



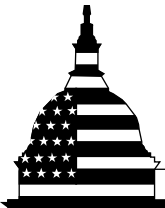
Testimony
before the Subcommittees on
Environment and Oversight, House
Committee on Science, Space, and
Technology

For Release on Delivery
Expected at 10:00 am EDT
Thursday, September 19, 2013

ENVIRONMENTAL SATELLITES

Focused Attention Needed to Improve Mitigation Strategies for Satellite Coverage Gaps

Statement of David A. Powner, Director
Information Technology Management Issues



G A O

Accountability * Integrity * Reliability

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.

Chairman Broun, Chairman Stewart, Ranking Member Maffei, Ranking Member Bonamici, and Members of the Subcommittees:

Thank you for the opportunity to participate in today's hearing on two satellite program acquisitions within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Both the Joint Polar Satellite System (JPSS) and the Geostationary Operational Environment Satellite-R series (GOES-R) programs are meant to replace current operational satellite programs, and both are considered critical to the United States' ability to maintain the continuity of data required for weather forecasting.

As requested, this statement summarizes our two reports being released today on (1) the JPSS program's status and plans, schedule quality, and gap mitigation strategies, and (2) the GOES-R program's status, requirements management, and contingency planning.¹ In preparing this testimony, we relied on the work supporting those reports. They each contain a detailed overview of our objectives, scope, and methodology, including the steps we took to assess the reliability of cost and schedule data. As noted in those reports, we found that the JPSS data on schedule milestones and estimated savings, and GOES-R data on schedules and cost reserves were sufficiently reliable for our purposes. All of our work for the reports was performed 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.

Background

Since the 1960s, the United States has used polar-orbiting and geostationary satellites to observe the earth and its land, ocean, atmosphere, and space environments. Polar-orbiting satellites constantly circle the earth in a nearly north-south orbit, providing global coverage of conditions that affect the weather and climate. As the earth rotates

¹GAO, *Polar Weather Satellites: NOAA Identified Ways to Mitigate Data Gaps, but Contingency Plans and Schedules Require Further Attention*, GAO-13-676 (Washington, D.C.: Sept. 11, 2013) and GAO, *Geostationary Weather Satellites: Progress Made, but Weaknesses in Scheduling, Contingency Planning, and Communicating with Users Needs to be Addressed*, GAO-13-597 (Washington, D.C.: Sept. 9, 2013).

beneath it, each polar-orbiting satellite views the entire earth's surface twice a day. In contrast, geostationary satellites maintain a fixed position relative to the earth from a high orbit of about 22,300 miles in space.

Both types of satellites provide a valuable perspective of the environment and allow observations in areas that may be otherwise unreachable. Used in combination with ground, sea, and airborne observing systems, satellites have become an indispensable part of monitoring and forecasting weather and climate. For example, polar-orbiting satellites provide the data that go into numerical weather prediction models, which are a primary tool for forecasting weather days in advance—including forecasting the path and intensity of hurricanes. Geostationary satellites provide the graphical images used to identify current weather patterns and provide short-term warning. These weather products and models are used to predict the potential impact of severe weather so that communities and emergency managers can help prevent and mitigate its effects.

Federal agencies are currently planning and executing major satellite acquisition programs to replace existing polar and geostationary satellite systems that are nearing the end of their expected life spans. However, these programs have troubled legacies of cost increases, missed milestones, technical problems, and management challenges that have resulted in reduced functionality and major delays to planned launch dates over time. We and others—including an independent review team reporting to the Department of Commerce and its Inspector General—have raised concerns that problems and delays on environmental satellite acquisition programs will result in gaps in the continuity of critical satellite data used in weather forecasts and warnings. According to officials at NOAA, a polar satellite data gap would result in less accurate and timely weather forecasts and warnings of extreme events, such as hurricanes, storm surge and floods. Such degradation in forecasts and warnings would place lives, property, and our nation's critical infrastructures in danger. The importance of having such data available was highlighted in 2012 by the advance warnings of the path, timing, and intensity of Superstorm Sandy. Given the criticality of satellite data to weather forecasts, concerns that problems and delays on the new satellite acquisition programs will result in gaps in the continuity of critical satellite data, and the impact of such gaps on the health and safety of the U.S.

population, we concluded that the potential gap in weather satellite data is a high-risk area and we added it to our High-Risk List in February 2013.²

Events Leading to the JPSS Program

For over forty years, the United States has operated two separate operational polar-orbiting meteorological satellite systems: the Polar-orbiting Operational Environmental Satellite series, which is managed by NOAA, and the Defense Meteorological Satellite Program, which is managed by the Air Force.³ Currently, there is one operational Polar-orbiting Operational Environmental Satellite and two operational Defense Meteorological Satellite Program satellites that are positioned so that they cross the equator in the early morning, midmorning, and early afternoon. In addition, the government relies on data from a European satellite, called the Meteorological Operational satellite.⁴

With the expectation that combining the Polar-orbiting Operational Environmental Satellite program and the Defense Meteorological Satellite Program would reduce duplication and result in sizable cost savings, a May 1994 Presidential Decision Directive⁵ required NOAA and the Department of Defense (DOD) to converge the two satellite programs into a single satellite program—the National Polar-orbiting Operational Environment Satellite System (NPOESS)—capable of satisfying both civilian and military requirements. To manage this program, DOD, NOAA, and the National Aeronautics and Space Administration (NASA) formed a tri-agency integrated program office. However, in the years after the program was initiated, NPOESS encountered significant technical challenges in sensor development, program cost growth, and schedule delays. Specifically, within 8 years of the contract's award, program costs grew by over \$8 billion, and launch schedules were delayed by over 5

²Every two years at the start of a new Congress, GAO calls attention to agencies and program areas that are high risk due to their vulnerabilities to fraud, waste, abuse, and mismanagement, or are most in need of transformation. See GAO, *High Risk Series: An Update*, GAO-13-283 (Washington, D.C.: Feb. 2013).

³NOAA provides command and control for both the Polar-orbiting Operational Environmental Satellite and Defense Meteorological Satellite Program satellites after they are in orbit.

⁴The European Organisation for the Exploitation of Meteorological Satellites' MetOp program is a series of three polar-orbiting satellites dedicated to operational meteorology. MetOp satellites are planned to be flown sequentially over 14 years. The first of these satellites was launched in 2006, the second was launched in 2012, and the final satellite in the series is expected to launch in 2017.

⁵Presidential Decision Directive NSTC-2, May 5, 1994.

years. In addition, as a result of a 2006 restructuring of the program, the agencies reduced the program's functionality by decreasing the number of originally planned satellites, orbits, and instruments.

Even after this restructuring, however, the program continued to encounter technical issues, management challenges, schedule delays, and further cost increases. Therefore, in August 2009, the Executive Office of the President formed a task force, led by the Office of Science and Technology Policy, to investigate the management and acquisition options that would improve the program. As a result of this review, the Director of Office of Science and Technology Policy announced in February 2010 that NOAA and DOD would no longer jointly procure NPOESS;⁶ instead, each agency would plan and acquire its own satellite system. Specifically, NOAA would be responsible for the afternoon orbit, and DOD would be responsible for the early morning orbit. The partnership with the European satellite agencies for the midmorning orbit would continue as planned.

When this decision was announced, NOAA and NASA immediately began planning for a new satellite program in the afternoon orbit—called JPSS—and DOD began planning for a new satellite program in the morning orbit—called the Defense Weather Satellite System, which has since been canceled.⁷ After the February 2010 decision to disband NPOESS, NOAA established a program office to guide the development and launch of the Suomi National Polar-orbiting Partnership (S-NPP) satellite⁸—a demonstration satellite that was developed under NPOESS and managed by NASA—as well as the two planned JPSS satellites, known as JPSS-1 and JPSS-2. NOAA also worked with NASA to establish its program office to oversee the acquisition, system engineering, and integration of the satellite program. NOAA estimates that the life cycle costs for the JPSS program will be \$11.3 billion through fiscal year 2025. The current anticipated launch date for the first JPSS satellite is March 2017, with a second satellite to be launched in December 2022.

⁶The announcement accompanied the release of the President's fiscal year 2011 budget request.

⁷After the decision to disband NPOESS, DOD established its Defense Weather Satellite System program office and modified its contracts accordingly before deciding in early 2012 to terminate the program and reassess its requirements (as directed by Congress).

⁸Originally called the NPOESS Preparatory Project, in January 2012 the name of the satellite was changed to the Suomi National Polar-orbiting Partnership satellite.

Over the last several years, we have issued a series of reports on the NPOESS program—and the transition to JPSS—that highlight the technical issues, cost growth, key management challenges, and key risks of transitioning from NPOESS to JPSS.⁹ In these reports, we made multiple recommendations to, among other things, improve executive-level oversight and establish mitigation plans for risks associated with pending polar satellite data gaps. NOAA has taken steps to address our recommendations, including taking action to improve executive-level oversight and in working to establish a contingency plan to mitigate potential gaps in polar satellite data. We subsequently assessed NOAA's progress in implementing both of these recommendations in our reports being issued today.

Overview of the GOES-R Program

In addition to the polar-orbiting satellites, NOAA operates GOES as a two-satellite geostationary satellite system that is primarily focused on the United States. The GOES-R series is the next generation of satellites that NOAA is planning; the satellites are planned to replace existing weather satellites that will likely reach the end of their useful lives in about 2015.

NOAA is responsible for GOES-R program funding and overall mission success. The NOAA Program Management Council, which is chaired by NOAA's Deputy Undersecretary, is the program oversight body for the GOES-R program. 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. Within the program office, there are two project offices that manage key components of the GOES-R system. NOAA has delegated responsibility to NASA to manage the Flight Project Office, including awarding and managing the spacecraft contract

⁹See, for example, GAO, *Environmental Satellites: Focused Attention Needed to Mitigate Program Risks*, GAO-12-841T (Washington, D.C.: June 27, 2012); *Polar-orbiting Environmental Satellites: Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention*, GAO-12-604 (Washington, D.C.: June 15, 2012); *Polar Satellites: Agencies Need to Address Potential Gaps in Weather and Climate Data Coverage*, GAO-11-945T (Washington, D.C.: Sept. 23, 2011); *Polar-orbiting Environmental Satellites: Agencies Must Act Quickly to Address Risks That Jeopardize the Continuity of Weather and Climate Data*, GAO-10-558 (Washington, D.C.: May 27, 2010); *Polar-orbiting Environmental Satellites: With Costs Increasing and Data Continuity at Risk, Improvements Needed in Tri-Agency Decision Making*, GAO-09-772T (Washington, D.C.: June 17, 2009); and *Polar-orbiting Environmental Satellites: With Costs Increasing and Data Continuity at Risk, Improvements Needed in Tri-Agency Decision Making*, GAO-09-564 (Washington, D.C.: June 17, 2009).

and delivering flight-ready instruments to the spacecraft. The Ground Project Office, managed by NOAA, oversees the Core Ground System contract and satellite data product development and distribution.

NOAA has made a number of changes to the program since 2006, including the removal of certain satellite data products and a critical instrument (the Hyperspectral Environmental Suite). In February 2011, as part of its fiscal year 2012 budget request, NOAA requested funding to begin development for two additional satellites in the GOES-R series. The program estimates that the development for all four satellites in the GOES-R series is to cost \$10.9 billion through 2036. In August 2013, NOAA announced that it would delay the launch of the GOES-R and S satellites from October 2015 and February 2017 to the second quarter of fiscal year 2016 and the third quarter of fiscal year 2017, respectively. These are the current anticipated launch dates of the first two GOES-R satellites; the last satellite in the series is planned for launch in 2024.

In September 2010, we recommended that NOAA develop and document continuity plans for the operation of geostationary satellites that include the implementation procedures, resources, staff roles, and time tables needed to transition to a single satellite, a foreign satellite, or other solution.¹⁰ In September 2011, the GOES-R program provided a draft plan documenting a strategy for conducting operations if there were only a single operational satellite.

In June 2012, we reported that, in order to oversee GOES-R contingency funding, senior managers at NOAA should have greater insight into the amount of contingency reserves¹¹ set aside for each satellite in the program and detailed information on how reserves are being used on both the flight and ground components. We recommended that the program assess and report to the NOAA Program Management Council the reserves needed for completing remaining development for each satellite in the series. We also found that unresolved schedule deficiencies remain in portions of the program's integrated master

¹⁰GAO, *Geostationary Operational Environmental Satellites: Improvements Needed in Continuity Planning and Involvement of Key Users*, [GAO-10-799](#) (Washington, D.C.: Sept. 1, 2010).

¹¹A contingency reserve provides program managers ready access to funding in order to resolve problems as they occur and may be necessary to cover increased costs resulting from unexpected design complexity, incomplete requirements, or other uncertainties. See GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: Mar. 2009).

schedule, including subordinate schedules for the spacecraft and core ground system.¹² We recommended that the program address shortfalls in schedule management practices, and NOAA has since taken steps to improve these practices. We subsequently assessed NOAA's progress in implementing both of these recommendations in our reports being issued today.

The JPSS Program Has Made Progress, but Faces Development Challenges, Has Weaknesses in Schedule Quality, and Lacks a Comprehensive Contingency Plan

NOAA has made progress towards JPSS program objectives of sustaining the continuity of NOAA's polar-orbiting satellite capabilities through the S-NPP, JPSS-1, and JPSS-2 satellites by (1) delivering S-NPP data to weather forecasters and (2) completing significant instrument and spacecraft development for the JPSS-1 satellite. However, the program has experienced delays on the ground system schedules for the JPSS-1 satellite. Moreover, the program is revising its scope and objectives to reduce costs and prioritize NOAA's weather mission.

The JPSS program has made progress on S-NPP since its launch. For example, in November 2012 the office completed an interim backup command and control facility that could protect the health and safety of the satellite if unexpected issues occurred at the primary mission operations facility. Also, since completing satellite activation and commissioning activities in March 2012, the JPSS program has been working to calibrate and validate S-NPP products in order to make them precise enough for use in weather-related operations by October 2013. While the program office plans to have 18 products validated for operational use by the end of September 2013, it is behind schedule for other products. Specifically, the program expects to complete validating 35 S-NPP products by the end of September 2014 and one other product by the end of September 2015, almost one and two years later than originally planned.

¹²GAO, *Geostationary Weather Satellites: Design Progress Made, but Schedule Uncertainty Needs to be Addressed*, [GAO-12-576](#), (Washington, D.C.: June 26, 2012).

In order to sustain polar-orbiting earth observation capabilities beyond S-NPP, the program is working to complete development of the JPSS-1 systems in preparation for a March 2017 launch date. To manage this initiative, the program office organized its responsibilities into two separate projects: (1) the flight project, which includes sensors, spacecraft, and launch vehicles and (2) the ground project, which includes ground-based data processing and command and control systems. JPSS projects and components are at various stages of system development. The flight project has nearly completed instrument hardware development for the JPSS-1 satellite and has begun testing certain instruments. Key testing milestones and delivery dates for the instruments and spacecraft have generally held constant since the last key decision point in July 2012, and both the instruments and the spacecraft are generally meeting expected technical performance. All instruments are scheduled to be delivered to the spacecraft by 2014. Also, the flight project completed a major design review for the JPSS-1 satellite's spacecraft.

The JPSS ground project has also made progress in developing the ground system components. However, the ground project experienced delays in its planned schedule due to issues with the availability of facilities required for hardware installation, software development, and testing. Consequently, the program has replanned the ground project schedule and is merging the next two major software releases. As a result, any complications in the merged ground system upgrades could affect the system's readiness to support the JPSS-1 launch date.

While NOAA is moving forward to complete product development on the S-NPP satellite and system development on the JPSS-1 satellite, the agency recently made major revisions to the program's scope and planned capabilities and is moving to implement other scope changes as it finalizes its plans pending congressional approval of the federal budget. We previously reported that, as part of its fiscal year 2013 budget process, NOAA was considering removing selected elements of the program in order to reduce total program costs from \$14.6 billion to \$12.9 billion.¹³ By October 2012, NOAA had reduced the program's scope by, among other things, reducing the previously planned network of fifteen ground-based receptor stations to two receptor sites at the north pole and two sites at the south pole and increasing the time it takes to obtain satellite data and deliver it to the end user on JPSS-2 from 30 minutes to

¹³GAO-12-604.

80 minutes.¹⁴ More recently, as proposed by the administration, NOAA began implementing additional changes in the program's scope and objectives in order to meet the agency's highest-priority needs for weather forecasting and reduce program costs from \$12.9 billion to \$11.3 billion. In this latest round of revisions, NOAA revised the program's scope by, among other things, transferring requirements for certain climate sensors to NASA, creating a new Polar Free Flyer program within NOAA that would be responsible for missions supporting continued solar measurements and user service systems, and reducing the JPSS program's mission life cycle by 3 years—from 2028 to 2025. The changes NOAA implemented over the last 2 years will have an impact on those who rely on polar satellite data. Specifically, satellite data products will be delivered more slowly than anticipated because of the reduction in the number of ground stations, and military users may not obtain the variety of products once anticipated at the rates anticipated because of the removal of their ground-based processing subsystems. As NOAA moves to implement these program changes, it will be important to assess and understand the impact the changes will have on satellite data users.

Integration Problems and Other Weaknesses Reduce JPSS Schedule Quality and Confidence

According to our guidance on best practices in scheduling,¹⁵ the success of a program depends, in part, on having an integrated and reliable master schedule that defines when and how long work will occur and how each activity is related to the others. The JPSS program office provided a preliminary integrated master schedule in June 2013, but this schedule is incomplete. The schedule contains the scope of work for key program components, such as the JPSS-1 and JPSS-2 satellites and the ground system, and cites linkages to more detailed component schedules. However, significant weaknesses exist in the program's schedule. Specifically, about one-third of the schedule is missing logical relationships called dependencies that are needed to depict the sequence in which activities occur. Complete network logic between all activities is essential if the schedule is to correctly forecast the start and end dates of activities within the plan. Program documentation acknowledges that this schedule is not yet complete and the program office plans to refine it over

¹⁴In January 2013, program officials revised this delay to 96 minutes to more precisely reflect the time it takes to send products from the ground system to the end users.

¹⁵GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-12-120G (exposure draft) (Washington, D.C.: May 30, 2012).

time. Until the program office completes its integrated schedule and includes logically linked sequences of activities, it will lack the information it needs to effectively monitor development progress, manage dependencies, and forecast the JPSS-1 satellite’s completion and launch.

While the program plans to refine its integrated master schedule, three component schedules supporting the JPSS-1 mission—VIIRS, the spacecraft, and the ground system—varied in their implementation of characteristics of high-quality, reliable schedules. Each schedule had strengths and weaknesses with respect to sound scheduling practices, but VIIRS was a stronger schedule with fewer weaknesses compared to the ground system and spacecraft schedules. The following table identifies the quality of each of the selected JPSS-1 component schedules based on the extent to which they met ten best practices of high-quality and reliable schedules.

Table 1: Assessment of JPSS-1 Component Schedule Quality

Schedule characteristic or best practice	Ground system	Spacecraft	VIIRS
Comprehensive			
Capturing all activities	●	○	●
Assigning resources to all activities	●	●	●
Establishing the duration of all activities	●	○	●
Well-constructed			
Sequencing all activities	●	○	●
Confirming that the critical path is valid	○	○	●
Ensuring reasonable total float	○	○	●
Credible			
Verifying that the schedule can be traced horizontally and vertically	○	○	●
Conducting a schedule risk analysis	○	○	○
Controlled			
Updating the schedule using actual progress and logic	●	●	●
Maintaining a baseline schedule	●	○	●

Source: GAO analysis of detailed schedules and related documentation for the VIIRS instrument, spacecraft, and ground system.

- = Met: The program office or contractor provided complete evidence that satisfies the entire criterion.
- = Substantially met: The program office or contractor provided evidence that satisfies a large portion of the criterion.
- = Partially met: The program office or contractor provided evidence that satisfies about half of the criterion.
- = Minimally met: The program office or contractor provided evidence that satisfies a small portion of the criterion.
- = Not met: The program office or contractor provided no evidence that satisfies any of the criterion.

The inconsistency in quality among the three schedules has multiple causes, including the lack of documented explanations for certain practices and schedule management and reporting requirements that varied across contractors. Since the reliability of an integrated schedule depends in part on the reliability of its subordinate schedules, schedule quality weaknesses in these schedules will transfer to an integrated master schedule derived from them. Consequently, the extent to which there are quality weaknesses in JPSS-1 support schedules further constrains the program's ability to monitor progress, manage key dependencies, and forecast completion dates. Until the program office addresses the scheduling shortfalls in its component schedules, it will lack the information it needs to effectively monitor development progress, manage dependencies, and forecast the JPSS-1 satellite's completion and launch.

The JPSS program office used data from flight project component schedules as inputs when it recently conducted a schedule risk analysis on the JPSS-1 mission schedule (and launch date) through NASA's joint cost and schedule confidence level (JCL) process.¹⁶ The JCL implemented by the JPSS program office represents a best practice in schedule management for establishing a credible schedule and reflects a robust schedule risk analysis conducted on key JPSS-1 schedule components. Based on the results of the JCL, the program office reports that its level of confidence in the JPSS-1 schedule is 70 percent and that it has sufficient schedule reserve to maintain a launch date of no later than March 2017. However, the program office's level of confidence in the JPSS-1 schedule may be overly optimistic for two key reasons. First, the model that the program office used was based on flight project activities rather than an integrated schedule consisting of flight, ground, program office, and other activities relevant to the development and launch of JPSS-1. As a result, the JPSS program office's confidence level projections do not factor in the ongoing scheduling issues that are impacting the ground project. Second, there are concerns regarding the spacecraft schedule's quality as identified above. Factoring in these concerns, the confidence of the JPSS-1 satellite's schedule and projected launch date would be lower. Until the program office conducts a schedule risk analysis on an integrated schedule that includes the entire scope of

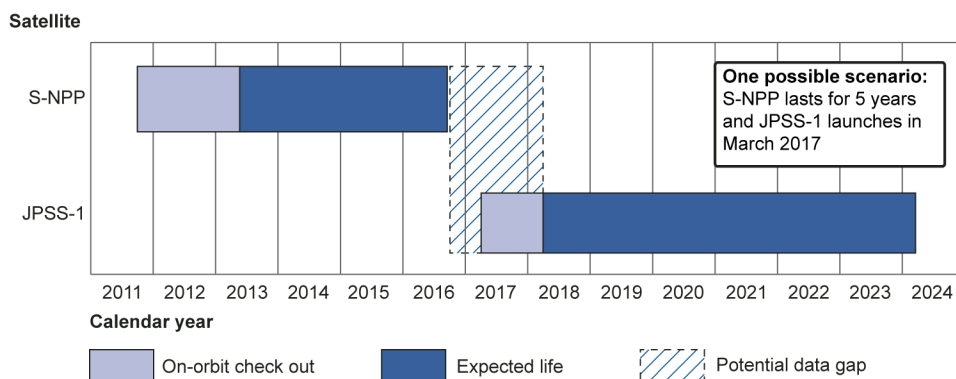
¹⁶The JCL is a probabilistic analysis that includes, among other things, all cost and schedule elements, incorporates and quantifies potential risks, assesses the impacts of cost and schedule to date, and addresses available annual resources to arrive at development cost and schedule estimates associated with various confidence levels.

effort and addresses quality shortfalls of relevant component schedules, it will have less assurance of meeting the planned March 2017 launch date for JPSS-1.

NOAA Has Analyzed Alternatives for Addressing Gaps in Satellite Data, but Lacks a Comprehensive Contingency Plan

In recent years, NOAA officials have communicated publicly and often about the risk of a polar satellite data gap. Currently, the program estimates that there will be a gap of about a year and a half from the time when the current Suomi NPP satellite reaches the end of its expected lifespan and when the JPSS-1 satellite will be in orbit and operational. Satellite data gaps in the morning or afternoon polar orbits would lead to less accurate and timely weather forecasting; as a result, advanced warning of extreme events—such as hurricanes, storm surges, and floods—would be affected. See figure 1 for a depiction of a potential gap in the afternoon orbit lasting 17 months.

Figure 1: A Potential Gap in Polar Environmental Satellite Coverage in the Afternoon Orbit



Source: GAO analysis of NOAA data.

Government and industry best practices call for the development of contingency plans to maintain an organization’s essential functions in the case of an adverse event and to reduce or control negative impacts from such risks.¹⁷ In October 2012, in response to our earlier recommendations

¹⁷See GAO, *Year 2000 Computing Crisis: Business Continuity and Contingency Planning*, GAO/AIMD-10.1.19 (Washington, D.C.: August 1998); National Institute of Standards and Technology, *Contingency Planning Guide for Federal Information Systems, NIST 800-34* (May 2010); Software Engineering Institute, *CMMI® for Acquisition, Version 1.3*, (Pittsburgh, Pa: November 2010).

to establish mitigation plans,¹⁸ NOAA established a mitigation plan to address the impact of potential gaps in polar afternoon satellite data. This plan identifies alternatives for mitigating the risk of a 14- to 18-month gap in the afternoon orbit beginning in March 2016, between the current polar satellite and the JPSS-1 satellite. However, NOAA did not implement the actions identified in its mitigation plan and decided to identify additional alternatives. In October 2012, at the direction of the Under Secretary of Commerce for Oceans and Atmosphere (who is also the Administrator of NOAA), NOAA contracted for a detailed technical assessment of alternatives to mitigate the degradation of products caused by a gap in satellite data in the afternoon polar orbit. This assessment solicited input from experts within and outside of NOAA and resulted in a range of alternatives that included relying on existing polar satellites, making improvements to the forecast models, and relying on the use of a foreign satellite.

By documenting its mitigation plan and conducting a study on additional alternatives, NOAA has taken positive steps towards establishing a contingency plan for handling the potential impact of satellite data gaps in the afternoon polar orbit. However, NOAA does not yet have a comprehensive contingency plan because it has not yet selected the strategies to be implemented or established procedures and actions to implement the selected strategies. In addition, there are shortfalls in the agency's current plans as compared to government and industry best practices, such as not always identifying specific actions with defined roles and responsibilities, timelines, and triggers. Moreover, multiple steps remain in testing, validating, and implementing the contingency plan. NOAA officials stated that the agency is continuing to work on refinements to its gap mitigation plan, and that they anticipate issuing an updated plan in fall 2013 that will reflect the additional alternatives. While NOAA expects to update its plan, the agency does not yet have a schedule for adding key elements—such as specific actions, roles and responsibilities, timelines, and triggers—for each alternative. Until NOAA establishes a comprehensive contingency plan that integrates its strategies and addresses the elements identified above to improve its plans, it may not be sufficiently prepared to mitigate potential gaps in polar satellite coverage.

¹⁸GAO-12-604.

GOES-R Has Made Development Progress, but Continues to Experience Milestone Delays and Weaknesses in Scheduling Practices and Contingency Planning

The GOES-R program has completed its design and made progress in building flight and ground components. Specifically, the program completed critical design reviews for the flight and ground projects and for the overall program between April and November 2012. The GOES-R flight components are in various stages leading up to the system integration review, with five of six completing a key environmental testing review. In addition, the program began building the spacecraft in February 2013. On the GOES-R core ground system, a prototype for the operations module was delivered in late 2012 and is now being used for initial testing and training.

The program has also installed antenna dishes at NOAA's primary satellite communications site, and completed two key reviews of antennas at the GOES remote backup site. After the completion of design, and as the spacecraft and instruments are developed, NASA plans to conduct several interim reviews and tests before proceeding to the next major program-level review, the system integration review.

However, the program has delayed several key milestones. Over the past 12 to 18 months, both the flight and ground segments experienced delays in planned dates for programwide milestones. More recently, in August 2013, the program announced that it would delay the launch of the first two satellites in the program. Specifically, the launch of the GOES-R satellite would be delayed from October 2015 to the quarter ending March 2016, and that the expected GOES-S satellite launch date would be delayed from February 2017 to the quarter ending June 2017.

The GOES-R program is also experiencing technical issues on the flight and ground projects that could cause further schedule delays. For example, the electronics unit of the Geostationary Lightning Mapper flight instrument experienced problems during testing, which led the program office to delay the tests. The program is considering several options to address this issue, including using the electronics unit being developed for a later GOES-R satellite to allow key components to proceed with testing. If the issue cannot be resolved, it would affect the instrument's performance. As a result, the program is also considering excluding the Geostationary Lightning Mapper from the first GOES-R satellite. It plans to make its decision on whether or not to include the instrument in late 2013. The removal of this instrument would cause a significant reduction in the satellite's functionality.

The program has reported that it is on track to stay within its \$10.9 billion life cycle cost estimate. However, program officials reported that, while the program is currently operating without cost overruns on any of its main components, program life cycle costs may increase by \$150 to \$300 million if full funding in the current fiscal year is not received.

While some improvements have been made, the GOES-R program continues to demonstrate weaknesses in the development of component schedules, which have the potential to cause further delays in meeting milestone timelines. In the time since our previous work on examining program schedules in June 2012, it has since improved selected practices on its spacecraft and core ground schedules. For example, NOAA has since included all subcontractor activities in the core ground schedule, and allocated a higher percentage of activities to resources in its schedules. As a result of these improvements, the program has increased the reliability of its schedules, and also decreased the risk of further delaying satellite launch dates due to incorrect schedule data.

However, the program's performance on other scheduling best practices stayed the same or worsened. For example, both the spacecraft and core ground schedules have issues with sequencing remaining activities and integration between activities. Without the right linkages, activities that slip early in the schedule do not transmit delays to activities that should depend on them. Both schedules also have a very high average of total float time for detailed activities.¹⁹ Such high values of total float time can falsely depict true project status, making it difficult to determine which activities drive key milestone dates. Finally, the project's critical path does not match up with activities that make up the driving path²⁰ on the core ground schedule. Without a valid critical path to the end of the schedule, management cannot focus on activities that will have a detrimental effect on the key project milestones and deliveries if they slip.

Taken together, delays in key milestones, technical issues, and weaknesses in schedule practices could lead to further delays in the launch date of the first GOES-R satellite, currently planned to occur by March 2016.

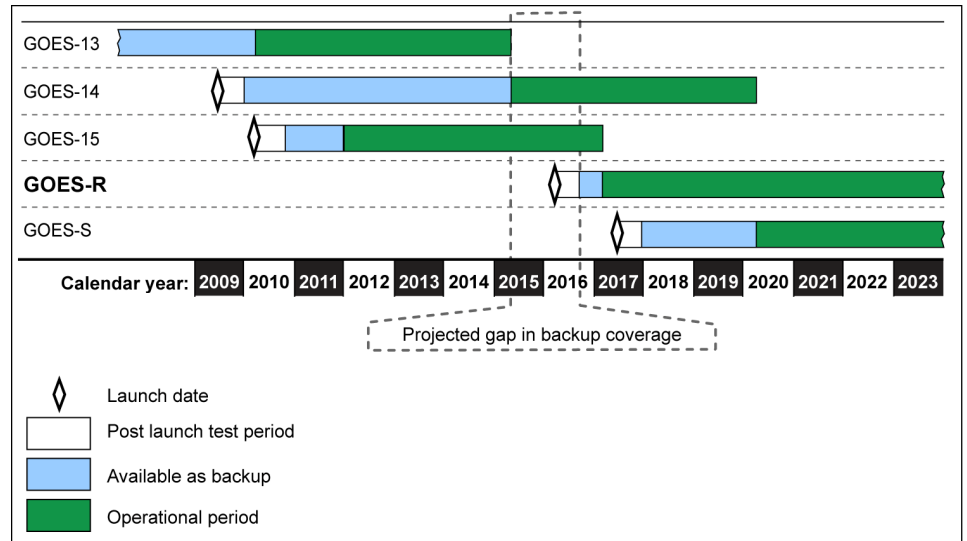
¹⁹Total float time is the amount of time an activity can be delayed or extended before the delay affects its successors or the program's finish date.

²⁰A driving path is the longest path of successive activities that drives the finish date for a key milestone. The driving path often corresponds to a schedule's critical path.

Launch Delays Increase the Risk of a Satellite Coverage Gap, and Weaknesses in Contingency Plans Increase the Impact of a Coverage Gap

Launch delays such as the one recently experienced by the GOES-R program also increase the time that NOAA is without an on-orbit backup satellite. This is significant because, in April 2015, NOAA expects to retire one of its operational satellites and move its back-up satellite into operations. The recent delay in expected launch of the first GOES-R satellite from October 2015 to as late as March 2016 increases the projected gap in backup coverage to just short of two years. Also, the first satellite is now expected to complete its post-launch testing by September 2016, only five months before NOAA expects to retire the GOES-15 satellite. If launch of the first satellite were to have a further slip of more than five months, a gap in satellite coverage could occur. Figure 2 shows current anticipated operational and test periods for the two most recent series of GOES satellites.

Figure 2: Potential Gap in Geostationary Operational Environmental Satellite Coverage



Source: GAO analysis of NOAA data.

Note: The GOES-R and GOES-S launch dates reflect the end of the quarters listed in NOAA's latest launch estimates. Thus, GOES-R is listed as launching by March 2016, and GOES-S by June 2017.

Because of the expected imminent use of the current on-orbit back-up satellite, a launch delay to GOES-R would also increase the potential for a gap in GOES satellite coverage should one of the two operational

satellites (GOES-14 or -15) fail prematurely (see graphic)—a scenario given a 36 percent likelihood of occurring by an independent review team. Without a full complement of operational GOES satellites, the nation’s ability to maintain the continuity of data required for effective weather forecasting could be compromised. This, in turn, could put the public, property, and the economy at risk.

The impact of a gap in satellite coverage may also increase based on issues with NOAA’s current contingency plans. Government and industry best practices call for the development of contingency plans to maintain an organization’s essential functions in the case of an adverse event.²¹ These practices include key elements such as identifying and selecting strategies to address failure scenarios, developing procedures to implement selected strategies, and involving affected stakeholders.

NOAA has established contingency plans for the loss of its GOES satellites and ground systems that are generally in accordance with best practices. Specifically, NOAA identified failure scenarios, recovery priorities, and minimum levels of acceptable performance. NOAA provided a final version of its satellite plan in December 2012 that included scenarios for three, two, and one operational satellites. It also established contingency plans that identify solutions and high-level activities and triggers to implement the solutions.

However, these plans are missing key elements. For example, NOAA has not demonstrated that the contingency strategies for both its satellite and ground systems are based on an assessment of costs, benefits, and impact on users. Furthermore, NOAA did not work with the user community to address potential reductions in capabilities under contingency scenarios or identify alternative solutions for preventing a delay in the GOES-R launch date. In addition, while NOAA’s failure scenarios for its satellite system are based on the number of available satellites—and the loss of a backup satellite caused by a delayed GOES-R launch would fit into these scenarios—the agency did not identify alternative solutions or time lines for preventing a GOES-R launch delay. Until NOAA addresses the shortfalls in its contingency plans and procedures, the plans may not work as intended in an emergency and

²¹See GAO, *Year 2000 Computing Crisis: Business Continuity and Contingency Planning*, [GAO/AIMD-10.1.19](#) (Washington, D.C.: August 1998); National Institute of Standards and Technology, *Contingency Planning Guide for Federal Information Systems*, [NIST 800-34](#) (May 2010); Software Engineering Institute, *CMMI® for Acquisition, Version 1.3*, (Pittsburgh, Pa: November 2010).

satellite data users may not obtain the information they need to perform their missions.

Implementation of Recommendations Should Help Mitigate Program Risks

Both the JPSS and GOES-R programs continue to carry risks of future launch delays and potential gaps in satellite coverage; implementing the recommendations in our accompanying reports should help mitigate those risks. In the JPSS report being released today, we recommend, among other things, that NOAA

- establish a complete JPSS program integrated master schedule that includes a logically linked sequence of activities;
- address the shortfalls in the ground system and spacecraft component schedules outlined in our report;
- after completing the integrated master schedule and addressing shortfalls in component schedules, update the joint cost and schedule confidence level for JPSS-1, if warranted and justified; and
- establish a comprehensive contingency plan for potential satellite data gaps in the polar orbit that is consistent with contingency planning best practices identified in our report. The plan should include, for example, specific contingency actions with defined roles and responsibilities, timelines, and triggers; analysis of the impact of lost data from the morning orbits; and identification of opportunities to accelerate the calibration and validation phase of JPSS-1.

In the GOES-R report being released today, we recommend, among other things, that NOAA

- given the likely gap in availability of an on-orbit GOES backup satellite in 2015 and 2016, address the weaknesses identified in our report on the core ground system and the spacecraft schedules. These weaknesses include, but are not limited to, sequencing all activities, ensuring there are adequate resources for the activities, and conducting a schedule risk analysis and
- revise the satellite and ground system contingency plans to address weaknesses identified in our report, including providing more information on the potential impact of a satellite failure, identifying alternative solutions for preventing a delay in GOES-R launch as well as time lines for implementing those solutions, and coordinating with key external stakeholders on contingency strategies.

On both reports, NOAA agreed with our recommendations and identified steps it is taking to implement them.

In summary, NOAA has made progress on both the JPSS and GOES-R programs, but key challenges remain to ensure that potential gaps in satellite data are minimized or mitigated. On the JPSS program, NOAA has made noteworthy progress in using S-NPP data in weather forecasts and developing the JPSS-1 satellite. However, NOAA does not expect to validate key S-NPP products until nearly 3 years after the satellite's launch, and there are remaining issues with the JPSS schedule that decrease the confidence that JPSS-1 will launch by March 2017 as planned. On the GOES-R program, progress in completing the system's design has been accompanied by continuing milestone delays, including delays in the launch dates for both the GOES-R and GOES-S satellites. The potential for further milestone delays also exists due to remaining weaknesses in developing and maintaining key program schedules. Faced with an anticipated gap in the polar satellite program and a potential gap in the geostationary satellite program, NOAA has taken steps to study alternatives and establish mitigation plans. However, the agency does not yet have comprehensive contingency plans that identify specific actions with defined timelines, and triggers. Until NOAA establishes comprehensive contingency plans that addresses these shortfalls, its plans for mitigating potential gaps may not be effective in avoiding significant impacts to its weather mission.

Chairman Broun, Chairman Stewart, Ranking Member Maffei, Ranking Member Bonamici, and Members of the Subcommittees, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

If you have any questions on matters discussed in this testimony, please contact David A. Powner at (202) 512-9286 or at pownerd@gao.gov. Other key contributors include Colleen Phillips (assistant director), Shaun Byrnes, Lynn Espedido, Nancy Glover, Franklin Jackson, Josh Leiling, and Meredith Raymond.