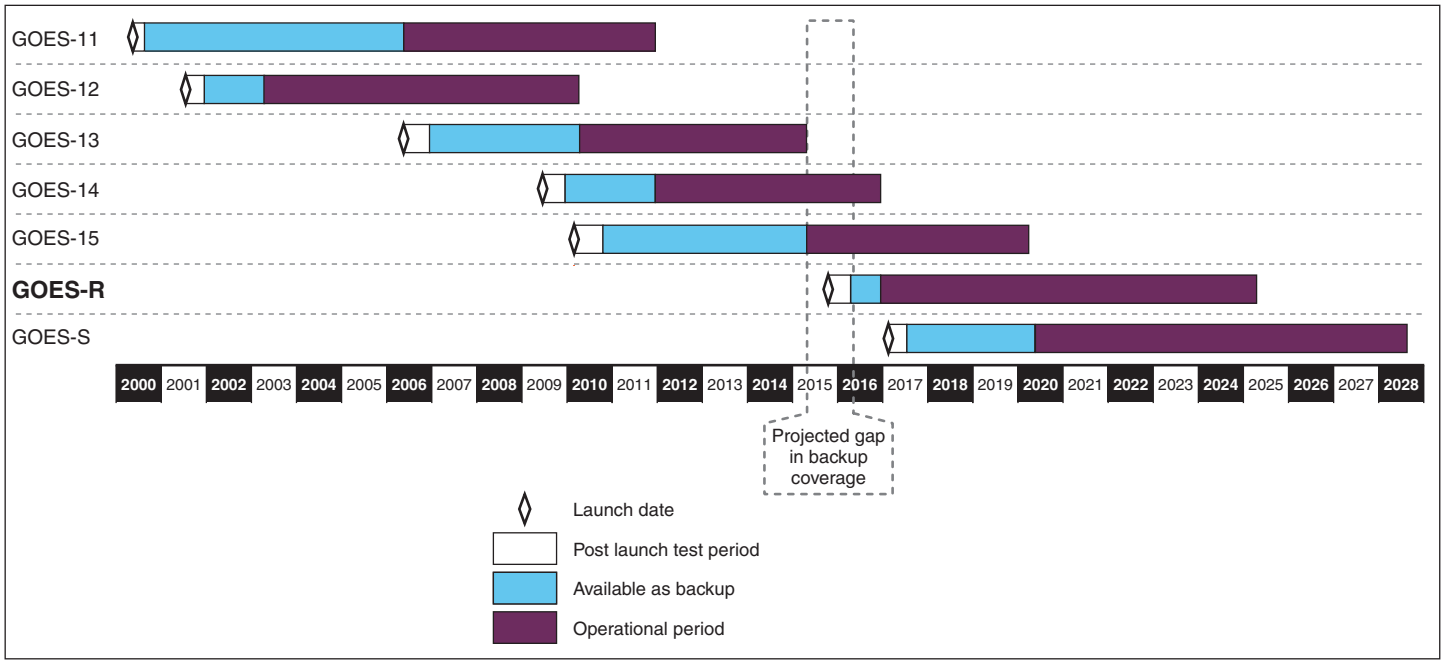
Table 8: Delays in Satellite Launch Dates

	As of June 2006	As of July 2007	As of March 2009	As of November 2009
First satellite launch (GOES-R)	Sept. 2012	Dec. 2014	Apr. 2015	Oct. 2015
Second satellite launch (GOES-S)	Apr. 2014	Apr. 2016	Aug. 2016	Feb. 2017

Source: GAO analysis of NOAA data.

While NOAA's policy is to have two operational satellites and one backup satellite in orbit at all times, continued delays in the launch of the first GOES-R satellite could lead to a gap in satellite coverage. This policy proved useful in December 2008, when NOAA experienced problems with GOES-12, but was able to use GOES-13 as an operational satellite until the problems were resolved. However, beginning in April 2015, NOAA expects to have two operational satellites in orbit (GOES-14 and GOES-15), but it will not have a backup satellite in place until GOES-R is launched and completes an estimated 6-month post-launch test period—resulting in a 12-month gap during which time a backup satellite would not be available. Figure 5 below depicts this gap in backup coverage.

Figure 5: Continuity of Satellite Operations



Source: GAO analysis of NOAA data.

Note: GOES-11 and GOES-12 are currently operating beyond their expected lifespans. However, GOES-12 is no longer supporting U.S. operations; it was moved to provide coverage of South America.

If NOAA experiences a problem with either of its operational satellites before GOES-R is in orbit and operating, it will need to rely on older satellites that are beyond their expected operational lives and therefore may not be fully functional. Any further delays in the launch of the first satellite in the GOES-R program would likely continue to increase the risk of a gap in satellite coverage.

NOAA Has Not Established Adequate Continuity Plans for Its Geostationary Satellites

While federal policy and industry best practices call for the development of plans for continuing essential operations during a disruption or emergency, NOAA has not developed adequate continuity plans for its geostationary satellites for the period of time when there will be no backup in orbit. Planning for the continuity of operations facilitates the performance of an organization's essential functions during emergency events or other situations that disrupt normal operations.[12] Federal policy requires agencies to develop and document continuity of operations plans for essential functions that provide, among other things, a description of the resources, staff roles, procedures, and timetables needed for the plan's implementation. NOAA has defined providing satellite imagery in support of weather forecasting as one of its essential functions.

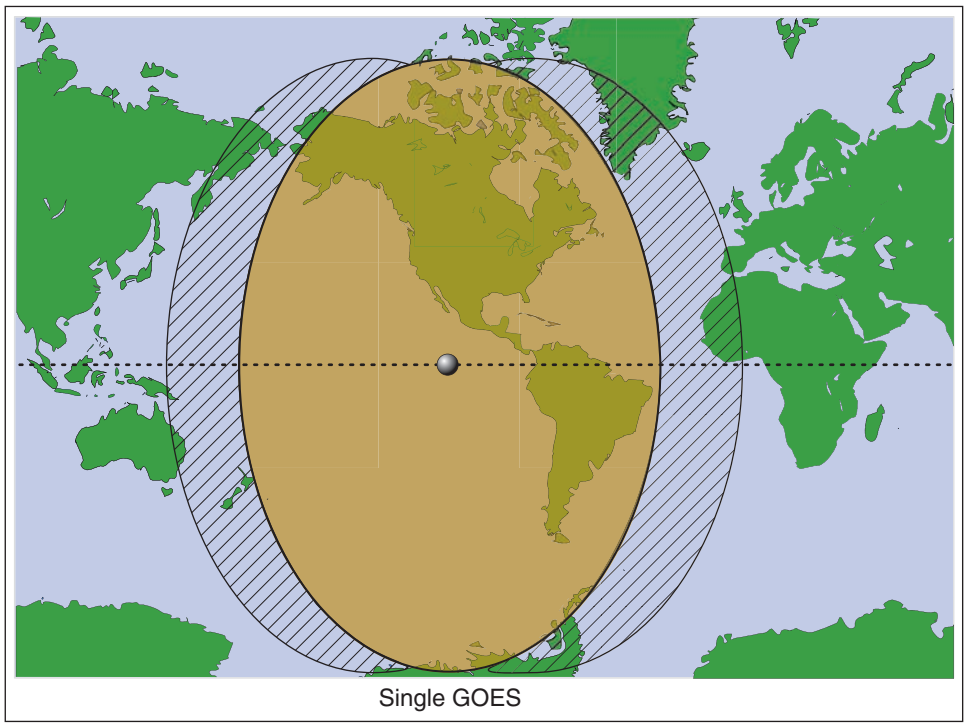
NOAA has developed continuity plans for the ground systems used to operate and process data from geostationary satellites. Specifically, NOAA's continuity plans for its Satellite Operation Control Center and its Environmental Data Processing Center describe plans to transfer critical functions to a backup facility during an emergency. Both of these continuity plans contain, among other things, descriptions of the alternate locations for performing key functions, resources, and implementation procedures.

In addition to planning for the continuity of its ground systems, NOAA has established a policy to ensure the continuity of its geostationary satellites—and high-level plans if that policy is not met. As previously mentioned, NOAA's policy is to have two operational satellites and one backup satellite in orbit at all times. That way, if an operational satellite fails, the backup satellite would be moved into place to pick up operations. However, if there is no backup satellite in orbit—as is expected to be the case during the year leading up to when GOES-R becomes operational—NOAA officials stated that they would move the single remaining operational satellite to the middle of the continental United States. According to NOAA officials, this would provide sufficient coverage of the continental United States, but would provide limited coverage of the Atlantic and Pacific Oceans (see fig. 6). In addition, NOAA would contact other nations to request that a spare geostationary satellite,

[12]Department of Homeland Security, *Federal Continuity Directive 1: Federal Executive Branch National Continuity Program and Requirements* (February 2008); and Software Engineering Institute, *Capability Maturity Model® Integration for Acquisition, Version 1.2*, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

if available, be positioned to provide temporary coverage of the coastal regions, as well as the oceans.[13]

Figure 6: Approximate Geographic Coverage in a Single GOES Configuration



Sources: NOAA (data), MapArt (map).

However, NOAA has not established continuity plans for its geostationary satellites that describe the resources, staff roles, procedures, and timetables needed for the plan's implementation. This is important because there are many procedures and coordinating activities that NOAA would need to perform to ensure the continuity of geostationary satellite data in the event of a satellite failure with no backup available. For example, the transition to a single satellite would require NOAA, at a

[13]NOAA has reciprocal agreements with the European Organisation for the Exploitation of Meteorological Satellites and the Japan Meteorological Agency to temporarily provide a backup geostationary satellite on a best-effort basis, if one is available.

minimum, to inform users of changes to the in-orbit configuration through various methods, including users groups and Web site postings. Alternatively, the transition to an international satellite would require modifications to the software code of several processing systems to account for expected differences in spectral channels, refresh rate, resolution, and coverage areas due to the repositioning of the satellites. Further, all geostationary satellite data products would need to be reverified and validated to account for differences in product coverage. Lastly, NOAA would have to notify GOES data users of differences in satellite capabilities, such as the loss of space weather instruments and data, and changes to viewing angles caused by satellite positions that are different from current GOES locations. For example, the orbital location of an international satellite positioned in a backup configuration may provide a less comprehensive view due to the more severe observing angle over the United States.

In addition, NOAA's lack of continuity plans has precluded the agency from documenting and communicating the operational impact of its plans to reduce to a single satellite and rely on an international satellite. For example, a single satellite configuration would reduce coverage of the Atlantic and Pacific Oceans where satellite data provide critical warnings of approaching severe weather, such as tropical cyclone and hurricane activity. According to air traffic officials from the Federal Aviation Administration, the reduction to a single satellite would have a significant impact on the agency's ability to make informed aviation planning decisions over the ocean areas surrounding the continental United States. In addition, transitioning to an international satellite would be dependent on the availability of foreign satellites and it could take several months to reposition an international satellite to provide backup coverage. Furthermore, foreign satellites lack capabilities currently available to GOES users, such as instruments that provide space weather information. For example, the National Weather Service's (NWS) Space Weather Prediction Center relies solely on space weather data from GOES for two-thirds of its data products, which are critical to providing warnings of severe space weather that may impact airline and maritime communication, satellite operations, and astronaut safety.

According to the Deputy Director of the Office of Satellite Operations, continuity plans for geostationary satellites have not been established because the transition to single satellite and to an international satellite has been done previously. Specifically, in 1989, after the failure of GOES-6, NOAA repositioned GOES-7 to the middle of the continental United States. Subsequently, in 1991, the European Organisation for the Exploitation of

Meteorological Satellites and the European Space Agency repositioned the Meteosat-3 satellite to backup NOAA's aging GOES-7 satellite in order to provide coverage of the Atlantic Ocean in case GOES-7 failed before a replacement could be launched and placed into operation. While this accomplishment has merit, current GOES and their related ground processing systems are increasingly complex and have enhanced capabilities as compared to earlier satellites, such as ability to capture and process higher resolution images of weather patterns and atmospheric measurements. In addition, there are likely new staff who will not be able to rely on the 1989 and 1991 experiences. Establishing continuity plans that describe the resources, staff roles, procedures, and timetables needed for the plans' implementation (as required by federal policy) would better ensure that NOAA can continue to provide these critical capabilities in the event of a satellite failure.

Without continuity plans, NOAA may not be able to fully meet its mission-essential function of providing satellite imagery in support of weather forecasting. This could have a devastating affect on the ability of meteorologists to observe the development of severe storm conditions, such as hurricanes and tornados, and track their movement and intensity to reduce or avoid major losses of property and life. In addition, the loss of a single satellite could affect many satellite data users outside NOAA, including the Federal Aviation Administration, which use satellite-provided weather data for air traffic management, and the U.S. Forest Service (within the U.S. Department of Agriculture), which uses satellite-provided weather data to predict and prevent wildfires and mitigate their damage.

NOAA's Efforts to Involve External GOES Data Users, Prioritize Their Data Needs, and Communicate Program Status Have Shortfalls

NOAA has identified key GOES data users and involved internal users in defining and prioritizing the GOES-R program requirements, but lacks a comprehensive approach for eliciting and prioritizing the satellite data needs of external users. Further, while NOAA has taken steps to communicate program status and changes to all GOES data users, important changes to currently available GOES data products have not been adequately communicated to external users. Until these weaknesses are addressed, NOAA faces the increased risk that its satellite acquisitions may not meet the needs of key GOES data users.

Key GOES Data Users Have Been Identified, but Efforts to Involve Other Federal Agencies and Prioritize Their Data Needs Are Not Sufficient

Leading organizations routinely identify relevant operational users and involve these users in key program activities, including requirements definition.[14] Moreover, best practices call for eliciting the needs of operational users and developing these needs into prioritized requirements. Prioritized requirements should serve as the basis for determining project scope and can help to ensure that requirements critical to key users are addressed quickly.

Key GOES data users can be categorized into three tiers. The first tier includes internal NOAA users that depend on GOES data for their primary mission, such as NWS. The second tier includes other federal agencies that depend on GOES data for their primary mission, such as the Department of Defense and the Federal Aviation Administration. The third tier includes all other users that receive GOES data, including private industry and universities. See table 9 below for descriptions and examples of each tier of GOES data users.

Table 9: Key GOES Data Users

Tier	Description	Examples
1	NOAA users who depend on GOES data for their primary mission	• NWS • NESDIS • Other NOAA offices (e.g., NOAA Marine and Aviation Operations, NOAA Ocean Service, etc.)
2	Other federal agencies that depend on GOES data for their primary mission	• Department of Defense • Department of Homeland Security • Department of the Interior • Federal Aviation Administration • Environmental Protection Agency • U.S. Department of Agriculture
3	All other users who receive GOES data	• Universities • Research institutions • Private industry • News media • Broadcasters • General public

Source: GAO analysis of NOAA data.

[14]GAO, *Information Technology Investment Management: A Framework for Assessing and Improving process Maturity*, GAO-04-394G (Washington, D.C.: March 2004); and Software Engineering Institute, *Capability Maturity Model® Integration for Acquisition, Version 1.2*, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

In formulating the GOES-R program, NOAA primarily involved internal NOAA users (tier 1) in requirements definition activities, but did receive input from one other federal agency, the Department of Defense. Beginning in 1998, NOAA collected high-level system requirements from NWS. Over the next few years, NOAA continued to collect and refine these requirements by including input from other NOAA offices, including NESDIS, NOAA Ocean Service, NOAA Research, NOAA Fisheries, and NOAA Marine and Aviation Operations. Also, in February 2003, the Department of Commerce requested that the Department of Defense provide a consolidated list of its environmental information needs, including those data needs that could be met by geostationary satellites. This input, combined with that of NOAA's offices, served as the basis for the 2004 GOES-R Program Requirements Document, which represented a preliminary set of GOES-R requirements.

In June 2007, prior to entering the development phase of the GOES-R program lifecycle, the Deputy Undersecretary for Commerce Oceans and Atmosphere approved a baseline set of prioritized GOES-R requirements (known as the Level 1 Requirements).[15] Efforts to prioritize the Level 1 Requirements were led by a working group of representatives from various NOAA organizations. This working group categorized the requirements into four priority levels according to the importance of each requirement to NOAA, as well as the requirements contribution to the GOES-R series.

However, other than the Department of Defense's input into the 2004 version of the requirements, external users that rely on GOES data were not adequately involved in the GOES-R requirements definition or prioritization process. According to NOAA officials, input to the requirements from other federal agencies (tier 2) and other interested users (tier 3) was collected via casual conversations between NOAA offices and these users, as well as during GOES User Conferences, which were held to educate and obtain input from prospective GOES-R users. While these methods are reasonable for eliciting input from tier 3 users, federal agencies that rely on GOES data to meet unique mission requirements warrant documented input to the GOES-R requirements. For example, the U.S. Forest Service relies on GOES for fire monitoring and detection capabilities to sustain an estimated 193 million acres of the

[15]The GOES-R Level 1 requirements were later updated in July 2008, December 2008, and August 2009.

nation's forests and grasslands. According to U.S. Forest Service officials, the lack of a structured process for their agency to provide input into the requirements definition process has made it difficult to ensure that its requirements have been and will be implemented.

Further, NOAA did not account for the priority data needs of other federal users in prioritizing the Level 1 requirements. As previously mentioned, the priorities of the requirements were established by the GOES-R requirements working group. However, this group only includes membership from NOAA offices, such as NWS and NESDIS, and does not include membership from other federal agencies. According to GOES-R program officials, the Level 1 Requirements are intended to reflect the priorities of NOAA users, primarily those of NWS, and the assumption is that other users will adapt to the data provided by NOAA. However, given the unique missions of other federal agencies and their reliance on GOES data to meet their missions, input into the prioritization of GOES-R requirements is critical to ensure that GOES-R will meet the needs of their organizations.

The lack of involvement by federal agencies in GOES-R requirements definition and prioritization is due to weaknesses in NOAA's processes for defining and prioritizing satellite data requirements. Specifically, the lack of a structured process for eliciting the data needs of key operational users inhibits NOAA's ability to produce prioritized requirements that reflect the needs of other federal agencies that depend on these satellites. Without improvements in these processes, NOAA's satellite acquisitions may not fully meet the needs of important GOES data users.

NOAA Has Not Effectively Communicated with Other Federal Agencies

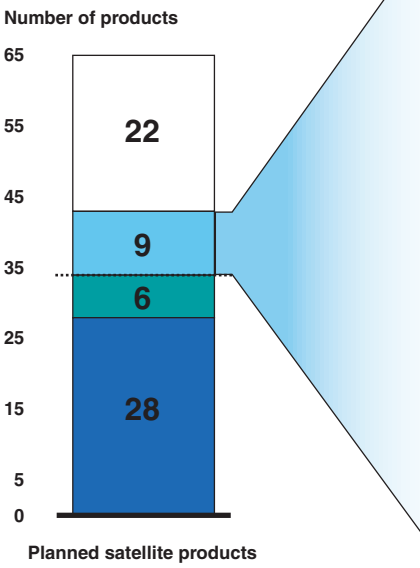
While NOAA has taken steps to communicate program status and changes to internal and external GOES data users, important changes to currently available GOES data products have not been communicated to key external users. According to industry best practices, programs should regularly communicate program status to relevant operational users.[16] Moreover, best practices call for identifying and documenting deviations from plans and communicating significant issues to relevant operational users.

[16]Software Engineering Institute, *Capability Maturity Model® Integration for Acquisition, Version 1.2*, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

NOAA has taken steps to communicate program status and changes to GOES data users. For example, the GOES-R requirements working group was established to identify and represent NOAA user requirements and serves as a forum for communication of GOES-R requirements status and changes with internal NOAA users. Another initiative, known as the GOES-R Proving Ground, engages the NWS forecast and warning community in preoperational demonstrations of selected capabilities anticipated from GOES-R. Through this program, NWS users are given the ability to test and evaluate expected GOES-R capabilities, such as lightning detection, before the satellites are operational. Lastly, GOES User Conferences are held to educate and obtain input from any prospective GOES users, including other agencies, universities, and industry.

However, the GOES-R program has undergone significant changes over the course of its acquisition lifecycle, and these changes have not been communicated to GOES data users outside of NOAA. As previously mentioned, in 2007, program officials removed requirements from the baseline program to treat them as a contract option that could be exercised if funds allow (known as Option 2). These changes resulted in a baseline program of 34 satellite data products and 31 Option 2 products. However, NOAA did not communicate the removal of these products to external federal agencies. In addition, 9 Option 2 products are currently available to GOES data users, which means that users may lose access to these products if the contract option is not exercised. These 9 products are critical to measuring cloud properties, infrared radiation, and sulfur dioxide in the atmosphere. However, NOAA did not inform external federal agencies about the potential loss of these products. See figure 7 for a description of the 9 currently available products removed from the GOES-R program baseline.

Figure 7: Nine Current Satellite Products Removed from the GOES-R Program Baseline



Product	Description
Cloud Ice Water Path	A measure of the equivalent water mass of the ice particles in a vertical column through the cloud.
Cloud Layers / Heights	The heights of the cloud layer bases above local terrain or above mean sea level.
Cloud Liquid Water	The amount of liquid water per unit volume of air.
Cloud Type	The main characteristic form of a cloud used in its identification.
Low Cloud and Fog	Low cloud is defined as clouds with a mean height level which is between the earth's surface and 6,500 feet. Fog is defined as clouds in contact with the earth's surface.
Downward Longwave Radiation: Surface	The downward component of infrared radiation across a given surface.
Upward Longwave Radiation: Surface	Outgoing/emitted infrared radiation at the earth's surface.
Upward Longwave Radiation: Top of Atmosphere	Outgoing/emitted infrared radiation at the top of the atmosphere.
Sulfur Dioxide Detection	Detection of sulfur dioxide, which is a non-inflammable colorless gas that can lead to acid rain.

Source: GAO analysis of NOAA data.

According to GOES-R program officials, the decision to make these products part of the contract option was based on NOAA's input and was approved by the requirements working group. However, key GOES data users at other federal agencies that currently rely on these products have not been involved in, nor told of, these changes. For example, the U.S. Department of Agriculture uses cloud-based products (such as cloud liquid water) to develop weather forecasts used by farmers and radiation-based products (such as upward longwave radiation) for streamflow simulation modeling. In addition, the Department of Defense relies on the cloud-based products (such as cloud type and cloud heights) as input into weather prediction models for forecasting of high-altitude winds, which are used to navigate ships and planes.

If the contract option is not exercised, these agencies will not have access to these GOES data products that they currently utilize. If this occurs, GOES-R program officials stated that GOES data users may be able to get these products via the Internet from NESDIS, but added that the details for this alternative have not been determined because the program expects to receive approval from NESDIS to exercise this contract option by December 2010. Given that these products are currently available to GOES data users, any significant changes to these products should be communicated to these users to ensure that they have sufficient time to implement workarounds or determine other sources for the data. Without communicating significant changes, other federal agencies may lose access to critical data products needed to meet mission requirements.

Conclusions

Over the last few years, the GOES-R program has continued to make progress on key development efforts, but much work remains to be completed. While the GOES-R program has awarded most development contracts, two instruments have experienced technical challenges that led to contract cost increases, and significant work remains on the program's flight and ground projects. In addition, continued delays in the launch date of the first two satellites in the GOES-R series have endangered satellite continuity because these delays extend the time in which there will not be a backup satellite in orbit. Any further delays in the launch of the first satellite in the GOES-R program increases the risk of a gap in satellite coverage.

The risk of a gap in coverage is further exacerbated because NOAA has not established adequate continuity plans. While NOAA plans to reduce to a single satellite and, if available, rely on an international satellite, these plans have weaknesses, including a lack of continuity plans needed to support geostationary satellite operations during an emergency. Until these weaknesses are addressed, NOAA faces a potential 12-month gap where it may not be able to provide critical geostationary data needed for predicting global and local weather events in the event of a satellite failure.

Finally, NOAA has taken steps to identify GOES data users, prioritize their data needs, and communicate program changes, but has not adequately involved or communicated with key external users. For example, while NOAA involved internal users in its process for defining and prioritizing the GOES-R requirements, improvements are needed in these processes to ensure that other federal agencies that rely on GOES data have a means to provide documented input to the requirements and the prioritization of those requirements. Further, while NOAA has taken steps to communicate with GOES data users, it has not established processes to notify other

federal agencies of GOES-R program status and significant changes. Until these improvements are made, important GOES users may lose access to critical data products and future GOES acquisitions may not meet the mission requirements of these users.

Recommendations for Executive Action

To improve NOAA's ability to maintain geostationary satellites continuity and improve efforts to involve key GOES data users, we recommend that the Secretary of Commerce direct the NOAA Administrator to ensure that the following three actions are taken:

- Develop and document continuity plans for the operation of geostationary satellites that include the implementation procedures, resources, staff roles, and timetables needed to transition to a single satellite, an international satellite, or other solution.
- Establish processes for satellite data requirements definition and prioritization to include documented input from external federal agencies that rely on GOES data on future satellite acquisitions.
- Establish and implement processes to notify these agencies of GOES-R program status and changes.

Agency Comments

We received written comments on a draft of this report from the Secretary of Commerce, who transmitted NOAA's comments. The department agreed with our recommendations and identified plans to implement them. For example, the department stated that NOAA will develop a plan for transitioning to a single satellite that leverages existing contingency agreements with its international partners. In addition, the department stated that NOAA will document a process to define and prioritize the requirements of other federal agencies and provide these users with updates on GOES-R program status and changes. The department's comments are provided in appendix II.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to interested congressional committees, the Secretary of Commerce, the Administrator of NASA, the Director of the Office of Management and Budget, and other interested parties. The report also will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions on the matters discussed in this report, please contact me at (202) 512-9286 or pownerd@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 who made major contributions to this report are listed in appendix III.

David A. Powner
Director, Information Technology
Management Issues

Appendix I: Objectives, Scope, and Methodology

Our objectives were to (1) determine the status of the Geostationary Operational Environmental Satellite-R (GOES-R) series acquisition, including cost, schedule, and performance trends; (2) evaluate whether the National Oceanic and Atmospheric Administration (NOAA) has established adequate contingency plans in the event of delays; and (3) assess NOAA's efforts to identify GOES data users, prioritize their data needs, and communicate with them about the program's status.

To determine GOES-R acquisition status, we evaluated various programmatic and technical plans, management reports, and other program documentation. We reviewed the cost and schedule estimates (including launch dates), planned system requirements, and monthly executive-level management briefings. We also interviewed agency officials from NOAA and the National Aeronautics and Space Administration (NASA) to determine key dates for future GOES-R acquisition efforts and milestones and progress made on current development efforts. Furthermore, we analyzed the earned value data on development efforts contained in contractor performance reports obtained from the program. To perform this analysis, we compared the cost of work completed with budgeted costs for scheduled work for a 12-month period to show trends in cost and schedule performances. To assess the reliability of the cost data, we compared it with other available supporting documents (including monthly program management reviews); electronically tested the data to identify obvious problems with completeness or accuracy; and interviewed program officials about the data. For the purposes of this report, we determined that the cost data were sufficiently reliable. We did not test the adequacy of the agency or contractor cost-accounting systems.

To evaluate whether NOAA has established adequate contingency plans, we analyzed relevant continuity planning documentation, agreements with international partners, and meeting reports from the Coordination Group for Meteorological Satellites.[1] In addition, we compared NOAA's continuity of operations plans to federal policy and industry best practices to determine the extent to which the plans will ensure the continuity of critical functions related to geostationary satellites in the event of a

[1]The Coordination Group for Meteorological Satellites is a forum for the international exchange of technical information on geostationary and polar orbiting meteorological satellite systems.

satellite failure.[2] We met with NOAA officials responsible for continuity of operations planning and coordination with international partners, as well as GOES data users within NOAA and at other federal agencies to determine the potential impact of NOAA's plans on their data needs.

To determine the adequacy of NOAA's efforts to identify GOES users, prioritize their data needs, and communicate program status, we analyzed relevant program documents, including acquisition plans, user requirements, and GOES user group meeting minutes. We compared NOAA's efforts to industry best practices to determine the extent to which users were appropriately identified and involved in program activities.[3] We also interviewed key users of GOES data to determine whether NOAA's efforts to identify and prioritize their data needs and communicate program status and changes were adequate. In consultation with NOAA officials, we identified key GOES users at organizations within NOAA and other federal agencies that depend on GOES data for their primary mission. We selected three organizations within NOAA that are primarily responsible for environmental satellite data acquisition, processing and exchange, and environmental research. These organizations include the National Weather Service, National Environmental Satellite, Data and Information Service, and the Office of Oceanic and Atmospheric Research. We also identified federal government users outside of NOAA with the largest funding levels for meteorological operations in fiscal year 2009.[4] These agencies were the Department of Defense and the Department of Transportation (including the Federal Aviation Administration). On the basis of discussions with GOES-R program officials and the Office of the Federal Coordinator for Meteorology, we then selected additional federal agencies that rely extensively on GOES data to meet their mission requirements. These agencies include the Department of the Interior (including the U.S. Geological Survey and Bureau of Reclamation), and the U.S. Department of Agriculture (including the U.S. Forest Service).

[2]Department of Homeland Security, *Federal Continuity Directive 1: Federal Executive Branch National Continuity Program and Requirements* (February 2008); and Software Engineering Institute, *Capability Maturity Model@ Integration for Acquisition, Version 1.2*, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

[3]Software Engineering Institute, *Capability Maturity Model@ Integration for Acquisition, Version 1.2*, CMU/SEI-2007-TR-017 (Pittsburgh, Pa.: November 2007).

[4]Office of the Federal Coordinator for Meteorology, *The Federal Plan for Meteorological Services and Supporting Research, Fiscal Year 2009*, FCM-P1-2008 (Washington, D.C.: October 2008).

We primarily performed our work at the Department of Defense, Department of the Interior, Department of Transportation, NOAA, NASA, and U.S. Department of Agriculture offices in the Washington, D.C., metropolitan area. In addition, we conducted work at Department of Defense weather agencies in Offutt Air Force Base, Nebraska and Stennis Space Center, Mississippi. We conducted this performance audit from October 2009 to September 2010, 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 audit objectives.

Appendix II: Comments from the Department of Commerce

UNITED STATES DEPARTMENT OF COMMERCE
The Secretary of Commerce
Washington, D.C. 20230

August 3, 2010

Mr. David A. Powner
Director
Information Technology Management Issues
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Mr. Powner:

Thank you for the opportunity to review and comment on the Government Accountability Office's draft report entitled "Geostationary Operational Environmental Satellites: Improvements Needed in Continuity Planning and Involvement of Key Users" (GAO-10-799).

On behalf of the Department of Commerce, I have enclosed the National Oceanic and Atmospheric Administration's programmatic comments on the draft report.

Sincerely,

Gary Locke

Enclosure

Department of Commerce

National Oceanic and Atmospheric Administration

Comments to the Draft GAO Report Entitled

"Geostationary Operational Environmental Satellites:

Improvements Needed in Continuity Planning and Involvement of Key Users"

(GAO-10-799/September 2010)

NOAA Response to GAO Recommendations

The draft General Accountability Office (GAO) report states, "To improve the National Oceanic and Atmospheric Administration's (NOAA) ability to maintain geostationary satellite continuity and improve efforts to involve key Geostationary Operational Environmental Satellite (GOES) data users, we recommend that the Secretary of Commerce direct the Under Secretary of Commerce for Oceans and Atmosphere to ensure that the following three actions are taken:"

Recommendation 1: Develop and document continuity plans for the operation of geostationary satellites that include the implementation procedures, resources, staff roles, and timetables needed to transition to a single satellite, an international satellite, or other solution.

NOAA Response: NOAA agrees with this recommendation. NOAA will develop a plan to implement a single satellite strategy of operations if there is a significant delay in the launch of GOES-R. This plan will include several operational options, taking into account the potential support of international partners through already existing contingency agreements with such partners. Also, NOAA will consult the user community to determine the best location and operational schedule of a single spacecraft to meet their requirements. The plan will address timely notification to users regarding all relevant operational changes.

Recommendation 2: Establish processes for satellite data requirements definition and prioritization to include documented input from external Federal agencies that rely on GOES data on future satellite acquisitions.

NOAA Response: NOAA agrees with this recommendation. NOAA will document a process to define and prioritize requirements to include documented input from NOAA, other Federal agencies, and non-Federal users for satellite data from future GOES satellites.

Recommendation 3: Establish and implement processes to notify these agencies of GOES-R program status and changes.

NOAA Response: NOAA agrees with this recommendation. The GOES-R Program will continue to present program status and changes to the broader user community at the GOES-R Users Conference, the NOAA Direct Read-out Conference, and other topical meetings at which the user community is typically in attendance. The GOES-R System Program Director will provide an annual program status to the Office of the Federal Coordinator for Meteorology (OFCM), which will be responsible for its distribution to agencies that will be users of GOES-R data and products. In addition, the Director of the OFCM has offered to convene a meeting of these agencies at which a briefing on the program status and changes can be presented.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

David A. Powner, (202) 512-9286 or pownerd@gao.gov

Staff Acknowledgments

In addition to the contact name above, individuals making contributions to this report included Colleen Phillips (Assistant Director), Clayton Brisson, William Carrigg, Neil Doherty, Rebecca Eyler, Franklin Jackson, Jonathan Ticehurst, and Adam Vodraska.

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