Testimony of

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Subcommittee on Space and Aeronautics and Subcommittee on Environment
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Looking Back to Predict the Future: The Next Generation of Weather Satellites

September 21, 2022

Chairwoman Sherrill, Chairman Beyer, Ranking Members Bice and Babin, and Members of the Subcommittees:

I appreciate the opportunity to testify today about results from our oversight of National Oceanic and Atmospheric Administration (NOAA) satellite programs. I would also like to convey Inspector General Peg Gustafson's gratitude for your continued interest in our work. Our mission is to improve the Department's programs and operations through independent and objective oversight.

Today I will summarize two challenges to NOAA's satellite programs described in our Top Management and Performance Challenges (TMC) report, which we prepare annually as required by the Reports Consolidation Act of 2000.[1] I will also provide highlights of two recent audits that illustrate these challenges and provide recommendations to address them.

Our TMC report identifies what we consider, from an independent perspective and based on our oversight, the Department's most significant management and performance challenges. Given the scale and importance of NOAA's satellite enterprise, we have identified satellite program-related challenges in TMC reports for many years. In our FY 2022 report, we published this challenge as *Challenge 2: Maintaining Continuity, Managing Risks, and Leveraging Investments to Improve Satellite Data, Products, and Services*.[2] Today, I will focus on two areas of that challenge:

- Managing technical challenges with polar and geostationary satellites
- Planning and implementing next-generation satellite systems to continue observations and meet future needs

In the first area, NOAA satellite programs face inherent technical challenges given the complexity of the systems and their need to be highly reliable. Addressing these challenges requires disciplined systems engineering and mission assurance processes to identify and manage risks. We noted that the Joint Polar Satellite System (JPSS)-2 satellite would undergo environmental testing in FY 2022. This testing can reveal build and workmanship deficiencies that require corrections, potentially further delaying the schedule. JPSS-2's launch was planned for September 2022 but later slipped to November 2022 as the program resolved testing issues. We also viewed the on-orbit testing of NOAA's Geostationary Operational Environmental Satellite (GOES)-T satellite as a challenge to prove the effectiveness of design changes driven by performance problems observed on its two predecessor missions, GOES-R and particularly, GOES-S (now GOES-16 and -17, respectively). Performance problems on orbit put at risk NOAA's ability to provide critical environmental observations for monitoring severe storms, weather and climate forecasts, and other uses.

The second challenge area I want to summarize relates to NOAA's efforts to plan and build its next generation of satellites. These systems will continue key observations and potentially provide new observations that are important to NOAA's mission. NOAA is now planning and

[1] 31 U.S.C. § 3516(d).
[2] OIG-22-001, Challenge 2

formulating follow-on programs in geostationary and low-earth orbits (LEOs, including polar), space weather observations, commercial weather data buys, and ground systems. To do this, NOAA must have sound processes in place to identify and manage its observing requirements. These processes must anticipate and ultimately validate NOAA's needs in the 2030s timeframe.

My staff have conducted many performance audits of NOAA satellite programs, and two recent reports further illustrate these challenges and provide recommendations to improve NOAA's programs and operations. The first is:

Redesigned GOES-T is Ready for Launch, but NOAA Should Reassess Its Assumptions for Satellite Launch Planning and Storage (OIG-22-015-A), January 20, 2022

This audit's objective was to assess the GOES-R Program's progress in achieving launch readiness for the GOES-T mission. To satisfy our objective, we examined technical performance challenges and changes to technical, schedule, and cost baselines since GOES-S (GOES-17) launched in March 2018. Our findings of particular relevance to this hearing were:

The Program Works Toward the Earliest Achievable Launch Dates at Potentially Increased Development Risk

The Program's commitment agreement with NOAA requires the Program to work toward the earliest achievable launch dates for its satellite missions. The intent of the agreement is to minimize the risk of a satellite coverage gap. However, aggressive planning dates can also increase pressure on schedules within the Program and potentially cause decisions to be predominantly schedule-driven, which can impact technical or cost performance.

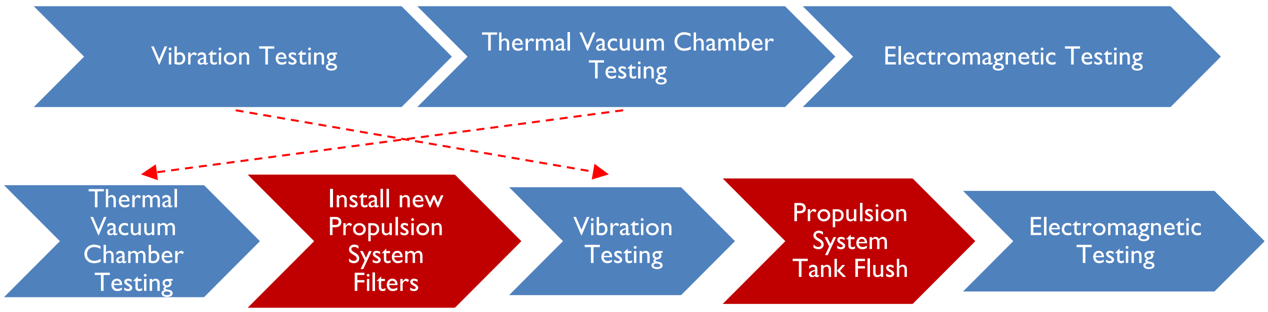
During GOES-T satellite acceptance testing, the Program made changes to the spacecraft propulsion system and test campaign (see figure 1). This means that the GOES-T satellite configuration that entered the test campaign was not the same configuration that will launch and fly on orbit, which is not aligned to the NASA rule to "test as you fly—fly as you test." This rule holds that testing of all critical mission-operation elements (such as the propulsion system) as they will be flown greatly reduces the risk of negative impacts upon mission success, whether from partial or full loss of capability.[3]

Further, the Program deviated from its test campaign that was based on NASA standards. In doing so, the test sequence as executed did not simulate a general mission profile from liftoff to orbit. If defects are not detected at the system level, they may potentially cause hardware anomalies that—in extreme cases—could cause an operational failure.

[3] National Aeronautics and Space Administration Goddard Space Flight Center, June 30, 2016. Rules for the Design, Development, Verification, and Operation of Flight Systems, GSFC-STD-1000G. Greenbelt, MD: NASA, Rule 1.09.

Figure 1. GOES-T Test Sequence as Planned and Executed

Test Sequence as Planned Based on NASA Standards



Test Sequence as Executed

Source: OIG analysis of Program test information

Our review found that changes to the planned testing campaign were predominantly a schedule-driven decision, which we attributed to the National Environmental Satellite, Data, and Information Services' (NESDIS') and the Program's stated approach of aggressively managing schedules toward the earliest possible launch dates to mitigate the risk of potential data gaps. If the Program does not assess the effectiveness of aggressive schedule management, it may make schedule-driven decisions without a full accounting of risks and tradeoffs. Overall, a schedule-driven approach focused on an earliest achievable launch date has been a contributing factor toward negative effects on the GOES-R series and could affect future programs if continued.

We also discussed the negative effects of schedule-driven approaches in prior reports. In 2017, we discussed a more than $1 million test mishap that could have catastrophically impacted the GOES-16 satellite, partially due to inadequate task planning and an aggressive, compressed schedule.[4] In 2019, we reported on Advanced Baseline Imager (ABI) integration and test anomalies, which occurred after the Program chose not to adhere to the "test as you fly—fly as you test" rule.[5] These anomalies preceded the launch of GOES-17, which has had ABI performance problems and is unable to fully meet its requirements. Since that report, the Program shared lessons learned that stated launching the GOES-17 ABI before understanding the root cause of unstable test performance at the time was a regrettable choice.

[4] OIG-17-013-A, finding I.

[5] ABI is the primary instrument on GOES-R Series satellites, generating imagery of the Western Hemisphere not duplicated by any other U.S. satellite platform. It provides forecasters with high-resolution images to track storms and offers a wide range of applications related to weather, oceans, land, climate, and hazards such as fires, volcanoes, hurricanes, and tornadoes. See OIG-19-022-A, finding I.

Recommendation

To address this finding, we recommended that the NOAA Deputy Under Secretary for Operations ensure that the Assistant Administrator for Satellite and Information Services does the following:

1. Conduct an analysis of alternatives or similar assessment to determine whether to continue the Program's approach of managing schedules toward the earliest possible launch dates.

NESDIS Is Planning GOES Launches Sooner Than Its Policy Requires Without Analyzing the Costs

In 2011, NESDIS issued its geostationary satellite launch and spare call-up policy, which established objective criteria for determining contingency launch dates and on-orbit spare activation for the GOES system. It set an 80 percent probability of maintaining mission availability[6] for a two-operational-satellite system—i.e., two-imager coverage by GOES-East and GOES-West satellites. The policy requires a GOES system composed of two operational satellites and one on-orbit spare.

<u>NESDIS plans for higher launch frequency than its policy requires</u>

Since 2018, NESDIS has been using a 93 percent threshold of two-imager coverage in its constellation availability planning scenarios and preliminary launch date considerations for GOES-R series and its follow-on system, GeoXO.[7] Although the 80 percent policy and GOES-R series requirement remain officially unchanged, the Program told us 93 percent has become NOAA's expectation. However, NESDIS and the Program were unable to provide any documented analyses as the basis of this determination, including any analyses of differential value between older GOES-N series and newer GOES-R series satellite imagers.

NESDIS planners stated that targeting a higher availability threshold (or probability) results in a higher launch frequency and therefore higher costs. In figure 2, the notional relationship of a higher availability threshold to an accelerated launch schedule is shown.

For this example, targeting a 93 percent minimum probability value instead of an 80 percent value to determine when to launch a satellite would result in needing a launch in year 9 instead of nearly year 13.

NESDIS planners explained that they based the justification for using the 93 percent value on NOAA Satellite Observing System Architecture analyses during the 2014–18 timeframe by balancing cost with historical observational performance. However, NOAA could not provide detailed analysis of this cost relationship.

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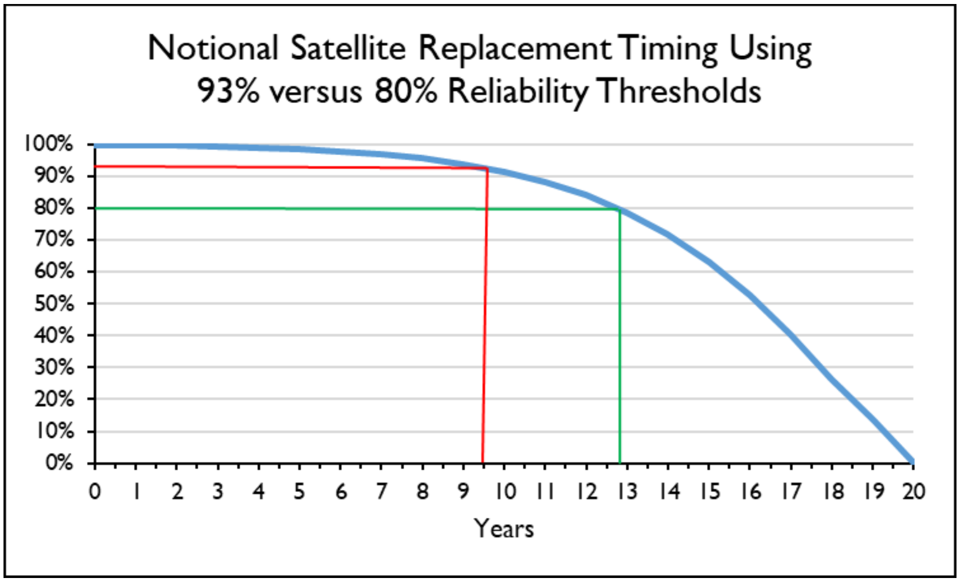
[6] For Key Performance Parameter cloud and moisture imagery.

[7] Geostationary Extended Observations.

Figure 2. The Effect of a Higher Coverage Threshold on Launch Timing



Source: OIG analysis of NOAA and Program data
Note: Although only a notional representation, the curve is similar to an actual GOES reliability curve and illustrates the reason that launch cadence may be higher for a higher coverage threshold.

NESDIS and the Program offered another explanation for the desire to exceed the policy threshold, which is that NOAA seeks to launch the newest technology as soon as ready and able. Since both the older GOES-N series and newer GOES-R series satellites have been fulfilling the geostationary policy requirements,[8] we asked NESDIS if it could show the level of data exploitation or the impact and value to its customers' mission performance by using the newest technology versus the older. NESDIS did not have that type of data, but it and the Program told us the user community prefers the newest imager data, such as that from the ABI on the GOES-R series.

NESDIS acknowledged targeting a higher coverage probability in its planning and the higher costs associated with more frequent launches. However, the 93 percent value is not consistent with standing geostationary policy and Program requirements, which target 80 percent availability. Further, NESDIS has not formally documented its deviation from the policy or quantified the costs, performance benefits, and exploitation of GOES-R series data over GOES-N series data.

<u>NESDIS has not accounted for the potential value of unused spares</u>

In addition to satellite development and launch costs, the higher launch frequency may also lead to other costs associated with having more satellites on orbit than required. With the launch of GOES-T, there are now five GOES on orbit—two more than NESDIS policy requires—that are

[8] For instance, GOES-15 has been filling in the gaps created by degraded GOES-17 ABI performance.

capable of meeting critical cloud and moisture data requirements.[9] We found that NESDIS has not accounted for the potential value of unused satellite capability that can result from overlapping individual satellite lifetimes due to launching multiple on-orbit spares.[10]

NESDIS may be able to improve the affordability of its geostationary constellation by more carefully accounting for the value of its operating satellites and reducing the amount of satellites stored on orbit. Efficient exploitation of satellite life can help foster less aggressive development schedules and mitigate increased development risk.

Recommendations

To address these findings, we recommended that the NOAA Deputy Under Secretary for Operations ensure that the Assistant Administrator for Satellite and Information Services does the following:

2. Conduct a cost-benefit analysis of selected geostationary coverage availability thresholds and update its geostationary launch policy as appropriate.

3. Determine the cost of operating spare satellites on orbit versus alternative options, including consideration of constellation longevity and satellite development risks, to help inform optimal acquisition and launch strategies.

The second report I would like to discuss is:

The Success of NOAA's Next-Generation Satellite System Architecture Depends on Sound Requirements Management Practices (OIG-22-022-A), June 8, 2022

NOAA's major environmental satellite systems—i.e., GOES-R Series, JPSS, Deep Space Climate Observatory (DSCOVR), and Space Weather Follow On-Lagrange 1 (SWFO-L1)—are expected to provide observations for earth and space weather into the late 2020s or the early 2030s.

NOAA has been planning and taking initial steps to build its next-generation satellite systems to ensure continuity of operations and enhance environmental data. The success of NOAA's next-generation satellite systems relies on a solid foundation of requirements, which form the basis for architecture, design, integration, and verification. Requirements management is important to ensure alignment between user needs and the delivered systems' capabilities.

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[9] GOES-14, GOES-15, GOES-16, GOES-17, GOES-T (-18). This does not include the potential capability of GOES-13, which NOAA transferred to the DOD in 2019.

[10] See a depiction of the notional value of spare satellites in orbit in OIG-22-015-A, appendix C.

This audit's objective was to assess NOAA's progress planning and implementing its next-generation satellite system architecture. Our primary finding was that NOAA requirements management practices need improvement. Notably,

NOAA's process for validating requirements is not adequate for next-generation satellite programs' needs

NOAA's policy defines user observation requirements as documented and validated user needs. The policy states that these requirements are captured independently from observing technologies (e.g., instruments on satellite systems).[11] Validation is an important step in systems engineering to ensure that defined requirements will meet actual user needs.

However, NOAA's formal process for validating user observation requirements is inadequate for new or updated observation requirements assigned to next-generation programs, given those programs' timeframes and the length of time NOAA takes to validate user observation requirements. We found that 76 percent of NOAA's user observation requirements have not been updated in more than 5 years, and 18 percent of requirements have not been updated in more than 10 years.[12]

As a result, satellite programs are forced to define or update their own requirements through user engagement and value assessments and make decisions based on these unvalidated requirements. If the NOAA process to validate those requirements subsequently results in changes to the programs' already established requirements, it could force programs to modify contracts and prolong schedules. It may also be too late in acquisition life cycles to change program requirements, resulting in delivered capabilities that do not fully satisfy user needs.

Recommendation

To address these findings, we recommended that the NOAA Deputy Under Secretary for Operations do the following:

1. Update policies and procedures to ensure user observation requirements are validated in advance of next-generation satellite system acquisitions.

NESDIS programs are developing satellites with more stringent requirement thresholds than those defined in the NOAA dataset

A system engineering best practice is to ensure a requirement can be traced to its higher-level source requirement. Requirements generally have two types of values: threshold (a minimum specification to achieve) and objective (a desired specification to achieve). The constraints of

[11] DOC NOAA, October 15, 2016. Policy on NOAA Observing Systems Portfolio Management, NAO 212-16. Silver Spring, MD: NOAA, 4. Available online at https://www.noaa.gov/sites/default/files/legacy/document/2020/Jun/NAO_212-16_UNSEC_Signed.pdf (accessed February 22, 2022).
[12] See OIG-22-022-A, appendix C.

each lower-level requirement threshold should not exceed the constraints of the higher-level requirement's threshold. Otherwise, more stringent lower-level requirements can lead programs to deliver systems that are more expensive and complex than originally intended. More stringent requirements can, however, be specified as objective values to establish goals for programs' improved performance, if resources are available. Maintaining a distinction between threshold and objective values creates *trade-space* that allows programs alternatives to address cost, schedule, or performance uncertainties.

We identified a significant number of legacy satellite program requirement thresholds that are more stringent than their corresponding user observation requirement thresholds in the validated NOAA dataset. Twenty-five percent of GOES-R requirement thresholds and 33 percent of JPSS requirement thresholds are more stringent than their corresponding user observation requirement thresholds. NOAA officials explained that the satellite programs' stricter thresholds stemmed from a desire to procure what was believed to be technologically achievable to improve performance.

Given that many next-generation system requirements derive from legacy systems' capabilities, it is likely that this condition—until it is addressed—will extend to next-generation satellite system requirement thresholds. However, if thresholds for next-generation system requirements exceed NOAA user observation needs, next-generation programs would limit their trade-space and potentially incur higher costs and prolonged schedules in the pursuit of such thresholds.

Additionally, GOES-R and GeoXO requirements documents lack objective values for their requirements in all but one instance.[13] While threshold values are critical for system success, defining objective values identifies trade-space that allows a program to better allocate its resources. NOAA's internal guidance indicates that trade-space analysis is particularly pertinent in times of significant budget constraints and shortfalls and allows for informed choices that provide the best overall value.

Recommendations

To address this finding, we recommended that the NOAA Deputy Under Secretary for Operations do the following:

2. Ensure that next-generation satellite programs do not define more stringent requirement thresholds than corresponding thresholds in the NOAA dataset.

3. Ensure that next-generation satellite programs include requirement objective values that are different from thresholds.

[13] We found that JPSS requirements are defined with both threshold and objective values.

NOAA does not sufficiently distinguish user observation requirement priorities

While it may not be feasible to implement all requirements within programmatic constraints, requirements prioritization ensures that implementation efforts focus on the most critical requirements first. Well-defined requirement priorities can assist NOAA in determining trade-space between implementation efforts.

Satellite system acquisition and development programs need clear priorities for performance trades. Satellite programs are often tasked with fulfilling multiple priority-1 (mission-critical) user observation requirements. Since NOAA does not further distinguish among these mission-critical requirements, satellite programs can be challenged to determine which ones should receive precedence within their trade-space.

With multiple priority-1 requirements assigned to programs, NESDIS tasks working groups to further interpret requirement priorities in support of program formulation efforts. However, these working groups find it difficult to rank the priorities of requirements for a program. For example, members of a requirements working group for the GeoXO program told us that their biggest challenge was competing line office priorities, and the working group did not recommend a set of prioritized requirements for the program.

Recommendation

To address this finding, we recommended that the NOAA Deputy Under Secretary for Operations do the following:

4. Assign responsibility and design a process for determining the relative priority of each NOAA user observation requirement.

NESDIS does not have standard definitions for satellite program requirement priorities

When NOAA user observation requirements are assigned to NESDIS' satellite programs, the programs assign their own priorities to their requirements. We found that satellite programs define their requirement priorities differently than NOAA's user observation requirements and are not consistent between programs. While there is a degree of alignment between the definitions, satellite programs—specifically GOES-R and JPSS—use distinct terminology both from the NOAA dataset and each other.

Requirements should remain consistent as they flow from top-level sources to the programs delivering capabilities to meet them. Absent a NESDIS standard for how satellite programs define requirement priorities, stakeholders are left to interpret inconsistent definitions from a variety of programs and risk misunderstanding the importance and relative contributions of programs' capabilities.

Recommendation

To address this finding, we recommended that the NOAA Deputy Under Secretary for Operations do the following:

5. Ensure that NESDIS standardizes requirement priority definitions for next-generation programs, to include information about the extent to which its programs contribute to meeting NOAA user observation requirements.

As these reports demonstrate, NOAA satellite programs face challenges that must be managed to maintain continuity of their important environmental observations. To better position the next generation of satellite programs for success, NOAA needs to improve its requirements management practices across its mission areas so that satellite programs can efficiently align their delivered systems' capabilities.

Finally, given their importance to the nation and their costs, NOAA satellite programs require independent and objective oversight. My team continues to assess aspects of these programs and has benefited from NOAA's and NASA's cooperation over the years. I look forward to continuing sharing the results of our work with you and your staff.

This concludes my prepared statement, and I will be pleased to respond to any questions.

Frederick J. Meny, Jr.

Frederick J. (Fred) Meny, Jr. became the Assistant Inspector General for Audit and Evaluation of the U.S. Department of Commerce on October 28, 2018. He leads the oversight efforts regarding intellectual property, IT security, cybersecurity, and satellite and weather systems. Mr. Meny has more than 35 years of federal government experience in leading, managing and directing organizations' staff, budgets, and IT resources, as well as major systems acquisition and development programs.

During his 25 years with the OIG, Mr. Meny has led numerous reviews that improved the 2020 and 2010 decennial censuses, department-wide acquisitions and grants, First Responders Network Authority management, USPTO's patents and trademarks, and NOAA's polar and geostationary satellites and weather systems development and operations. His interactions with the executive branch and Congressional leadership on OIG reports have strengthened stakeholder oversight and departmental efforts in meeting its missions, as well as increased OIG resources for audit reviews.

Prior to joining the OIG, Mr. Meny gained more than a decade of hands-on experience in acquiring complex systems as a federal civilian for the U.S. Department of Defense. He successfully managed the acquisition development for thousands of communications security systems for the joint services, as well as unique large-scale computer meteorological and oceanographic systems for the Navy.

Mr. Meny was born and raised in Pittsburgh, Pennsylvania. He received his Bachelor of Science in Electrical Engineering from West Virginia University and has certifications in Program Management from the Defense Systems Management College and The George Washington University.