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ENVIRONMENTAL SATELLITES

Launch Delayed; NOAA Faces Key Decisions on Timing of Future Satellites

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Accessible Version

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GAO Highlights

Highlights of GAO-16-143T, a testimony before the Subcommittees on Environment and Oversight, Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

NOAA is procuring the next generation of polar and geostationary weather satellites to replace aging satellites that are approaching the end of their useful lives. GAO has reported that gaps in polar satellite coverage and in backup coverage for geostationary satellites are likely in the near future. Given the criticality of satellite data to weather forecasts, concerns that problems and delays on the new satellite programs will result in gaps in the continuity of critical satellite data, and the impact such gaps could have on the health and safety of the U.S. population, GAO added mitigating weather satellite gaps to its High-Risk List in 2013 and it remained on the list in 2015.

GAO was asked to testify, among other things, on the cause and impact of a recent launch delay on the GOES-R program, and the status and key remaining challenges on the JPSS program. To do so, GAO relied on prior reports issued from 2012 to 2015 as well as on ongoing work on both programs. That work included analyzing progress reports and interviewing officials.

What GAO Recommends

GAO is not making any new recommendations in this statement, but—since 2012—has made 23 recommendations to NOAA to strengthen its satellite acquisition programs and contingency plans. The department agreed with GAO's recommendations and is taking steps to implement them. To date, NOAA has implemented 6 recommendations and is working to address the remaining 17. Timely implementation of these recommendations will help mitigate program risks.

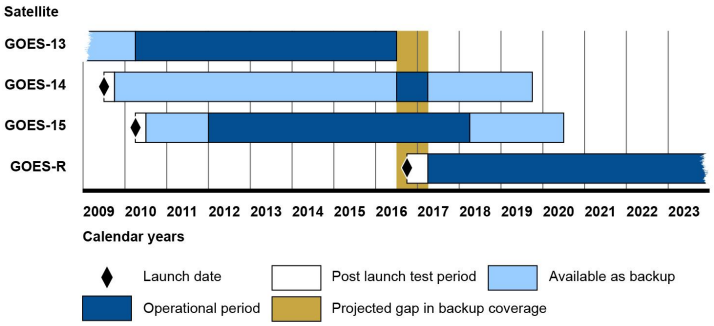
View GAO-16-143T. For more information, contact David A. Powner at (202) 512-9286 or pownerd@gao.gov.

What GAO Found

The National Oceanic and Atmospheric Administration's (NOAA) $10.9 billion Geostationary Operational Environmental Satellite-R (GOES-R) program recently delayed the planned launch of the first satellite in the new series from March 2016 to October 2016. Based on its ongoing work, GAO found that the decision to delay the launch was due to poor schedule performance over the last few years (losing more than 10 days a month on average), recent technical issues with key components, and little schedule margin as the program entered integration testing. The October 2016 launch date may also be delayed if additional technical challenges arise or if schedule performance remains poor.

NOAA recently changed assumptions about the expected lifespan of existing GOES satellites from 7 to 10 years based on the longevity of prior satellites. However, the analysis supporting this change is over 10 years old. Even with this extension, NOAA may fall short of its policy of having 2 operational satellites and 1 backup satellite in orbit. The agency faces an 11 month gap in backup coverage until GOES-R is operational, during which time there would be only 2 operational satellites (see figure). Any further delays in the GOES-R launch date could exacerbate that gap. NOAA is now facing important decisions on when to launch the remaining satellites in the GOES-R series to maximize satellite coverage while minimizing development and storage costs.

Timeline for a Potential Gap in Backup Geostationary Satellite Coverage



Source: GAO analysis of NOAA data. | GAO-16-143T

Based on its ongoing work, GAO found that NOAA's $11.3 billion Joint Polar Satellite System (JPSS) program is making progress toward the planned launch of the JPSS-1 satellite in March 2017. However, the program has experienced technical issues that have affected internal schedule deadlines, such as an issue with debris in an instrument's subsystem that delayed its delivery by approximately 8 months, and faces key risks in the remainder of development. NOAA is also facing the risk of a potential near-term gap in polar data prior to the launch of the JPSS-1 satellite. Similar to the decision on the GOES satellites, in April 2015, NOAA revised its assumptions about the expected life of the satellite that is currently in-orbit by adding up to 4 years, which would reduce the chance of a near-term gap. However, risks to the performance and health of the on-orbit satellite, and to development of the JPSS-2 satellite could increase the risk of a gap. Also, NOAA faces key decisions on timing the development and launch of the remaining JPSS satellites to ensure satellite continuity while balancing the possibility that satellites could last much longer than anticipated.

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Chairmen Bridenstine and Loudermilk, Ranking Members Bonamici and Beyer, and Members of the Subcommittees:

Thank you for the opportunity to participate in today's hearing on two important satellite acquisition programs within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Both the Geostationary Operational Environmental Satellite-R series (GOES-R) and the Joint Polar Satellite System (JPSS) are expected to replace current operational satellites as they near the end of their expected lifespans. Both programs are critical to the United States' ability to maintain the continuity of data required for weather forecasting.

As requested, this statement discusses (1) the GOES-R program: our prior concerns about the program's schedule, recent events that have delayed the planned launch date and their impact, and key decisions facing the program as it moves forward; and (2) the JPSS program: our prior findings on key risks and the potential for a satellite data gap, as well as the program's current status and key remaining challenges. To prepare this testimony, we relied on the work supporting our prior reports on GOES-R and JPSS.[1] More detailed information on our objectives, scope, and methodology for that work can be found in the issued reports. We also obtained information on the current status and key challenges facing the JPSS program through ongoing work we are doing for the full Committee, which is to be issued in spring 2016. We assessed documentation associated with NOAA's efforts to address our prior recommendations on both programs. Specifically, we analyzed program office documents on cost, schedule, and key risks, and assessed

[1]GAO, *Geostationary Weather Satellites: Launch Date Nears, but Remaining Schedule Risks Need to be Addressed*, GAO-15-60 (Washington, D.C.: Dec. 16, 2014); *Polar Weather Satellites: NOAA Needs To Prepare for Near-term Data Gaps*, GAO-15-47 (Washington, D.C.: Dec. 16, 2014); *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); *Geostationary Weather Satellites: Progress Made, but Weaknesses in Scheduling, Contingency Planning, and Communicating with Users Need to Be Addressed,* GAO-13-597, (Washington, D.C.: Sept. 9, 2013); and *Geostationary Weather Satellites: Design Progress Made, but Schedule Uncertainty Needs to be Addressed*, GAO-12-576, (Washington, D.C.: June 26, 2012); and *Polar-orbiting Environmental Satellites: Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention*, GAO-12-604 (Washington, D.C.: June 15, 2012).

changes in assumptions on the longevity of existing satellites. We also interviewed program officials and key contractors. We confirmed facts and analyses presented in this statement with NOAA officials.

All of our work was performed and is being conducted 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 geostationary and polar-orbiting satellites to observe the earth and its land, ocean, atmosphere, and space environments. Geostationary satellites maintain a fixed position relative to the earth from a high orbit of about 22,300 miles in space. In contrast, polar-orbiting satellites circle the earth in a nearly north-south orbit, providing global observation of conditions that affect the weather and climate. As the earth rotates beneath it, each polar-orbiting satellite views the entire earth's surface twice a day.

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, geostationary satellites provide the graphical images used to identify current weather patterns and provide short-term warning. 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. 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 geostationary and polar 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 the department's Inspector

General—have raised concerns that problems and delays with 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 surges, 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.

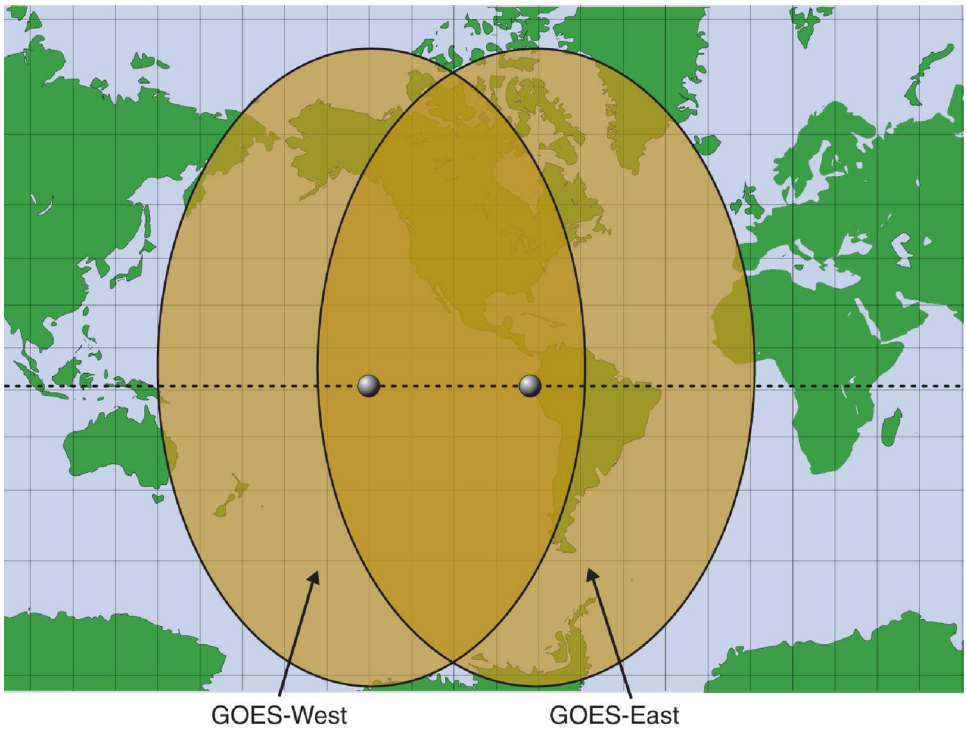
Given the criticality of satellite data to weather forecasts, concerns that problems and delays on the new satellite acquisition programs will result in gaps in the continuity of critical satellite data, and the impact of such gaps on the health and safety of the U.S. population, we concluded that the potential gap in weather satellite data is a high-risk area. We added this area to our High-Risk List in 2013 and it remained on the High-Risk List in 2015.[2]

The GOES-R Program: An Overview

NOAA operates a two-satellite geostationary satellite system that is primarily focused on the United States (see figure 1). The GOES-R series is the next generation of satellites that NOAA is planning; the satellites are planned to replace existing weather satellites. The ability of the satellites to provide broad, continuously updated coverage of atmospheric conditions over land and oceans is important to NOAA's weather forecasting operations.

[2]Every 2 years, at the start of a new Congress, we call 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. 14, 2013) and *High Risk Series: An Update*, GAO-15-290 (Washington, D.C.: Feb. 11, 2015).

Figure 1: Approximate Geographic Coverage of the Geostationary Operational Environmental Satellites (GOES)



Source: NOAA (data), Mapart (map). | GAO-16-143T

NOAA is responsible for GOES-R program funding and overall mission success, and has implemented an integrated program management structure with the National Aeronautics and Space Administration (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 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.

The program estimates that the development for all four satellites in the GOES-R series will cost $10.9 billion through 2036. In 2013, NOAA announced that it would delay the launch of the GOES-R and S satellites

from October 2015 and February 2017 to March 2016 and May 2017, respectively.

Since 2012, we have issued three reports on the GOES-R program that highlighted management challenges and the potential for a gap in backup satellite coverage.[3] In these reports, we made 12 recommendations to NOAA to improve the management of the GOES-R program. These recommendations included improving satellite contingency plans, addressing shortfalls in defect management, and addressing weaknesses in scheduling practices. The agency agreed with these recommendations.

As of October 2015, the agency implemented 4 of these recommendations and is working on the remaining 8 recommendations. For example, NOAA improved its geostationary satellite contingency plan and improved its risk management processes. Also, while NOAA has made progress by improving selected practices, it has not yet fully implemented our recommendation to address multiple weaknesses in its scheduling practices. For example, the agency included subcontractor activities in its core ground schedule, but has not yet provided details showing a realistic allocation of resources. We have ongoing efforts to assess the agency's progress in addressing the open recommendations.

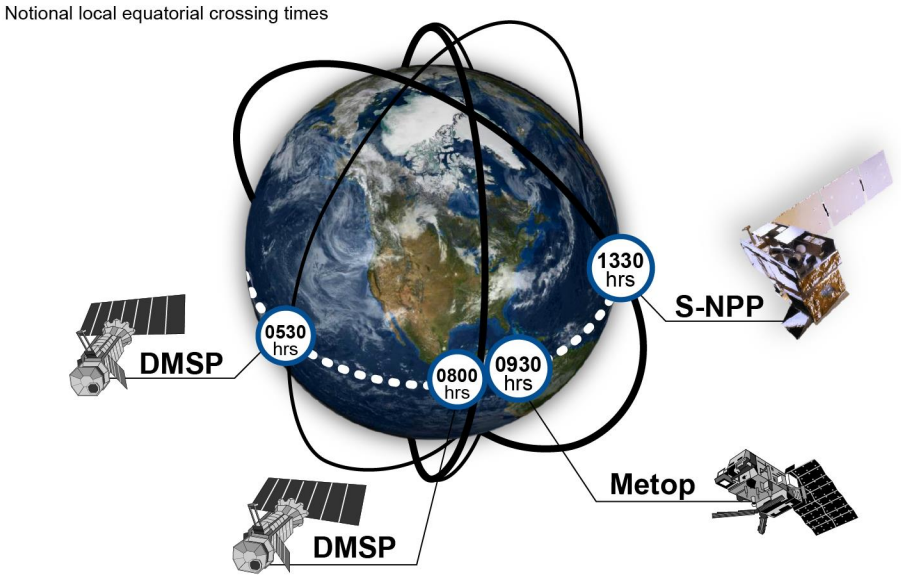
The JPSS Program: An Overview

In addition to the geostationary satellite constellation, for over 40 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 (DMSP), which is managed by the Air Force. Currently, there is one operational Polar-orbiting Operational Environmental Satellite (called the Suomi National Polar-orbiting Partnership, or S-NPP) and two operational DMSP 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

[3]See GAO-15-60, GAO-13-597, and GAO-12-576.

satellite, or Metop.[4] Figure 2 illustrates the current operational polar satellite constellation.

Figure 2: Configuration of Operational Polar Satellites



Sources: GAO, based on NPOESS Integrated Program Office, NOAA, and DOD data; NASA/Goddard Space Flight Center Scientific Visualization Studio (earth); S-NPP image provided courtesy of University of Wisconsin-Madison Space Science and Engineering Center. | GAO-16-143T

Note: DMSP—Defense Meteorological Satellite Program; Metop—Meteorological Operational (satellite); S-NPP—Suomi National Polar-orbiting Partnership; NPOESS—National Polar-orbiting Operational Environmental Satellite System; NOAA—National Oceanic and Atmospheric Administration; DOD—Department of Defense; and NASA—National Aeronautics and Space Administration.

A May 1994 Presidential Decision Directive[5] 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

[4]The 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.

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

civilian and military requirements. However, in the years after the program was initiated, NPOESS encountered significant technical challenges in sensor development, program cost growth, and schedule delays.

Faced with costs that were expected to reach about $15 billion and launch schedules that were delayed by over 5 years, in February 2010, the Director of the Office of Science and Technology Policy announced that NOAA and DOD would no longer jointly procure NPOESS; 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.

When this decision was announced, NOAA and NASA began planning for a new satellite program in the afternoon orbit—called JPSS. In 2010, NOAA established a program office to guide the development and launch of the S-NPP satellite[6] as well as the two planned JPSS satellites, known as JPSS-1 and JPSS-2. NOAA's current life cycle cost baseline for the JPSS program is $11.3 billion through fiscal year 2025. The current anticipated launch dates for JPSS-1 and JPSS-2 are March 2017 and December 2021, respectively. More recently, NOAA has also begun planning the Polar Follow-On program, which is to include the development and launch of a third and fourth satellite in the series. These satellites are planned to be nearly identical to the JPSS-2 satellite.

Since 2012, we have issued three reports on the JPSS program that highlighted technical issues, component cost growth, management challenges, and key risks.[7] In these reports, we made 11 recommendations to NOAA to improve the management of the JPSS program. These recommendations included addressing key risks and establishing a comprehensive contingency plan consistent with best practices. The agency agreed with these recommendations.

As of October 2015, the agency has implemented 2 recommendations and was working to address the remaining 9 recommendations.

[6]S-NPP was originally planned as a demonstration satellite, but due to schedule delays that had the potential to lead to satellite data gaps, NOAA made the decision to use it as an operational satellite. This means that the satellite's data is used for climate and weather products.

[7]See GAO-15-47, GAO-13-676, and GAO-12-604.

Specifically, NOAA established contingency plans to mitigate the possibility of a polar satellite data gap and began tracking completion dates for key risk mitigation activities. NOAA also took initial steps to improve its scheduling practices, contingency plans, and assessment of the potential for a gap. We have ongoing work reviewing the agency's efforts to fully implement these open recommendations, and plan to issue our report in spring 2016.

Prior Schedule Concerns Were Warranted; GOES-R Program Delayed Its Committed Launch Date and Faces Important Decisions on How to Proceed

As previously noted, we have issued a series of reports on the GOES-R program that highlighted schedule delays, management challenges, and the potential for a gap in backup satellite coverage.[8] In these reports, we found that technical issues had caused a series of delays to major program milestones, which in turn had the potential to affect the GOES-R satellite's launch readiness date. In 2012 and 2013, we made recommendations to NOAA to strengthen its scheduling practices. While the agency is making progress on these recommendations, they have not yet been fully implemented.

Most recently, in December 2014, we reported that the GOES-R program had made significant progress in developing its first satellite, including completing testing of the satellite instruments. However, we also reported that even though NOAA had delayed the launch of the GOES-R satellite from October 2015 to March 2016, the program continued to experience schedule delays that could affect the new launch date.[9] Specifically, the program had delayed multiple key reviews and tests, with delays ranging from 5 to 17 months. We also reported that the program's actions to mitigate its schedule delays introduced further risks, which could increase the extent of the delays. For example, the program attempted to mitigate delays in developing detailed plans for ground-based data operations by performing system development while concurrently working on the detailed plans. In addition, the program compressed its testing schedule by performing spacecraft integration testing 24-hours-a-day, 7-days-a-week. As we reported previously, methods such as conducting planning and development work concurrently and compressing test schedules are activities that increase the risk of further delays because there could be too little time to resolve any issues that arise. At the time of our report,

[8]See GAO-12-576, GAO-13-597, and GAO-15-60.

[9]GAO-15-60.

program officials acknowledged that they could not rule out the possibility of further delays, and that these delays could affect the planned March 2016 launch date.

Other entities, including a NOAA standing review board and the Department of Commerce's Inspector General, shared these concerns. In late 2014, NOAA's standing review board noted that the program's plan for the remaining integration and testing activities was very aggressive, and that additional failures and subsequent rework could threaten the then-expected planned launch date in early 2016. In May 2015, the Inspector General expressed concerns about the program's lagging progress and reported that the program needed to proactively address testing risks in order to maintain its launch schedule.[10]

Based on information collected during our ongoing work, these prior concerns about the program schedule were warranted. The program continued to experience poor schedule performance as it moved through integration and testing. Program data show that the program lost more than 10 days of schedule reserve each month, on average, between July 2013 and July 2015. When asked about this poor schedule performance, program officials stated several reasons, including the complexity of the satellite build, the difficulties faced as part of a first-time build, and that the testing schedule was extremely aggressive. The monthly loss in margin occurred even though the program introduced steps designed to minimize a loss in reserves, such as switching to round-the-clock testing, eliminating selected tests, and implementing process and management changes. In October 2015, program officials reported that schedule performance improved for the month of September.

[10]U.S. Department of Commerce Office of the Inspector General, *National Oceanic and Atmospheric Administration: Audit of the Geostationary Operational Environmental Satellite–R Series: Leadership Must Proactively Address Integration and Test Risks to Maintain Revised Launch Schedule*, OIG-15-030-A (Washington, D.C.: May 28, 2015).

GOES-R Satellite Launch Date Delayed; NOAA Extends the Expected Lifespans of Current Satellites, but the Risk of a Gap in Backup Coverage Remains

In August 2015, NOAA decided to delay the planned launch date of the first GOES-R satellite from March 2016 to October 2016. While previously reported schedule delays contributed to this decision by decreasing the overall amount of available schedule reserves, program officials noted several other reasons for this decision. These reasons included finding debris in the solar array drive assembly[11] that required them to replace the component, needing additional spacecraft repair and rework after testing was completed, and resolving disconnects in the expected duration of tasks at the launch site. NOAA also considered the likelihood of future delays in thermal vacuum testing, which is considered to be one of the more difficult environmental tests. NOAA officials stated that they chose the new launch date because it was the next available launch slot at the Kennedy Space Center and was consistent with expectations on when the GOES-R satellite would be ready to launch.[12]

Based on findings from our ongoing work, recent events have increased the risk of achieving the October 2016 launch date. In September 2015, NOAA identified a new technical issue in a component that helps regulate and distribute the satellite's power supply.[13] To try to address this issue, the GOES program replaced the component on the GOES-R satellite with the same component from GOES-S, the next satellite in the series. The program has experienced delays as a result of the need to replace and retest this component, and it is not yet clear that this switch will address the problem. According to a recent NOAA review of the program, this issue, along with several other issues discovered in testing, has put the new October 2016 launch date at risk. In late 2015, NOAA officials plan to reassess the schedule leading up to the planned launch date. Program officials stated that if GOES-R does not launch in October 2016, another launch slot would likely be available by May 2017.

[11]The solar array drive assembly is a rotating mechanism which passes power from the solar panel array to the GOES-R instruments.

[12]The October 2015 launch slot became available because the mission which previously had that slot wanted to launch sooner.

[13]This component is called the Scalable Power Regulation Unit.

NOAA Extended the Expected Life Span of Its Operational Satellites, but the Agency Continues to Face a Potential Gap in Backup Satellite Coverage

NOAA's policy for geostationary satellites is to have two operational satellites and one backup satellite in orbit at all times. Three viable GOES satellites—GOES-13, GOES-14, and GOES-15—are currently in orbit. Both GOES-13 and GOES-15 are operational satellites, with GOES-13 covering the eastern United States (GOES-East in figure 1, on page 4) and GOES-15 covering the western United States (GOES-West in figure 1). GOES-14 is currently in an on-orbit storage mode and is available as a backup for the other two satellites should they experience any degradation in service. As we previously reported, this backup policy proved useful on two previous occasions when the agency experienced problems with one of its operational satellites, and was able to move its backup satellite into place until the problems had been resolved.[14]

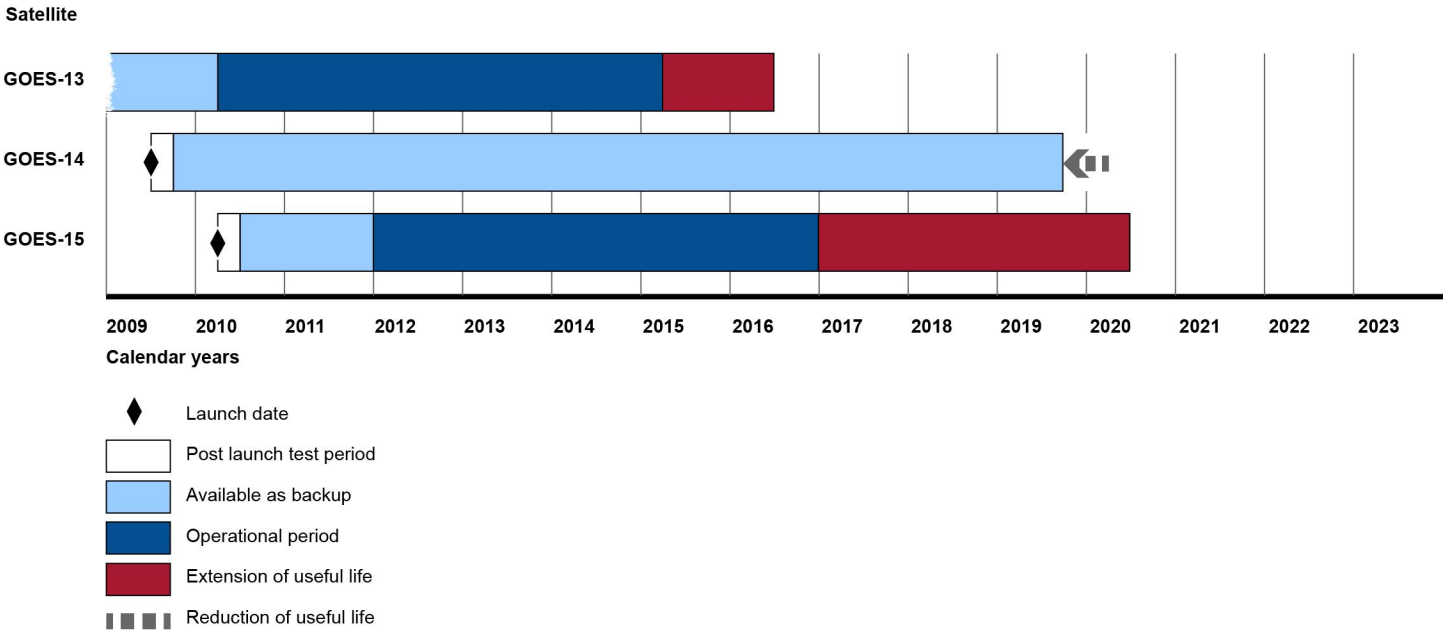
Based on ongoing work, we found that NOAA recently decided to change its assumptions about the lifespan of the currently operational GOES satellites. The satellites were originally designed to have a 7-year life, consisting of 5 operational years and 2 years in storage. NOAA officials stated that, in April 2015, the agency revised its expectations for the total life for the GOES-13, GOES-14, and GOES-15 satellites to 10 years (including both operational and storage years). On October 21, 2015, the Deputy Assistant Administrator for Systems in NOAA's National Environmental Satellite, Data, and Information Service informed us that the decision to change the lifespan was based on an analysis performed in 2005 that showed a 3-year extension was reasonable. At that time, NOAA chose to continue to depict the shorter lifespan due to its judgment of overall risk. The Deputy Assistant Administrator stated that in spring 2015, NOAA determined that it had sufficient history and performance on the GOES-13 and 15 satellites to begin reflecting the 10-year lifespan in its planning documents. This change had the effect of increasing the expected life of GOES-13 and GOES-15 from the previous estimate, and slightly decreasing the expected life of GOES-14.[15] Figure 3 shows the original and extended estimates of the useful lives of the geostationary satellite constellation.

[14]GAO-15-60.

[15]GOES-14 was launched in June 2009 and has served as the backup satellite in on-orbit storage for the 6 years since that time. Combining the actual storage time with the anticipated 5-year operational period exceeded NOAA's new assumption of a 10-year lifespan. Thus, the change to an estimated 10-year life is slightly less than NOAA's prior plans for GOES-14.

If NOAA had not made the decision to extend its expectation of the useful life of GOES-15, the recent delay in the GOES-R launch could have put NOAA at risk of a coverage gap in early 2017. With the change in assumptions, NOAA officials now expect that there will be coverage of the GOES-East and West satellite positions through 2019 regardless of when the GOES-R series of satellites are available.

Figure 3: NOAA's Expected Life Span of Geostationary Satellites Currently in Orbit



Source: GAO analysis of NOAA data. | GAO-16-143T

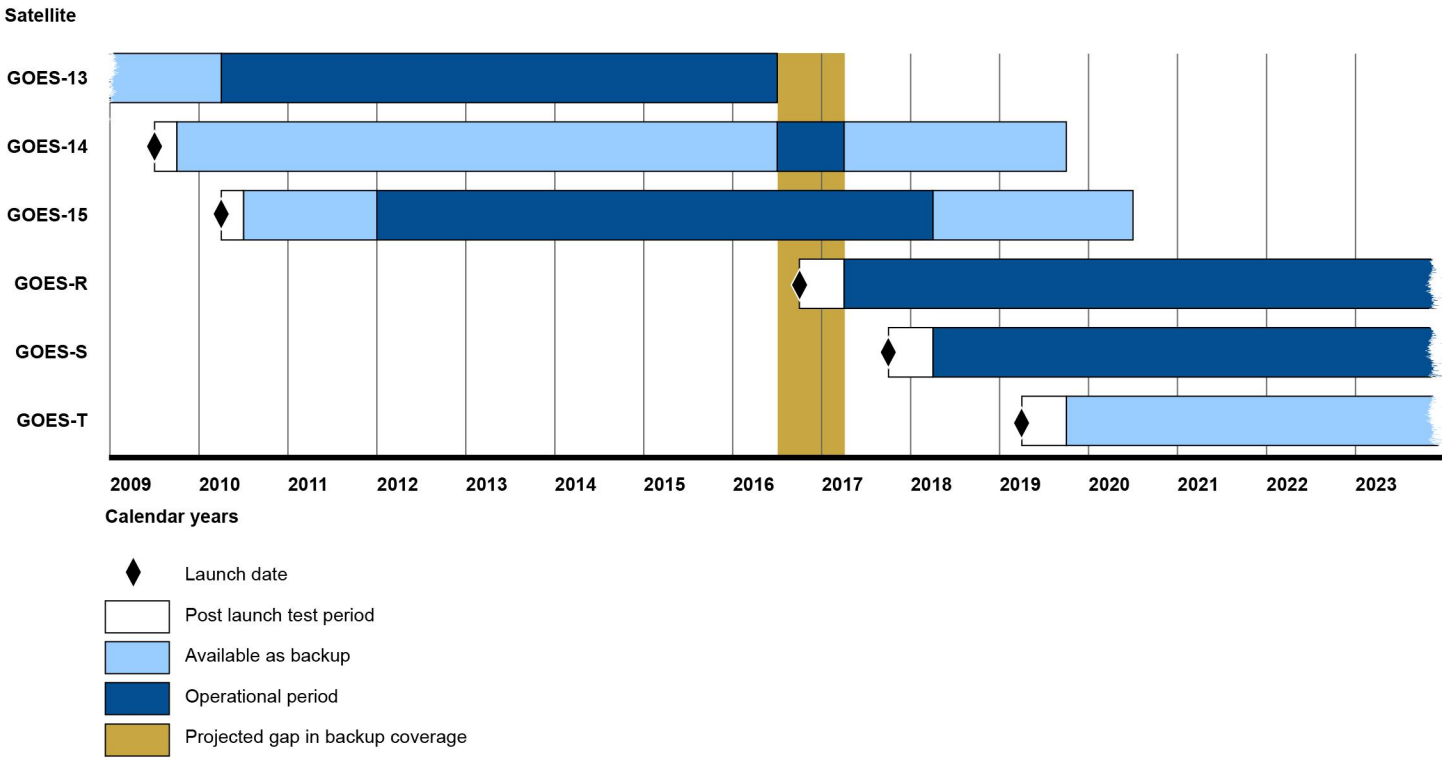
Note: NOAA moved the estimated useful life for the GOES-14 satellite from early 2020 to mid-2019 in the most current estimate.

However, the risk of a gap in backup satellite coverage remains. In December 2014, we reported that the geostationary satellite constellation was at risk of a gap in backup coverage, based on the GOES-R launch date of March 2016.[16] This risk is increased by moving the launch date to October 2016 or later. The GOES-13 satellite, which has experienced issues with 4 of 11 subsystems and had previously been taken offline twice, is still expected to reach the end of its useful life in mid-2016. If

[16]GAO-15-60.

GOES-R were to launch in October 2016, and then undergo a 6-month on-orbit checkout period, it would begin operations in April 2017, close to a year after the expected end of GOES-13's useful life. Figure 4 shows the backup gap based on current assumptions of satellite life. Any further delays in the GOES-R launch date would increase this gap in backup coverage, which could mean a gap in coverage if one of the primary operational satellites were to fail.

Figure 4: Potential Gap in Geostationary Operational Environmental Satellite Backup Coverage, as of October 2015



Source: GAO analysis of NOAA data. | GAO-16-143T

Note: NOAA has a policy requiring two operational and one backup satellite in orbit. This chart shows a potential gap in backup satellite coverage for the period leading up to when GOES-R is operational. This chart also makes the assumption that GOES-S will begin operation immediately at the end of its post-launch test period. However, NOAA has not yet decided when it will put GOES-S into operation.

NOAA Faces Significant Decisions on Building, Storing, and Launching Future Geostationary Satellites

NOAA now faces a series of significant decisions on the development, launch, and maintenance of its GOES-R series satellites. Based on our ongoing work, these decisions include the following:

- **Determine how to manage schedule risks to ensure GOES-R launches on schedule.**

  NOAA and the GOES program continue to experience issues in completing integration and testing of the GOES-R satellite. NOAA officials have stated that the program was still losing about 10 reserve days per month through August 2015. As of September 2015, the program had 113 days of schedule reserve, which is 43 days more than suggested by NASA's guidelines. Program officials expect the monthly loss of schedule reserve to decrease because they are using more realistic estimates of how long tasks will take based on past performance. However, given the potential for a gap in backup coverage leading up to the time that GOES-R is in orbit and operational, NOAA continues to look for ways to minimize remaining schedule risks on the GOES-R satellite. As previously noted, we made recommendations to NOAA in 2012 and 2013 to improve schedule management practices; these recommendations remain open today.[17] Timely implementation of our recommendations could help to mitigate program risks.

- **Determine when GOES-S should be launched.**

  NOAA's current plans to launch GOES-R in October 2016 and to launch GOES-S in May 2017 would allow 7 months between launch dates. However, NOAA officials would prefer to maintain a 14-month interval between the launch dates of these two satellites. Officials have stated that this interval is necessary due to the limited number of qualified personnel that work to develop both satellites, the need to rebuild the hardware planned for GOES-S that will now be used on GOES-R, and to allow adequate time for test and checkout of the GOES-R satellite before launching GOES-S. In late 2015 or early 2016, NOAA plans to conduct a detailed schedule analysis on GOES-S development. From this analysis, NOAA plans to decide whether to move the GOES-S planned May 2017 launch date to a later time.

[17]See GAO-12-576 and GAO-13-597.

- **Decide the appropriate spacing of the GOES-T and GOES-U satellite launches to ensure satellite coverage and minimize costs.**

  In addition to GOES-R and GOES-S, NOAA has established planned launch dates for the final two satellites in the GOES-R series. GOES-T is planned for launch in April of 2019, and GOES-U is planned for launch in October 2024. Key questions exist about the optimal timing for these later satellites.

  Program officials believe that it would be best to develop and launch the GOES-T satellite as soon as possible to sustain NOAA's policy of having two operational satellites and one spare satellite on-orbit and to obtain the enhanced functionality these satellites offer. NOAA officials are considering options related to delaying the development of the GOES-U satellite or developing it and putting it into storage.

  Alternatively, delaying the development of GOES-T and GOES-U could result in cost efficiencies. For example, if the GOES-R and S satellites last for a minimum of 10 years, NOAA could be in the position of storing GOES-U on the ground for an extended time. NOAA officials stated that they would consider a later launch date for GOES-U depending on the health of the satellite system when it is due to launch. Storing satellites on the ground is costly and requires maintenance to ensure the satellites function once finally launched. Delaying the development of GOES-U would both reduce storage costs and delay annual costs associated with these satellites' development. Moving forward, thoroughly assessing the relative costs and benefits of various launch scenarios will be important.

The JPSS Program Is Making Progress; Key Risks Remain in Meeting the March 2017 Launch Date

In December 2014, we reported that the JPSS program had completed significant development work on the JPSS-1 satellite and had remained within its cost and schedule baselines.[18] However, we noted that the program had encountered technical issues on a key component that led to cost growth and a very tight schedule. We also noted that while the program reduced its estimate of a near-term gap in satellite data, this gap assessment was based on incomplete data. We recommended that

[18]GAO-15-47.

NOAA update its assessment of potential polar satellite data gaps to include more accurate assumptions about launch dates.

We also assessed NOAA's efforts to improve its satellite contingency plan and to implement mitigation activities. Specifically, we reported that while NOAA improved its polar satellite contingency plan by identifying mitigation strategies and actions, the contingency plan had shortfalls when compared to best practices. For example, the plan did not include an assessment of available mitigation alternatives based on their cost and impact. Moreover, NOAA was not providing consistent or comprehensive reporting of its progress on all mitigation projects. As a result, NOAA had less assurance that it was adequately prepared to deal with a gap in polar satellite coverage. We recommended that NOAA revise the polar satellite contingency plan to, among other things, include an assessment of available alternatives based on their costs and potential impacts, and ensure that the relevant entities provide monthly and quarterly updates on the progress on all mitigation projects and activities. We currently have ongoing work for your Committee assessing NOAA's efforts to address each of these recommendations, and we plan to report our results by spring 2016.

NOAA Is Planning to Launch the JPSS-1 Satellite in 2017, but Continues to Face Schedule and other Risks

Based on our ongoing work, NOAA and the JPSS program continue to make progress towards the launch of the JPSS-1 satellite as a replacement for the currently on-orbit S-NPP satellite. Since 2013, the program's life cycle cost baseline through 2025 has remained stable at $11.3 billion, and the launch date has remained set for March 2017.

While the launch date has not changed, the JPSS program has experienced technical issues that have affected internal schedule deadlines. For example, the expected completion date of the Advanced Technology Microwave Sounder instrument was recently delayed from March 2015 to November 2015, due to foreign object debris in a key subsystem. NOAA has also experienced delays in completing a needed upgrade that will allow the JPSS ground system to provide command, telemetry, and data processing for more than one JPSS-class satellite, a capability that will become necessary when both S-NPP and JPSS-1 are in orbit.

In addition to these ongoing technical issues, there is the possibility of conflicts with the GOES-R program for both resources and facilities as both programs complete testing at the NOAA Satellite Operations Facility.

NOAA officials stated that they are aware of this issue and are taking steps to mitigate needs for common resources.

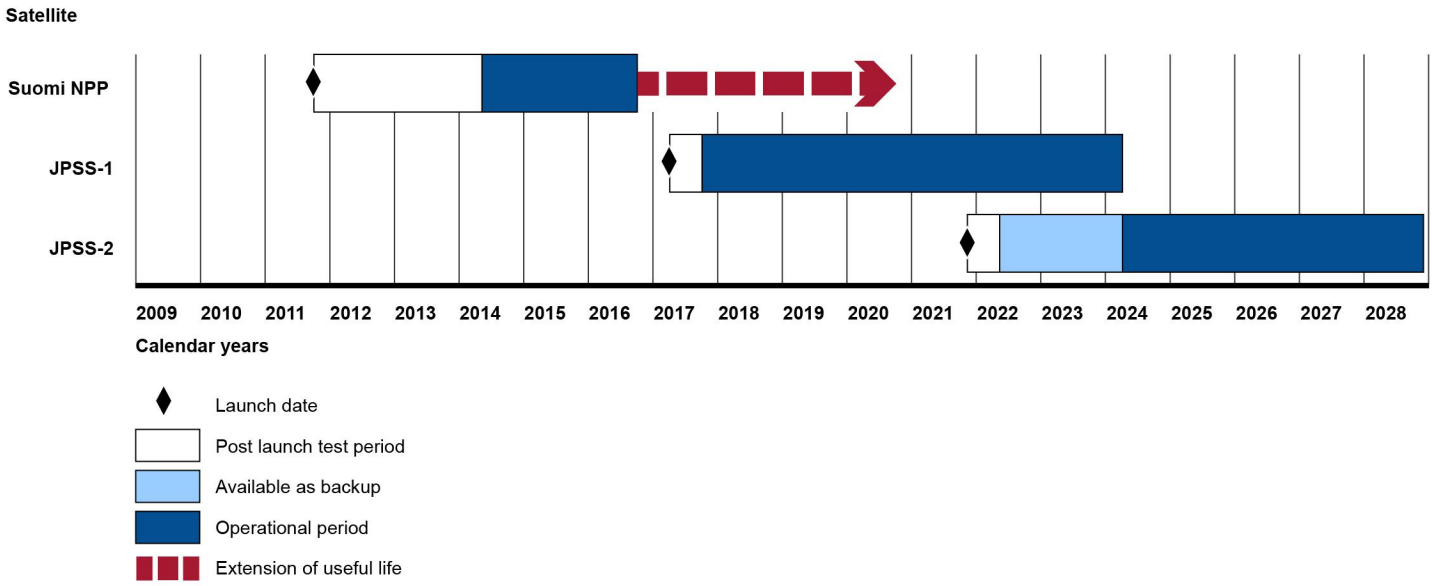
The Possibility of a Gap in Polar Satellite Data Remains; JPSS Program Faces Key Risks, and Decisions Are Needed on Developing and Timing Future Satellites

We previously reported that NOAA is facing a potential near-term gap in polar data between the expected end of useful life of the S-NPP satellite and the launch of the JPSS-1 satellite. As of December 2014, NOAA officials stated that a 3-month gap was likely based on an analysis of the availability and robustness of the polar constellation. However, we reported that several factors could cause a gap to occur sooner and last longer—potentially up to several years.[19] For example, if S-NPP were to fail today—exactly 4 years after its launch—the agency would face a gap of about 23 months before the JPSS-1 satellite could be launched and put into operation. Concerns about a near-term gap will remain until the JPSS-1 satellite is launched and operational. Further, if JPSS-1 fails on launch, there could be a gap until JPSS-2 is launched and operational in mid-2022.

In April 2015, based on an updated analysis of its performance over time, NOAA decided to extend the expected life of the S-NPP satellite. Specifically, NOAA officials estimated that S-NPP would last as long as 9 years, up from its initial estimate of 5 years. Should S-NPP last for 9 years, it could alleviate a potential near-term gap. NOAA provided us with an assessment of the S-NPP satellite's availability over time, and we have ongoing work analyzing the assessment. Figure 5 shows the original and extended estimates of the useful lives of the S-NPP and first two JPSS satellites.

[19] GAO-15-47.

Figure 5: NOAA's Expected Life Span of Current Satellites in Joint Polar Satellite Program



Source: GAO analysis of NOAA data. | GAO-16-143T

While NOAA's changes in assumptions on how long S-NPP will last may lessen the likelihood of a near-term data gap, our ongoing work shows that the JPSS program continues to face key risks which could increase the possibility of a gap.

- **Risks to the currently on-orbit satellite:** The S-NPP satellite continues to experience isolated performance issues. For example, a mechanical component that facilitates the collection of sounding data on the S-NPP Advanced Technology Microwave Sounder instrument experienced electrical currents that were higher than expected in early 2015. While program officials believe that the issue has been addressed, the JPSS program is carrying it as a risk because it could affect the satellite's useful life. There is also a risk that space debris could collide with S-NPP,[20] which will not factor into NOAA availability calculations until its 2015 analysis is complete.

[20]NOAA officials noted that while a collision with space debris is possible, they have not observed any debris impacts. They have, however, maneuvered the satellite to avoid debris.

- **Risks to satellites in development:** As discussed above, the JPSS program is currently dealing with technical issues on both the flight and ground components of the JPSS-1 satellite which have caused schedule delays and decreased the remaining margin to launch. In addition, NOAA switched to a new spacecraft contractor beginning with the JPSS-2 satellite. With a new contractor, it may be more difficult to apply lessons learned from issues in JPSS-1 development if similar issues arise on JPSS-2.

Moving forward, NOAA also faces decisions on timing the development and launch of the remaining satellites in the JPSS program. The design life of the JPSS satellites is 7 years and NOAA plans, beginning with JPSS-2, to launch a new satellite every 5 years in order to achieve a robust constellation of satellites. However, NOAA officials stated that they expect the satellites to last 10 years or more. If the satellites last that long, then there could be unnecessary redundancy. If they do not, then there is an increased potential for future gaps in polar satellite coverage, as there will be several periods in which only one satellite is on orbit. Similar to its geostationary program, evaluating the costs and benefits of different launch scenarios to ensure robust coverage while decreasing unnecessary costs will be important.

In summary, we have made multiple recommendations to NOAA to improve management of the GOES-R and JPSS satellite programs and to address weaknesses in contingency plans in case of a gap in satellite coverage. NOAA has addressed about a quarter of our recommendations to date; it is important that the agency expedite its efforts to address the remaining ones in order to reduce existing risks and strengthen its programs.

NOAA recently decided to delay the GOES-R satellite launch until October 2016 and to change its assumption for how long the currently operational satellites will last. Even with the new assumption that existing satellites will last longer, the risk remains that there will be a gap in backup satellite coverage that lasts for almost a year. The agency is now facing important decisions on how to achieve the new launch schedule and how to space out future satellites to ensure satellite coverage while minimizing costs.

Regarding the JPSS program, NOAA continues to make progress developing and testing the JPSS-1 satellite as it moves toward a March 2017 launch date. Moreover, NOAA decided to extend its expectation for how long the current satellite will last. However, there is the potential for a

coverage gap should the currently on-orbit satellite not last until the launch and calibration of the JPSS-1 satellite is completed. According to NOAA officials, it is also possible that JPSS-1 and -2 will last longer than anticipated. Moving forward, reconsidering development and launch calendars to ensure robust satellite coverage while decreasing unnecessary costs will be important.

Chairmen Bridenstine and Loudermilk, Ranking Members Bonamici and Beyer, 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 Contacts and Staff Acknowledgments

GAO Contacts

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