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Environmental Satellites: NOAA Needs to Ensure Its Timelines Are Accurate, Clear, and Fully Documented

Information Presented to Staff Members of the House Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies

May 31, 2016*

*Slides 26, 32, and 55 of this briefing were amended after the date it was provided to the subcommittee to reflect technical corrections clarifying the role of a NOAA office and the expected availability of a satellite in 2024.

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Introduction

The National Oceanic and Atmospheric Administration (NOAA) manages two weather satellite programs that provide critical environmental data used in weather forecasts and warnings:

- a geostationary environmental satellite program, and
- a polar-orbiting environmental satellite program.

NOAA is acquiring the next generation of geostationary and polar-orbiting satellites to (1) replace aging satellites that are approaching the end of their expected lives, and (2) maintain continuity of critical weather observations.

Introduction

NOAA regularly publishes “flyout charts” for the geostationary and polar-orbiting satellite programs on its website. These charts depict timelines for the launch, on-orbit storage, and operational life of its satellites.

NOAA uses these flyout charts to

- support budget requests, provide status reports, and facilitate appropriations discussions with congressional committees;
- alert satellite data users about when they will need to upgrade their systems to accommodate new satellite technologies; and
- inform the public of plans for maintaining continuity of satellite data.

Objectives

Our objectives were to:

1. Describe NOAA's process for updating, approving, and publishing its satellite flyout charts;
2. Identify changes NOAA has made to its flyout charts in recent years and the justification for those changes; and
3. Assess NOAA's recent efforts to update its flyout charts.

Scope and Methodology

To describe NOAA's process for updating, approving, and publishing its flyout charts

- we reviewed agency policy and procedures;
- we analyzed the documentation associated with recent updates to determine the process that was used to modify the flyout charts and obtain approval; and
- we interviewed program officials.

Scope and Methodology

To identify changes NOAA has made to its charts in recent years, we

- analyzed changes in how individual satellites were depicted among the last four flyout chart updates, which are dated from March 2014 to January 2016;
- reviewed relevant supporting materials documenting reasons for the changes, including information from satellite program offices regarding changes in satellite launch schedules and e-mails among NOAA offices seeking review of the proposed changes to the flyout charts; and
- interviewed program officials.

Scope and Methodology

To assess NOAA's recent efforts to update its charts:

- we compared NOAA's approach to updating its charts to an approach used by the Department of Defense (DOD);
- we compared the flyout charts that were published between March 2014 and January 2016 to relevant supporting information to determine if the charts accurately depicted the information. Specifically,
  - we compared the flyout charts to the relevant program offices' latest schedules for launching new geostationary and polar satellites, and
  - we compared the flyout charts to agency assessments of the health of operational satellites, where applicable.
- in these comparisons, we considered the flyout chart and program data to be inconsistent when they differed by a quarter or more because NOAA officials reported that the flyout charts are intended to be accurate to the nearest quarter and not to the exact month.

Scope and Methodology

To assess NOAA's recent update efforts, cont'd:

- we assessed the way NOAA depicts satellites that are expected to last longer than they were originally designed to last;
- we compared the agency's documentation supporting its recent changes to its own draft policy and general governmental internal controls for supporting documentation; and
- we interviewed agency officials.

Scope and Methodology

We conducted this performance audit from February 2016 to May 2016 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.

Results in Brief

NOAA's process for updating its flyout charts involves obtaining updated information on the health of operational satellites and schedules for new satellites, having relevant individuals and entities review the new charts, and obtaining approval to publish the new chart. This process is partially documented in a draft June 2011 policy.

NOAA has updated its geostationary and polar flyout charts three times since March 2014. Key changes included adding newly planned satellites; removing a satellite that reached the end of its life; and adjusting planned dates for when satellites would launch, begin operations, and reach the end of their lives.

Results in Brief

While NOAA regularly updates its flyout charts and most of the data on specific satellites were aligned with supporting program documents, the agency has not consistently ensured that its charts were supported by stringent analysis, accurate, clearly communicated, and fully documented.

Because of shortfalls in its updating practices and the lack of a complete and finalized policy guiding how its flyout charts are updated, the information that NOAA provides Congress is not as accurate as it needs to be.

To ensure that the information that NOAA uses to facilitate congressional decision making and inform the public is accurate and clearly communicated, we are making recommendations to NOAA to address shortcomings in its policy and practices for updating its geostationary and polar-orbiting satellite timelines.

Results in Brief

We received comments on a draft of our briefing from NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). The agency generally agreed with our recommendations and noted it plans to revise the policy guiding how flyout charts are updated.

Background

NOAA procures, manages, and operates two primary types of weather-observing satellites:

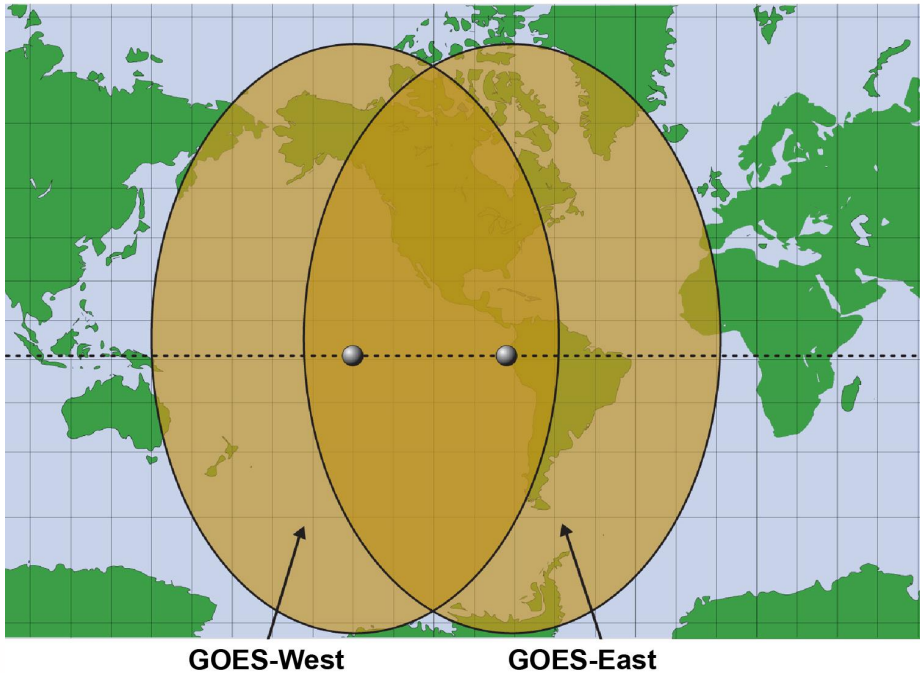
- Geostationary satellites
- Polar-orbiting satellites

These environmental satellites provide critical data used in observing and forecasting weather, and providing watches and warnings of severe weather events.

Background—Geostationary Satellites

NOAA's geostationary satellites maintain a fixed view of the eastern and western United States from a high orbit. The agency currently has two operational geostationary satellites and a backup satellite in orbit.

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

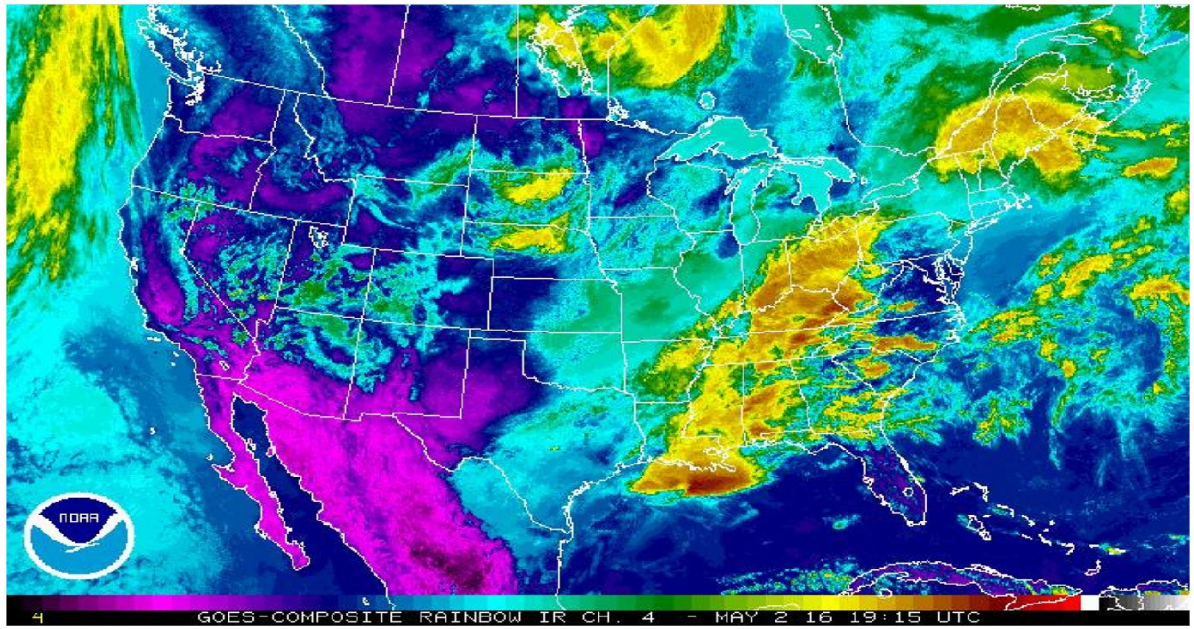


Source: National Oceanic and Atmospheric Administration (data), Mapart (map).

Background—Geostationary Satellites

Geostationary satellites provide data and graphical images to depict current weather conditions and provide short-term warnings, including the path and intensity of hurricanes.

Figure 2: Composite Infrared Image from Geostationary Operational Environmental Satellites



Source: The National Oceanic and Atmospheric Administration.

Background—Geostationary Satellites

NOAA's geostationary satellites are called Geostationary Operational Environmental Satellites (GOES).

- There are currently three GOES satellites in orbit, called GOES-13, 14, and 15. GOES-15 was launched in 2010.
- NOAA is currently procuring the next generation of geostationary satellites, called the GOES-R series, to replace GOES-13, 14, and 15 as they reach the end of their operational lives.
- This new series is planned to contain four satellites (GOES-R, S, T, and U); GOES-R is planned to launch in October 2016.

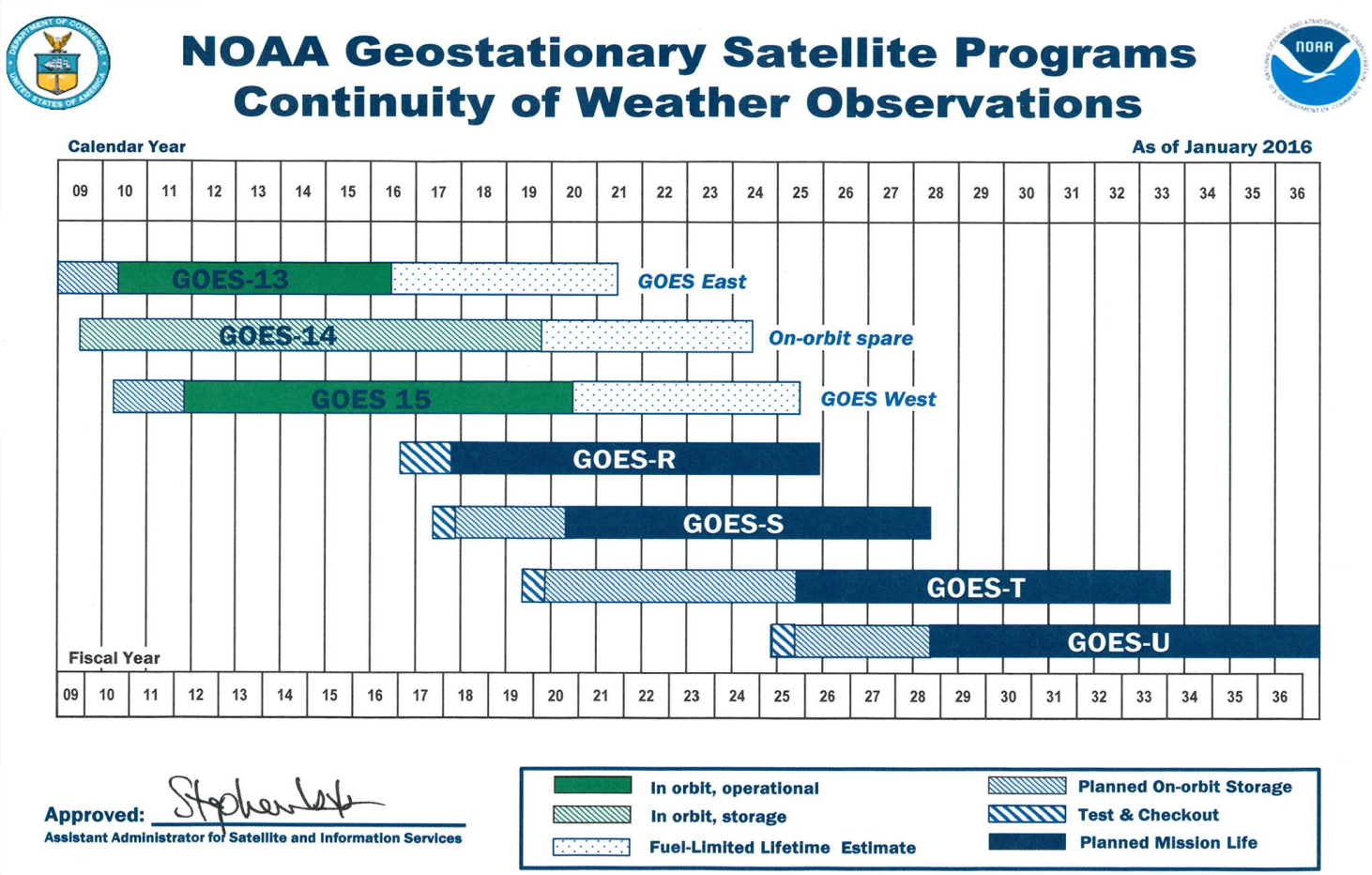
Background—Geostationary Satellites

NOAA has published a series of flyout charts that depict the expected launch dates and end-of-life dates for each of the current and planned GOES satellites.

The most recent flyout chart is provided in figure 3.

Background—Geostationary Satellites

Figure 3: January 2016 Flyout Chart for the Geostationary Operational Environmental Satellite (GOES) Program



Source: National Oceanic and Atmospheric Administration.

Note: NOAA uses the term "fuel limited life" to mean that current projections based on actual fuel usage to date would allow a satellite to last through this period, if the satellite reaches the end of its mission as a result of fuel depletion.

Background—Polar-Orbiting Satellites

Polar-orbiting satellites circle the earth over the north and south poles. As the earth rotates, each polar satellite is able to view the entire earth's surface twice a day.

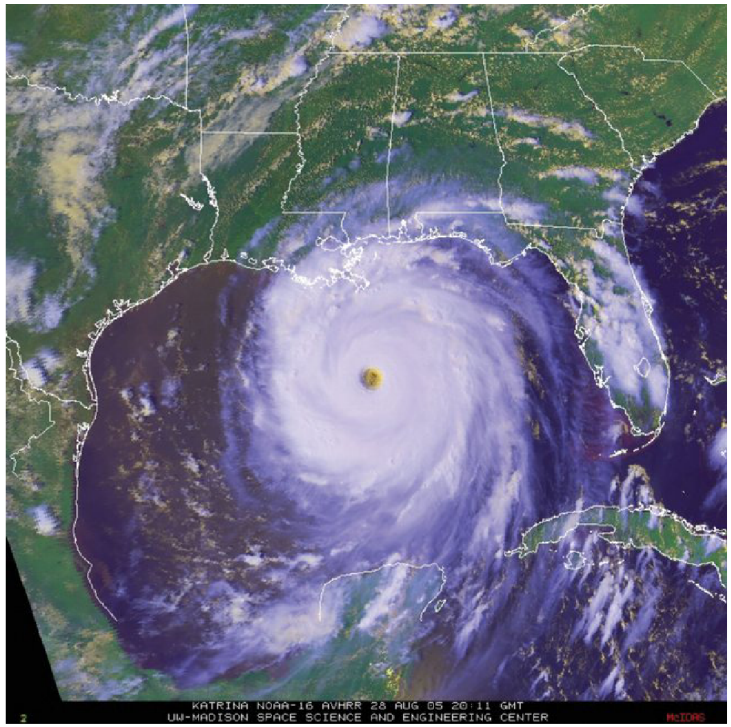
Figure 4: Visualization of Polar-orbiting Satellites

Source: GAO representation of National Oceanic and Atmospheric Administration data; NASA/Goddard Space Flight Center Scientific Visualization Studio (earth).

Background—Polar-Orbiting Satellites

Polar-orbiting satellites provide imagery and data; the data are used in prediction models that provide weather forecasts days in advance.

Figure 5: Polar Satellite Image of Hurricane Katrina, 2005



Source: Courtesy of the University of Wisconsin-Madison Space Science and Engineering Center (as displayed on the National Oceanic and Atmospheric Administration website).

Background—Polar-Orbiting Satellites

NOAA's polar satellites were developed and launched through the Polar-orbiting Operational Environmental Satellite (POES) program; these satellites include NOAA-15, 18 and 19, which are still operational.

In 2010, NOAA formed the Joint Polar Satellite System (JPSS) program to procure and launch the next generation of polar-orbiting weather satellites:

- the first of these is the Suomi-National Polar-orbiting Partnership (S-NPP) satellite, which was launched in October 2011;
- others include JPSS-1, and JPSS-2, which are scheduled for launch in March 2017 and November 2021, respectively; and
- NOAA is planning for two additional satellites, JPSS-3 and JPSS-4, under the Polar Follow-On initiative.

Background—Polar-Orbiting Satellites

In addition to NOAA's polar-orbiting weather satellites, the agency relies on two other polar satellite programs:

- A European satellite program, which manages a series of Meteorological Operational (Metop) satellites
- A DOD satellite program, called the Defense Meteorological Satellite Program (DMSP)

The three organizations position their satellites so that they cross the equator at different times of day.

- DMSP satellites cross the equator in the early and mid-morning,
- Metop satellites cross the equator in the mid-morning, and
- NOAA satellites cross the equator in the early afternoon.

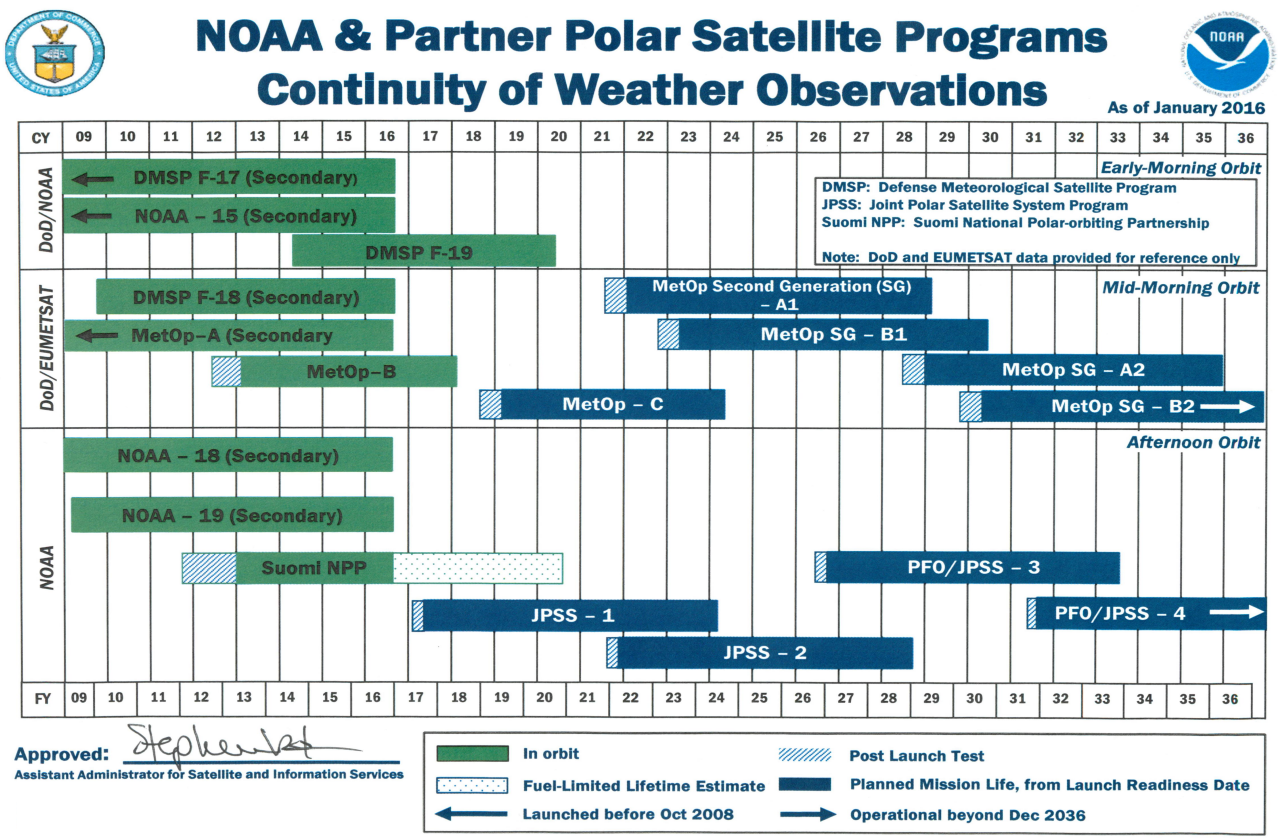
NOAA uses data from the Metop and DMSP satellites in its numerical weather prediction models.

Background—Polar-Orbiting Satellites

NOAA's latest polar flyout chart depicts the expected launch dates and end-of-life dates for each satellite in early morning, mid-morning, and afternoon orbits (see figure 6).

Background—Polar-Orbiting Satellites

Figure 6: January 2016 Flyout Chart for the Polar-orbiting Satellite Programs



Source: The National Oceanic and Atmospheric Administration.

Note: DMSP-19 stopped providing data in February 2016 and the Air Force has ceased efforts to recover the satellite. DMSP-17 is now the primary operational satellite in the early morning orbit.

Background—NOAA's Organization

Within NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), multiple offices have a role in preparing flyout charts:

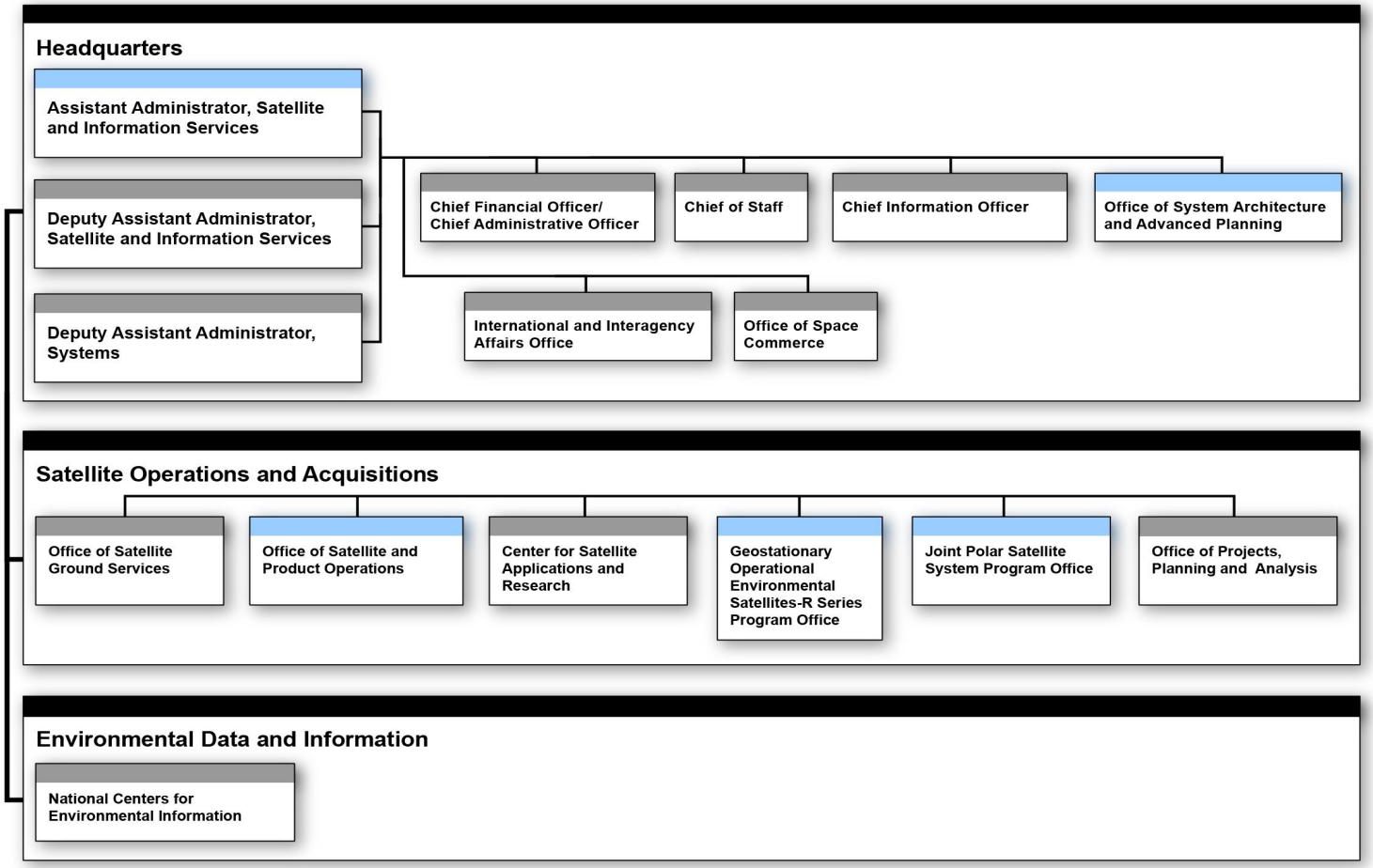
- the Office of Satellite and Product Operations manages operational satellites and monitors their health;
- The JPSS and GOES-R program offices[1] manage new satellite acquisition programs;
- the Office of System Architecture and Advanced Planning (OSAAP) is responsible for preparing the flyout charts; and
- the Assistant Administrator approves the charts.

These offices are depicted on the NESDIS organizational chart in figure 7.

[1] NOAA works with the National Aeronautics and Space Administration on both of these acquisition programs; both agencies are represented in the JPSS and GOES program offices.

Background—NESDIS Organization

Figure 7: Organizational Chart for NOAA's National Environmental Satellite, Data, and Information Service



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: Blue shaded entities are discussed in this briefing.

Background—Prior GAO Satellite Work

We recently reported on NOAA's satellite programs, focusing on program risks and the importance of ensuring the continuity of data:

- Polar Weather Satellites: NOAA is Working to Ensure Continuity but Needs to Quickly Address Information Security Weaknesses and Future Program Uncertainties (GAO-16-359)
- Geostationary Weather Satellites: Launch Date Nears, but Remaining Schedule Risks Need to be Addressed (GAO-15-60)
- Polar Weather Satellites: NOAA Needs To Prepare for Near-term Data Gaps (GAO-15-47)
- Environmental Satellites: Launch Delayed; NOAA Faces Key Decisions on Timing of Future Satellites (GAO-16-143T)

Also, given the criticality of data from these satellites to weather forecasts and the impact such gaps could have on the health and safety of the U.S. population, we added mitigating weather satellite gaps to our High-Risk List in 2013 and it remained on the list in 2015.[2]

[2] GAO, *High-Risk Series: An Update:* GAO-15-290 (Washington, D.C.: Feb. 11, 2015).

Results: NOAA's Process for Updating Flyout Charts

In June 2011, NESDIS drafted a policy for updating its flyout charts.

- While this policy was not finalized and some details have since changed (such as the name of the office responsible for updating the flyout charts), officials stated that it serves as documentation of the agency's process for updating its flyout charts.
- The Assistant Administrator stated that the agency recently appointed a new director with responsibility for updating and finalizing the policy. However, there is not yet a schedule for releasing the updated policy.

Results: NOAA's Process for Updating Flyout Charts

Based on the NESDIS draft policy, interviews with responsible officials, and our review of documentation, NOAA's process for updating its flyout charts involves the following steps:

- The Office of System Architecture and Advanced Planning updates the flyout charts at least once a year in preparation for the budget process.
  - Charts are updated more often when important changes occur, such as the loss of use of a satellite or when a budget decision affects a launch date.
- Our analysis of NOAA documentation shows that, since January 2012, NOAA has updated its charts at least once a year, and often twice a year.

Results: NOAA's Process for Updating Flyout Charts

NOAA's process, cont'd:

- To obtain input for updating the charts, officials reach out to:
  - satellite operations specialists for information on the health of operational satellites and how long the satellites are expected to last, and
  - the GOES-R and JPSS program offices for information on changes to launch schedules.
- To provide input on expected lifespans, satellite operations specialists analyze the current health of operational satellites (which is available online at www.ospo.noaa.gov) as well as the results of any other studies the programs might have conducted, such as polar satellite availability assessments.

Results: NOAA's Process for Updating Flyout Charts

NOAA's process, cont'd:

- OSAAP officials then draft the updated charts and circulate them for review among program officials, operational satellite experts, and senior NOAA and NESDIS management.
- The NESDIS Assistant Administrator signs the new flyout charts.
- OSAAP officials then work with a graphics team to make the chart suitable for publishing on the web, and subsequently publishes the updated charts on its website.
- Officials estimated that it can take several weeks to prepare, review, and obtain consensus to publish the new charts.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

NOAA has adjusted its geostationary and polar flyout charts three times since March 2014 to reflect changes in expected launch dates, anticipated operational life, and end-of life dates.

We analyzed changes between the following months:

Geostationary Satellite Charts	Polar-orbiting Satellite Charts
• March 2014	• March 2014
• June 2014	• August 2014
• April 2015	• April 2015
• January 2016	• January 2016

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Key changes between the March 2014 and June 2014 charts include:

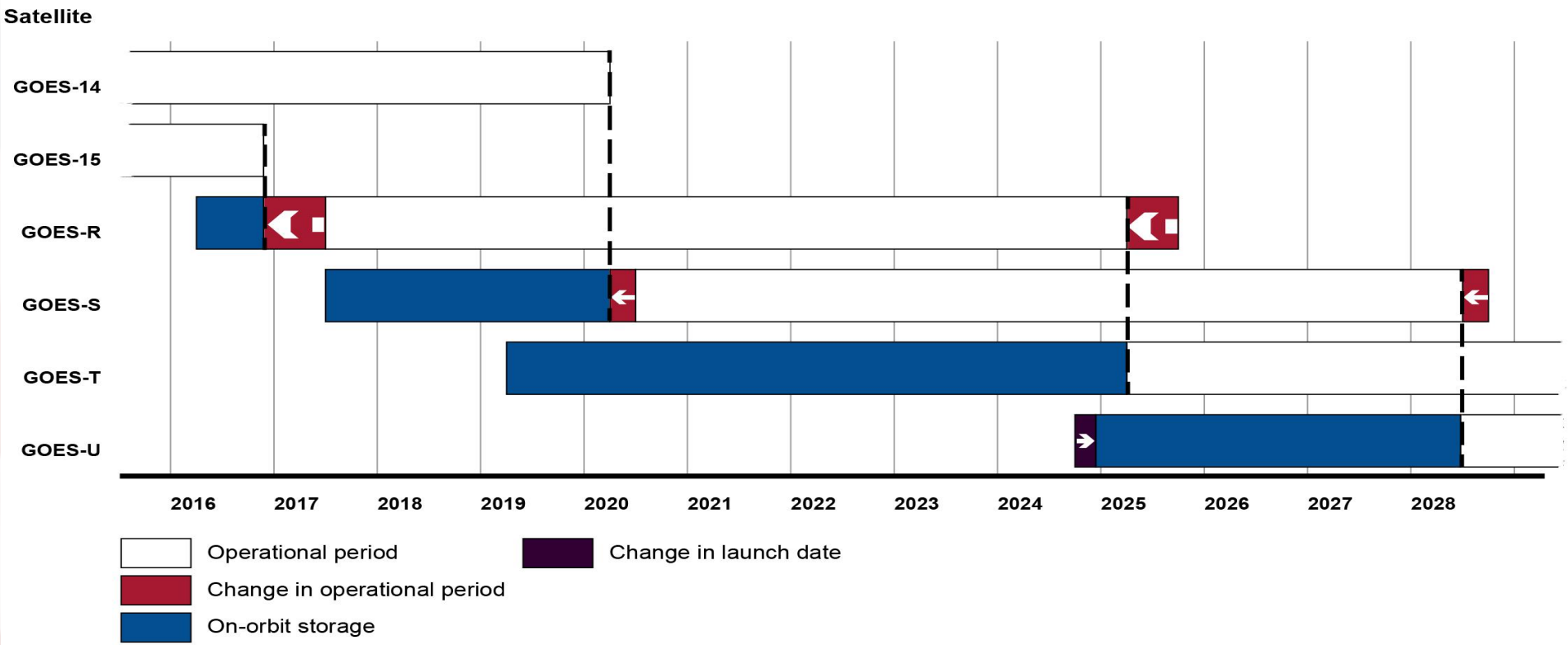
- GOES-R on-orbit storage period reduced from 18 months to 1 year, operations moved 6 months sooner and end-of-life moved 6 months sooner;
- GOES-S dates for beginning operations and end-of-life start 3 months sooner; and
- GOES-U launch moved 3 months later.

See figure 8 for a depiction of these changes.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Figure 8: Key Changes between March 2014 and June 2014



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: GOES=Geostationary Operational Environmental Satellite.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Reasons for the changes between March 2014 and June 2014 include:

- NOAA decided to reduce the time that GOES-R would spend in storage while in orbit to show the satellite beginning operations at the same time that GOES-15 is due to go offline, which in turn affected the end-of-life date.
- Similarly, NOAA made adjustments to better reflect the latest program estimates for the GOES-S and -U satellites.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Key changes between the June 2014 and April 2015 charts include:

- GOES 13-15 on-orbit/operational period adjusted (from 9, 11 and 7 years, respectively) to 10 years from launch for each satellite.
- GOES 13-15 lifespans extended by 5 years, labeled as fuel limited life.[3]
- GOES-R on-orbit storage period relabeled as an on-orbit checkout period.

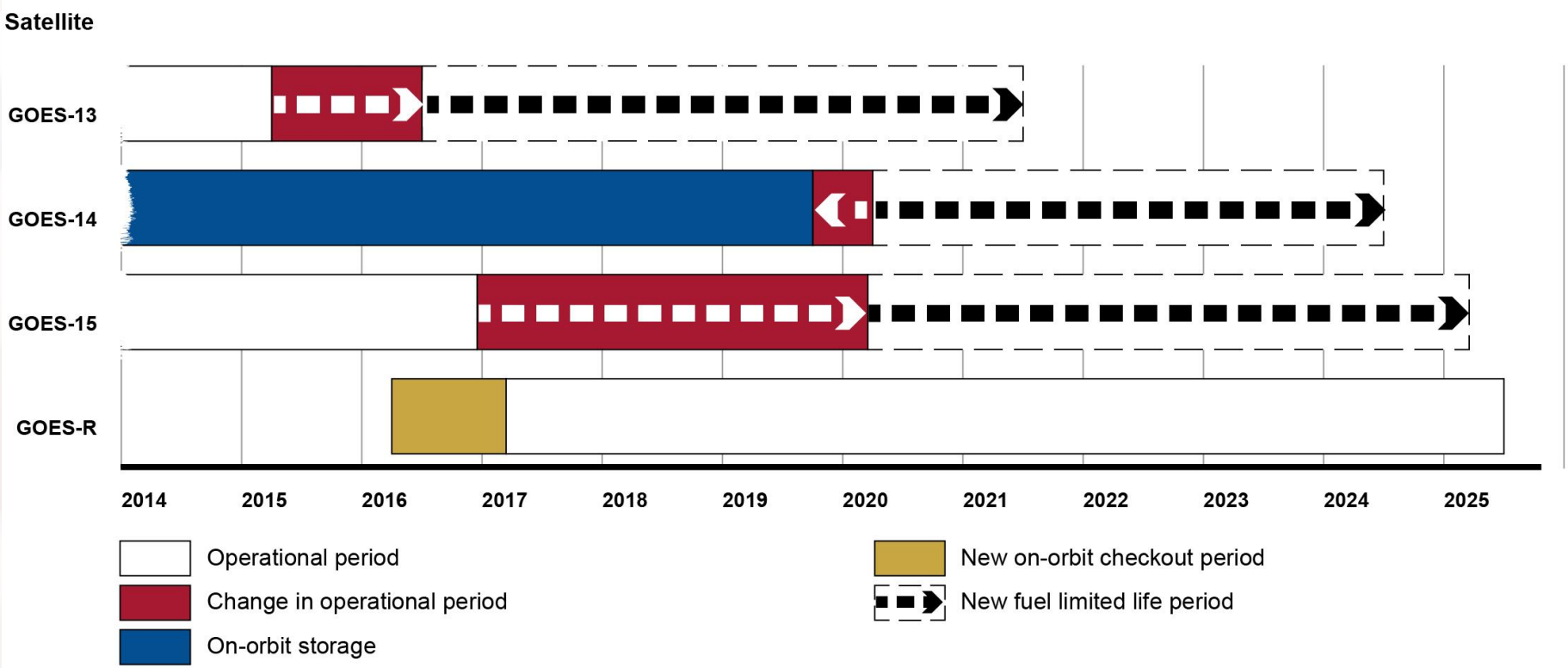
See figure 9 for a depiction of these changes.

[3] NOAA labeled this extension as fuel limited life, meaning that current projections based on actual fuel usage to date would allow a satellite to last through this period, if the satellite reaches the end of its mission as a result of fuel depletion.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Figure 9: Key Changes between June 2014 and April 2015



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: GOES=Geostationary Operational Environmental Satellite.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

According to NOAA documentation, the reasons for the changes between June 2014 and April 2015 include:

- NOAA decided to use a standard lifespan for GOES 13-15 based on a 2005 contractor assessment and the recent performance of the satellites during their time in orbit.
- NOAA decided to show that the satellites will likely last longer than their standard lifespans by adding 5 years of life, based on fuel availability.
- NOAA decided to more accurately depict the on-orbit checkout period instead of showing that the satellite was in storage.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Key changes between the April 2015 and January 2016 charts include:

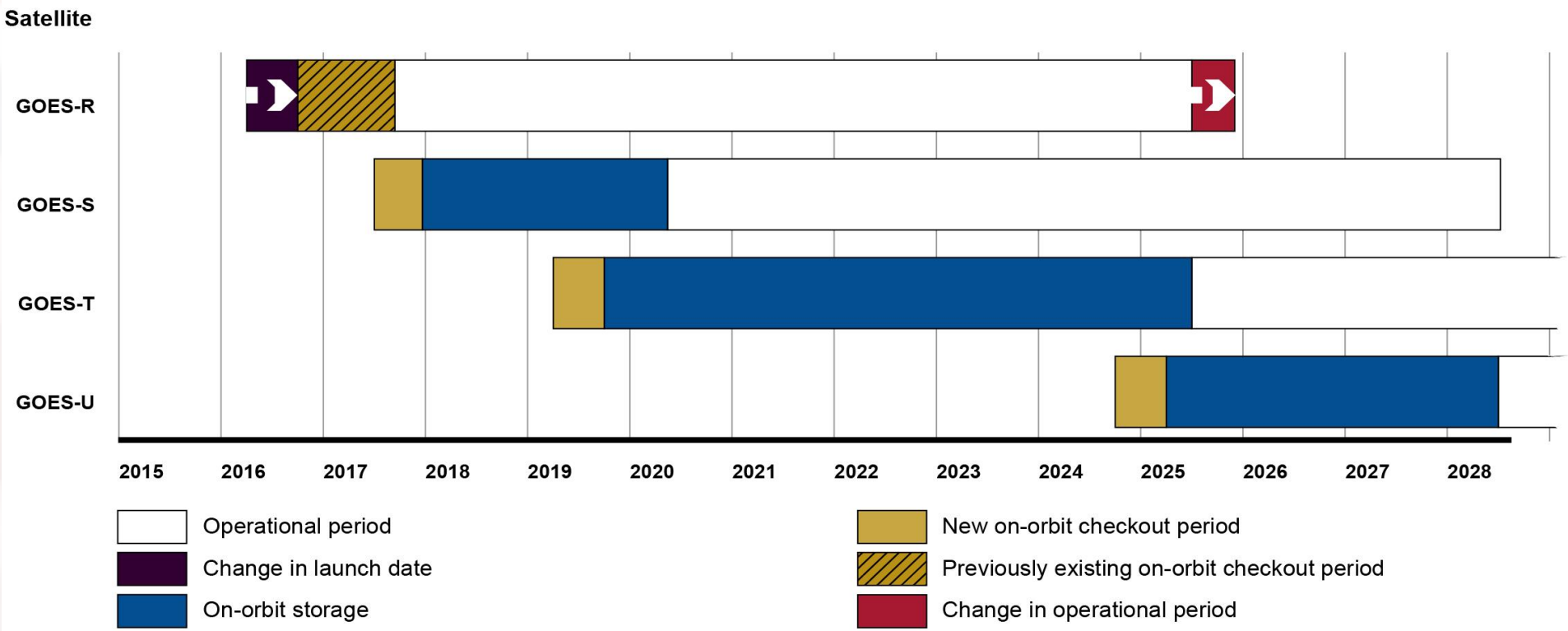
- GOES-R launch delayed from March to October 2016, resulting in a corresponding move in its estimated end-of-life; and
- a 6-month portion of the GOES-S, -T, -U on-orbit storage period relabeled as a test and checkout period.

See figure 10 for a depiction of these changes.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

Figure 10: Key Changes between April 2015 and January 2016



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: GOES=Geostationary Operational Environmental Satellite.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Geostationary Satellite Flyout Charts

According to NOAA documentation, the reasons for the changes between April 2015 and January 2016 include:

- NOAA delayed the GOES-R launch due to issues in developing key spacecraft components.
- NOAA decided to more accurately depict the on-orbit checkout periods for GOES-S, T, and U as distinct from the time the satellites are in storage while in orbit.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Key changes between the March 2014 and August 2014 charts include:

- NOAA-16 was removed.
- NOAA-19 now identified as secondary.

According to agency documentation, the reasons for the changes include:

- NOAA-16 experienced a mission-ending failure.
- NOAA-19 was shown as secondary because S-NPP is primary.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Key changes between the August 2014 and April 2015 charts include:

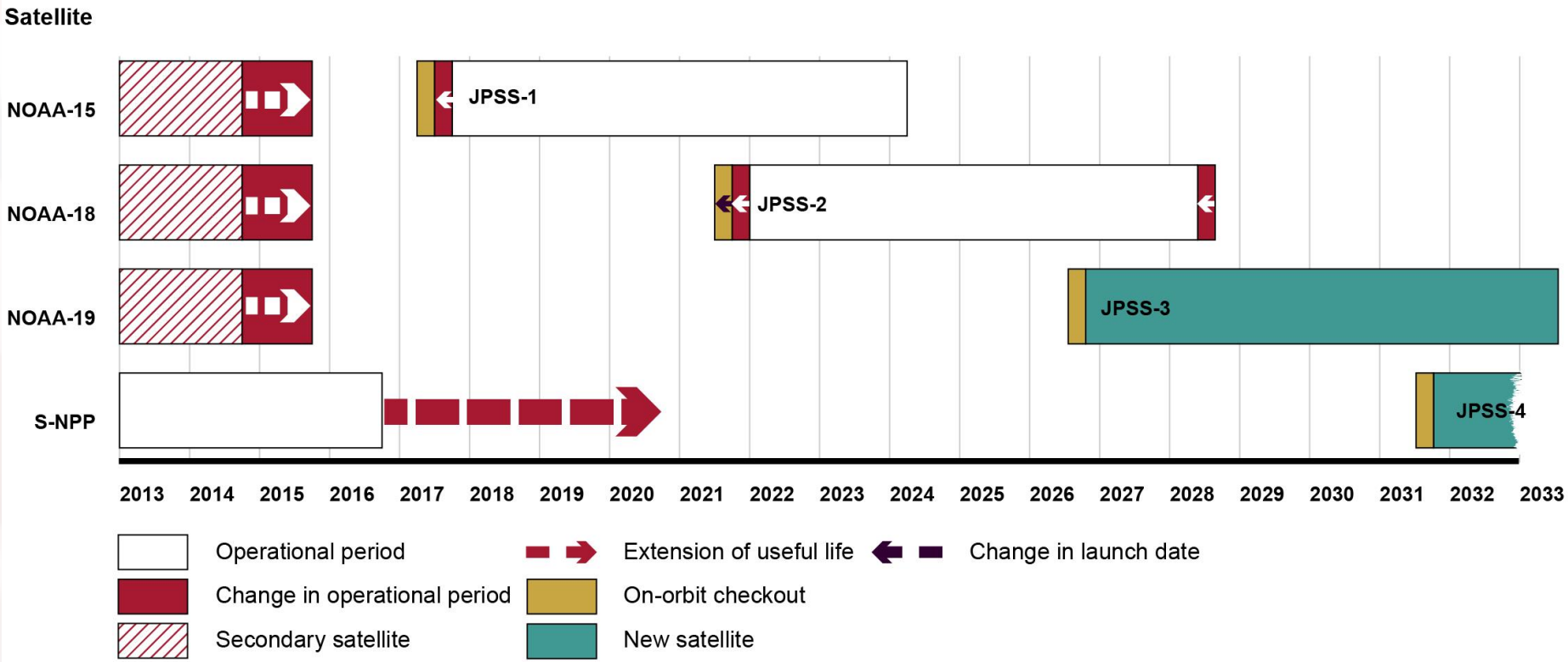
- NOAA-15, 18, and 19 lifespans extended 1 year.
- S-NPP life extended by 4 years.
- JPSS-1 and 2 on-orbit checkout period reduced from 6 to 3 months.
- JPSS-2 to launch 4 months sooner (in July 2021 vs November 2021).
- JPSS-3 and 4 satellites were added.

See figure 11 for a depiction of these changes.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Figure 11: Key Changes between August 2014 and April 2015



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: JPSS=Joint Polar Satellite System; NOAA=National Oceanic and Atmospheric Administration; S-NPP=Suomi-National Polar-orbiting Partnership.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

According to agency documentation, the reasons for the changes between August 2014 and April 2015 include:

- Acknowledging that NOAA-15, 18, and 19 are well beyond their expected lifespans, NOAA extended the lives of the satellites by 1 year because they were still operating.
- NOAA decided to show that S-NPP might last up to 4 more years based on its strong performance to date and the availability of fuel.
- NOAA decided to reduce the on-orbit checkout period for JPSS-1 and 2 based on its experience with S-NPP.
- The JPSS-2 launch change was an error; program documentation before and after held to the November 2021 launch date.
- NOAA added JPSS-3 and 4 because it began planning the Polar Follow-On program.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Key changes between the April 2015 and January 2016 charts include:

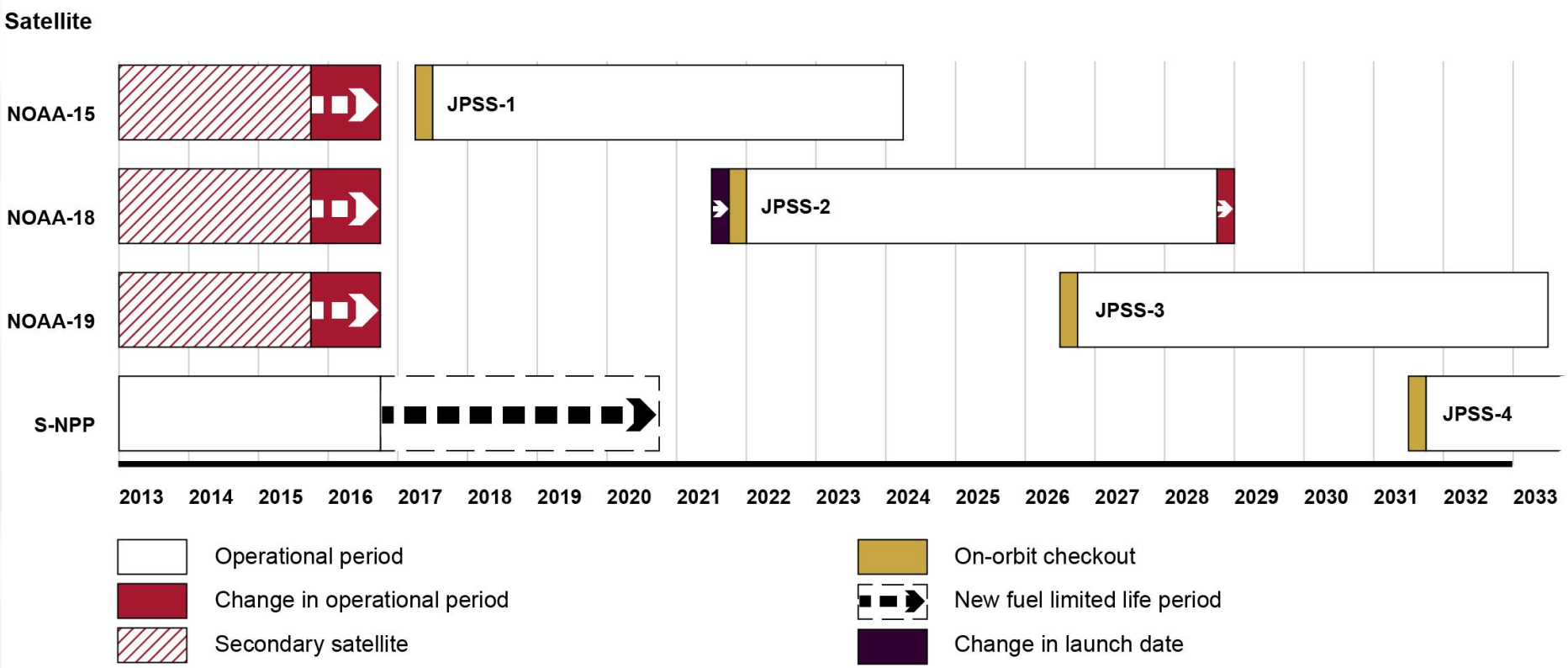
- NOAA extended the lives of NOAA-15, 18, and 19 by 1 year
- S-NPP still shows 4 years of extended life, but this period is now called “fuel limited life”
- JPSS-2 launch date moved back to November 2021

See figure 12 for a depiction of these changes.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Figure 12: Key Changes between April 2015 and January 2016



Source: GAO analysis of National Oceanic and Atmospheric Administration data.

Note: JPSS=Joint Polar Satellite System; NOAA=National Oceanic and Atmospheric Administration; S-NPP=Suomi-National Polar-orbiting Partnership.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Polar Satellite Flyout Charts

Reasons for the changes between April 2015 and January 2016 include:

- NOAA extended the lives of NOAA-15, 18, and 19 because they were still operating.
- NOAA officials stated that the extended life for S-NPP is based on expected fuel availability, and is not intended to portray the degradation of critical instruments or other failures.
- NOAA corrected the prior error on the JPSS-2 launch date.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

DOD and European Elements of the Polar Satellite Flyout Charts

NOAA obtains information from DOD and the European satellite agency on changes to their programs.

Key DOD and European changes between the April 2015 and January 2016 charts include:

- DMSP-17 expected life extended by over 2 years.
- DMSP-20 removed.
- Metop-C and Metop-SG A1 launch dates moved back approximately one year to September 2018 and June 2021, respectively; Metop-A expected life extended by about 1 year into 2016.
- Metop-SG A2 planned mission life on the chart shortened to 7.5 years.

Results: Recent Changes in Flyout Charts and Reasons for the Changes

Reasons for the changes in DOD and European charts include:

- NOAA reported that DOD extended the expected life of DMSP-17 because of strong past performance of a key navigation component, which is a known life-limiting factor.
- Development of DMSP-20 ended after DOD did not certify that it would launch the satellite by the end of calendar year 2016, and as a result, Congress rescinded funding in fiscal year 2015 and halted funding in fiscal year 2016.
- NOAA reported that the European satellite organization decided to shorten the Metop-SG A2 lifetime on the chart to match standard design lifetime for the Metop-SG system.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

Relevant guidance in facilitating congressional decision-making[4] as well as government internal controls call for agencies to ensure the information they present to Congress is accurate, clear, and supported by documentation.

NOAA regularly updates the flyout charts it uses to brief Congress, and for the charts we reviewed:

- most updates accurately reflected the relevant satellite information from the satellite program offices at the time they were published;
- several updates had supporting documentation that provided justification for at least one change; and
- most flyout chart updates were subject to internal review before they were finalized as evidenced by e-mails, documents tracking changes, and the official approval of the final charts.

[4] See GAO, *Agencies' Annual Performance Plans under the Results Act: An Assessment Guide to Facilitate Congressional Decisionmaking*, GAO/GGD/AIMD-10.1.18 (Washington, D.C.: February 1998), and *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

However, in its efforts to provide updated flyout charts to Congress, NOAA has not consistently ensured that the data were supported by stringent analysis, accurate, clearly communicated, and fully documented. Key shortfalls include:

- NOAA does not require regular availability assessments analyzing the health and anticipated longevity of its operational satellites;
- NOAA's updates were not always accurate, in that they were not always consistent with supporting information (availability assessments of polar operational satellites or program estimates for future satellites);
- NOAA does not consistently depict how long a satellite might last once it is beyond its design life; and
- NOAA does not consistently document the justification for its updates.

These shortfalls are discussed in more detail on the following slides.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

Assessing NOAA Efforts (analysis): NOAA does not require regular availability assessments of its operational satellites.

- Satellite-managing agencies often perform technical assessments of the health and future availability of operational satellites to aid in planning and budgeting. For example, the Air Force requires satellite programs to complete an independent assessment of satellite and constellation health each year as part of its budget preparations.[5]
- While NOAA's JPSS program has performed such an analysis annually for the last 3 years, the GOES-R program has not. NOAA does not require annual assessments.
- Without regular availability assessments, NOAA risks not having timely information on the probability of continued success of its operational satellites to use in program and budget planning.

[5] U.S. Air Force, Air Force Space Command Instruction 10-140, "Satellite Functional Availability Planning, " 23 August 2012; Incorporating Change 1, 21 August 2013.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

Assessing NOAA Efforts (accuracy): Flyout chart updates are not always consistent with agency documentation, including polar availability assessments and program schedules.

- NOAA's flyout chart updates are not always consistent with the polar satellite availability assessments. For example:
  - The 2016 flyout chart shows JPSS-1 lasting through March 2024 while the 2015 assessment shows a 55 percent probability that the satellite will be fully functional in 2024.
  - The 2016 flyout chart shows JPSS-2 lasting through 2028 while the 2015 assessment shows about a 55 percent probability that the satellite will be fully functional in 2028.
- Program officials explained that the two documents have different purposes: the polar availability assessment shows degrading health over time, while the flyout charts portray expected satellite lifespans. However, we believe it is not accurate to show a satellite as functioning on the flyout chart when underlying analyses show that the satellite is unlikely to be fully functioning.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

NOAA Efforts (accuracy) cont'd:

- Similarly, NOAA's flyout charts are usually, but not always, consistent with program schedules for JPSS and GOES satellites. Out of 26 instances where we compared flyout chart data to underlying program data for a particular satellite, we identified two instances where the flyout charts did not accurately depict the underlying program data.
  - Program data as of April 2015 listed the JPSS-2 launch as November 2021, but the April 2015 flyout charts showed it 4 months earlier, in July 2021.
  - Program data from June 2014 listed the GOES-U launch in October 2024, but the corresponding flyout charts showed it 3 months later, at the end of December 2024.
- According to agency officials, both of these issues were due to chart formatting errors that were corrected when the next chart was established 6-12 months later. We confirmed that these issues were corrected in subsequent charts. However, they were inaccurate at the time they were provided to Congress.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

NOAA Efforts (accuracy), cont'd:

- Part of the reason for this lack of consistency is that NOAA does not have a policy in place that requires taking steps to ensure the accuracy of the charts.
- Until NOAA ensures its flyout charts correctly represent the best available knowledge on the health and availability of the satellites, the agency runs an increased risk that its charts will not be useful or trusted to inform the budget and appropriations processes and provide program updates.
- Further, unless NOAA more accurately depicts when a satellite's expected life falls below a certain threshold (such as a 70 percent or 50 percent probability of success), the agency risks misleading Congress and the public on how long its satellites are expected to last.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

Assessing NOAA Efforts (clarity): NOAA does not consistently depict how long a satellite is expected to last once it is beyond its design life. For example,

- In 2005, NOAA received a contractor study showing that GOES-13 to 15 were likely to last a total of 10 years after launch, which was beyond the 7-year design life (including 2 years of on-orbit storage and 5 years of operation); the agency's flyout charts from 2012-2014 did not reflect any increase in potential expected life.
- In 2015, NOAA adjusted its flyout chart to show extended life on GOES-13 to 15 using an extension labeled as fuel extended life. In 2016, it did the same for S-NPP.
- While the 2015 and 2016 polar flyout charts show an anticipated extended life for S-NPP, the charts do not reflect NOAA information showing that other JPSS satellites could last well beyond their design lives.
- Also in its 2015 and 2016 polar flyout charts, NOAA shows its expectation that NOAA-18 and 19 will last 1 more year by extending the expected operation of the satellites, even though the polar availability assessments show they will likely last longer.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

NOAA Efforts (clarity), cont'd:

- According to NOAA officials, the agency is evolving on how best to show that a satellite is expected to last once it is beyond its design life. Officials also stated that situations are different for different satellites. However, the inconsistencies have the effect of implying that some satellites will reach their end-of-life sooner or later than the agency anticipates.
- Agency officials also explained that the term "fuel-limited life" is intended to show the maximum possible life assuming all instruments and the spacecraft continue functioning. However, the agency did not clearly define this term on its charts, thereby allowing readers to assume the agency expects the satellites to last through the end of the fuel-limited life period.
- Part of the reason NOAA does not consistently describe how long a satellite is expected to last is that the agency does not have a policy in place requiring a standard approach or nomenclature. Until the agency establishes a consistent approach to describing a satellite's extended life, it is at risk that its charts will be misleading to those making budget decisions.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

Assessing NOAA Efforts (documentation): NOAA does not consistently document justification for its updates.

Consistent with basic internal controls, NOAA's draft policy calls for documenting the reasons for changes to the flyout charts and executive approval of those changes.

- In practice, OSAAP officials prepare a summary package for each flyout chart update.
- A standard package includes the new flyout chart, e-mails justifying the necessary changes, a routing list for review and approval, and a summary of the disposition of any comments that come up through the review process.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

NOAA Efforts (documentation), cont'd:

- However, our review of the six summary packages (supporting three updates to the geostationary flyout charts and three updates to the polar flyout charts since 2014) showed that
  - while two of the geostationary satellite packages include justification for at least one key change, none of them include justification for all of the key changes;
  - while one of the three polar satellite packages includes justification, the other two packages did not include justification for key changes; and
  - key documents, such as a routing list and summary of the disposition of comments, were not included in three of the six packages.
- Furthermore, of the 27 key changes we noted on the flyout charts between March 2014 and January 2016, 9 were justified in the associated summary packages and 18 were not.

Results: NOAA Has Not Consistently and Accurately Updated Its Flyout Charts

NOAA Efforts (documentation), cont'd:

- Program officials explained that documentation supporting each change exists and is widely circulated and vetted; however, we were unable to find this documentation in the packages provided by NOAA.
- Part of the reason for the inconsistencies is that NOAA does not have a policy in place requiring the creation and approval of standard justification packages.
- Until the agency documents and maintains a standard justification and approval package for each update, it risks not having all of the information it needs to justify a change to its flyout charts.

Conclusions

NOAA updates the flyout charts it uses to inform Congress of its planned timelines for current and future satellites using a process similar to one that is documented in a June 2011 draft policy. Under this process, the office responsible for the charts is to call for updated information, revise the charts, and circulate the revised charts for internal review and approval before publishing them on its website and sharing them with congressional committees.

Between March 2014 and January 2016, agency officials revised the flyout charts three times to add newly planned satellites, to remove a satellite that ceased operations, and to change the expected dates for launch, beginning operations, and end-of-life.

Conclusions

In its efforts to update its flyout charts, NOAA provides regular updates that are mostly consistent with supporting documentation. However, the agency does not require its satellite programs to conduct regular assessments of satellite availability, which could aid in determining how long its satellites will likely last. Moreover, the information in the flyout charts is not always consistent with supporting agency documentation; is not always consistent in how it presents a satellite's extended life; and is not always supported by a complete justification package. Part of the reason for these issues is that NOAA has not established a policy that includes these steps.

Until NOAA addresses the shortfalls in its practices and updates its policy to help ensure the flyout charts are accurate, consistent, and well-documented, it runs an increased risk that its flyout charts will mislead Congress and may lead to less-than-optimal decisions.

Recommendations for Executive Action

GAO is making the following five recommendations to the Secretary of Commerce to direct NOAA's Assistant Administrator for Satellite and Information Services to:

1. Require satellite programs to perform regular availability assessments and use these analyses to inform the flyout charts and support its budget requests.
2. Ensure that flyout chart updates are consistent with supporting data from the program and from satellite availability assessments.
3. Establish and implement a consistent approach to depicting satellites that are expected to last beyond their design lives.
4. For each flyout chart update, maintain a complete package of documentation on the reasons for any changes and executive approval of the changes.
5. Revise and finalize the draft policy governing how flyout charts are to be updated to address the shortfalls with analysis, accuracy, consistency, and documentation noted in the above recommendations.

Agency Comments and Our Evaluation

We obtained e-mailed comments on a draft of this briefing from the NOAA Audit Liaison, who transmitted NESDIS's response to our recommendations. NESDIS generally concurred with our recommendations and noted that it plans to revise the policy guiding how flyout charts are to be updated.

Specifically:

- NESDIS concurred with our recommendation to require regular availability assessments and use them to inform the flyout charts. The agency also noted that operational personnel regularly assess the health and availability of satellites under their command and control, and post this information in near real-time on the operational satellite web pages.
- NESDIS concurred with our recommendation to ensure that the flyout chart updates are consistent with supporting data, and noted that the flyout charts are used to inform stakeholders and the public about the results of complex operational and acquisition decisions. NESDIS officials also noted that the flyout charts are not the sole source of information for external stakeholders; the agency also uses written reports, press releases, management reviews, and budget submittals to alert stakeholders of operational events and acquisition decisions.

Agency Comments and Our Evaluation

Agency responses, cont'd:

- NESDIS partially concurred with our recommendation to establish and implement a consistent approach to depicting satellites that are expected to last beyond their design lives. The agency noted that while their approach is to depict the same kinds of events, every satellite series is different in terms of age, technology, orbit regime, operational, approach, and end-of-life criteria. As such, according to NESDIS, consistency across several different kinds of satellites can only be done in a simplistic manner. We agree that it is a challenge to present complex satellite information in a single graphic chart and that simplifying the depictions would be valuable.
- NESDIS concurred with our recommendation to maintain a complete package of documentation for each flyout chart update.
- NESDIS concurred with our recommendation to revise and finalize the draft policy governing how flyout charts are to be updated to address the shortfalls we noted in analysis, accuracy, consistency, and documentation.

We believe that addressing our recommendations to improve processes and policies will help ensure that the flyout charts NOAA uses to inform Congress and other stakeholders are supported by strong analyses, accurately reported, and clearly communicated.