U.S. GOVERNMENT ACCOUNTABILITY OFFICE

441 G St. N.W.
Washington, DC 20548

December 9, 2014

The Honorable Carl Levin
Chairman
The Honorable James Inhofe
Ranking Member
Committee on Armed Services
United States Senate

Space Acquisitions: DOD Needs More Guidance on Decisions to Store Satellites

Most of the Department of Defense's (DOD) current, major satellite acquisition programs are in the later stages of acquisition, with the initial satellites having been designed, produced, and launched into orbit while additional satellites of the same design are being produced. Several of the satellites now being produced will be placed in storage before being launched—either in facilities on the ground or on orbit in space. Recent challenges, including a fiscal climate of reduced funds, have led DOD to consider efforts that could significantly change the way it acquires satellites, which may also affect how and when it stores satellites. As DOD considers such changes, it is important that DOD has sufficient insight into the acquisition costs—including storage of satellites—to minimize the government's risk of paying contractors more than necessary.

In a report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2014, the Senate Armed Services Committee mandated that GAO assess the costs, risks, and benefits of storage on produced satellites.[1] This report formally transmits the information we provided in a briefing on September 10, 2014, to the committee staff, updated to reflect current data. See enclosure I: *DOD Satellite Storage Costs Briefing to the Senate Armed Services Committee*. The briefing addressed the following: (1) How does storage factor into DOD's satellite acquisition programs and strategies, including those for reconstituting satellites? (2) What satellite storage costs has DOD identified for the last 5 years and what costs does it expect during the next 5 years? (3) What steps has DOD taken to assess the effects of satellite storage on operational lifetimes and the associated risks and benefits of storage? and (4) How do other agencies—National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and National Reconnaissance Office (NRO)—use satellite storage?

To determine DOD's acquisition strategy and approach to storing satellites as well as the costs involved, we obtained and analyzed storage cost data from the eight satellite program offices identified by the Air Force and Navy as having had or planning on having storage in the last or

[1]S. Rep. No. 113-44, at 162, 113th Cong. (1st Sess. 2013).

next 5 years—Advanced Extremely High Frequency (AEHF) Satellite System, Defense Meteorological Satellite Program (DMSP), Global Positioning System II-F (GPS-IIF), Global Positioning System III (GPS-III), Mobile User Objective System (MUOS), Space Based Infrared System (SBIRS), Space Based Space Surveillance (SBSS),and Wideband Global SATCOM (WGS). We discussed the source of the cost data with each program office and determined that the data was sufficiently reliable for the purposes of our review. We also reviewed the associated satellite production contracts to identify the terms and conditions related to storage. We interviewed DOD officials, including officials from the eight satellite program offices to discuss the overall approach to using storage as part of a satellite's acquisition strategy. We also contacted the Defense Contract Audit Agency (DCAA) and Defense Contract Management Agency (DCMA) to determine their roles in assessing the reasonableness of the storage costs. We also reviewed the Federal Acquisition Regulation, best practices related to acquisition management and strategic sourcing, and past reviews of satellite programs to determine what data on storage costs would enhance negotiations as well as efficient management and oversight of satellite storage. To determine what is known about the effects of storage on the operational lifetimes of satellites, we performed a literature search for studies regarding the effects of satellite storage, and discussed the known effects with DOD officials. To determine how NASA, NOAA, and NRO store satellites, we obtained information from NASA, NOAA, and NRO officials regarding their acquisition strategies for storing satellites.

We conducted this performance audit from January 2014 to December 2014 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

DOD's general approach is to launch satellites as soon as they are built. Program offices handle storage on a case-by-case basis based on mission needs and production and launch schedules. Over the last 5 years, DOD generally decided to use storage when satellites on orbit were lasting longer than expected and thereby pushed out the originally planned launch dates for the newer satellites. However, satellite storage is now more often considered earlier while the acquisition strategy is developed. As programs use block buys to efficiently procure more than one satellite at a time to support a constellation, the satellites' production is spread out over multiple years in a continuous production line that necessitates storage as satellites are produced earlier than needed for launch. As a result, planned storage is now beginning to be considered or included in production contracts at the time of award. However, no specific DOD or service acquisition policies exist regarding how and when to contract for satellite storage. Currently, satellite program offices determine their own approaches to using and contracting for satellite storage. For example, one program is negotiating long-term storage in block buys for incremental periods at fixed cost, while another awarded its contract without storage and plans to negotiate it separately when the need arises. Furthermore, some program offices are studying the actual storage costs incurred on earlier cost-reimbursement contracts to evaluate current fixed-price proposals for storage. Regardless of the approach taken, the Federal Acquisition Regulation requires that contracting officers have sufficient information to determine that proposed prices are fair and reasonable.[2] DCAA and DCMA officials—who can be called on

[2] Federal Acquisition Regulation Subpart 15.4—Contract Pricing.

to review cost proposals and pricing data—were not asked to review actual or proposed storage costs for any of the eight satellite programs in our review. Such information might have provided insights regarding the reasonableness of storage costs for use in contract negotiations and helped DOD to better assess disparities in costs, as well as trends, across satellite programs.

According to officials from the eight satellite programs that stored or plan to store satellites, DOD spent over $130 million for satellite storage over the last 5 years and is expected to spend over $206 million over the next 5 years. The total for the past 5 years does not include storage costs for three satellites—two DMSP and one SBIRS—because they were undergoing upgrades after being stored. In the case of the two DMSP satellites, for example, DOD was upgrading the satellites for part of the time they were in storage. The upgrades were needed, in part, due to the long length of time the DMSP satellites were in storage. Since DOD considered the satellites to be in an upgrade status, no storage costs were reported for the past 5 years. Among the programs, the total costs for storing individual satellites ranged from $40,000 to an expected $120 million. Individual satellite storage costs vary across and within programs based on several factors, including the expertise and number of staff needed to monitor and maintain the satellite, types and frequency of testing needed while in storage, and the length of time stored. According to program officials, the majority of the storage costs are comprised of labor costs for personnel to perform maintenance and testing and then prepare the satellite for launch. However, satellite program offices were not able to provide storage cost data at a detailed level—such as the number of personnel and costs for each type of storage activity—since such data are not collected at that level. A detailed breakdown of storage costs could provide insights into the cost variations experienced across programs and an identification of the cost drivers that could provide contracting officers an advantage in negotiations to potentially obtain better storage rates.

Storage generally has had a minimal effect on a satellite's operational lifetime, according to DOD officials and the limited number of studies available regarding the effects. Satellites stored on the ground face risks, such as batteries being partially depleted and lubricants settling in rotating wheel assemblies. According to department officials, DOD mitigates these risks when satellites are stored on the ground by performing maintenance and testing activities to ensure the satellite stays ready for launch. When stored on orbit, the most significant risk is the harsh space environment.

According to officials from NASA, NOAA, and NRO, their satellites are generally built and launched immediately. NOAA acquires some weather satellites in block buys and generally stores them on orbit to enable NOAA to immediately respond to a capability gap caused by an on-orbit satellite failure. In contrast, NRO stores some satellites on the ground as part of the planned production of multiple satellites.

Conclusions

Although it now appears that DOD generally has begun to consider satellite storage earlier in its procurement process, no guidance exists to ensure that satellite storage will continue to be addressed early in the acquisition process. Furthermore, DOD has limited insight into the components of the satellite storage costs it has incurred. As a result, DOD may be missing opportunities to better inform its contract negotiations on the costs of satellite storage since it has not cultivated detailed cost data and has not involved DCAA or DCMA in assessing the reasonableness of contractors' actual or proposed costs. As DOD moves forward with its efforts

to change the way it acquires satellites, having more detailed data on satellite storage costs could provide critical information for use in decision making.

Recommendation for Executive Action

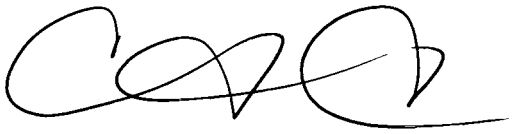
To ensure that satellites storage is fully considered at the beginning of the acquisition process for all satellite programs and sufficient detailed cost data are maintained, we recommend that the Secretary of Defense provide guidance regarding when and how to use storage in the acquisition process, and establish mechanisms so that more detailed data are maintained for use in evaluating the reasonableness of contractors' storage cost proposals and for informing DOD's oversight of satellite acquisitions.

Agency Comments

We provided a draft of this report to DOD. In its written comments DOD concurred with our recommendation. The comments are reproduced in enclosure II. DOD also provided technical comments that have been incorporated where appropriate.

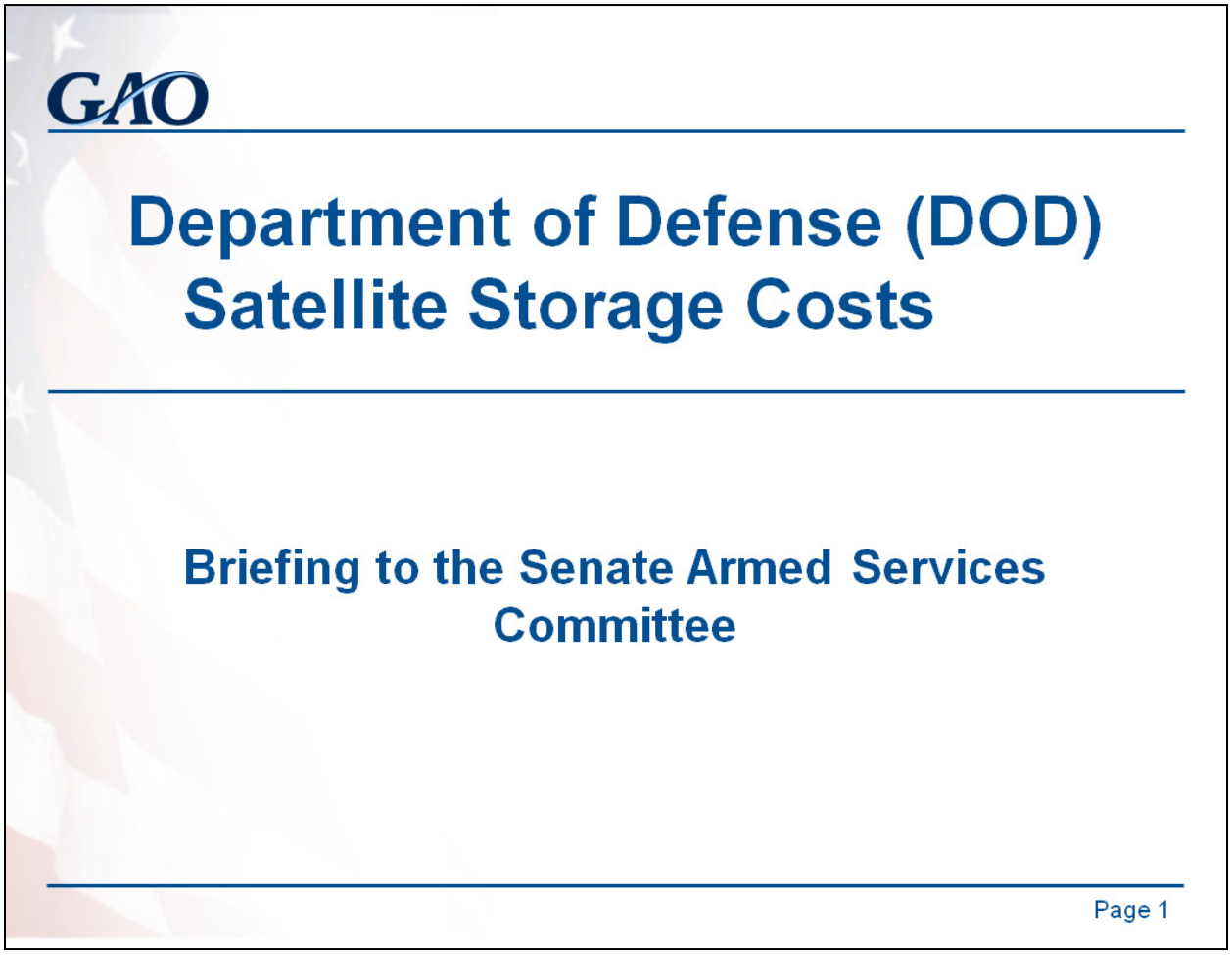
We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, Director of NASA, Director of NOAA, and Director of the NRO. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

Should you or your staff have questions concerning this report, contact me at (202) 512-4841 or at chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are Art Gallegos, Assistant Director; Marie Ahearn; R. Eli DeVan; and Jean Lee.



Cristina T. Chaplain
Director, Acquisition and Sourcing Management

Enclosures - 2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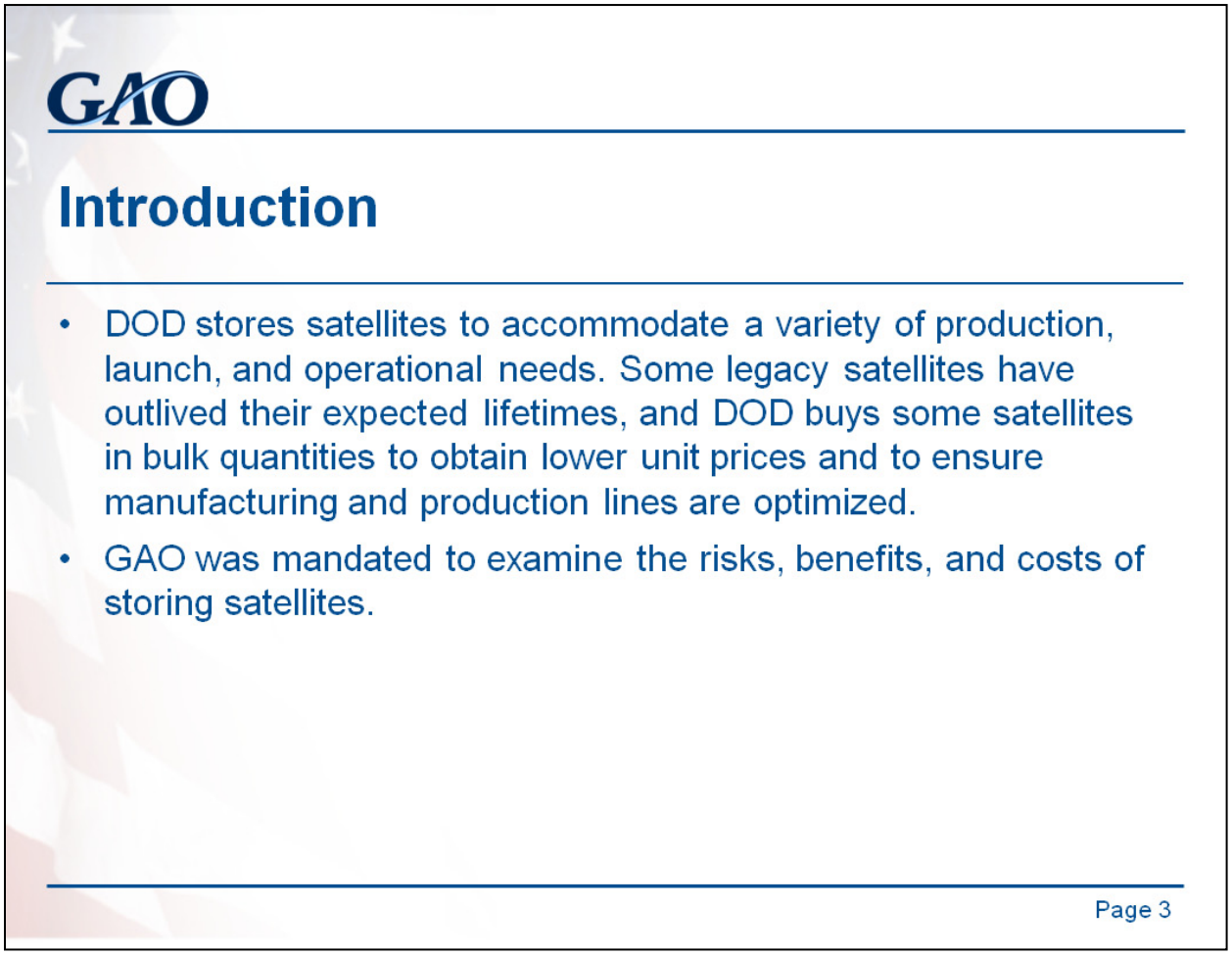
GAO
Introduction
• DOD stores satellites to accommodate a variety of production, launch, and operational needs. Some legacy satellites have outlived their expected lifetimes, and DOD buys some satellites in bulk quantities to obtain lower unit prices and to ensure manufacturing and production lines are optimized.
• GAO was mandated to examine the risks, benefits, and costs of storing satellites.
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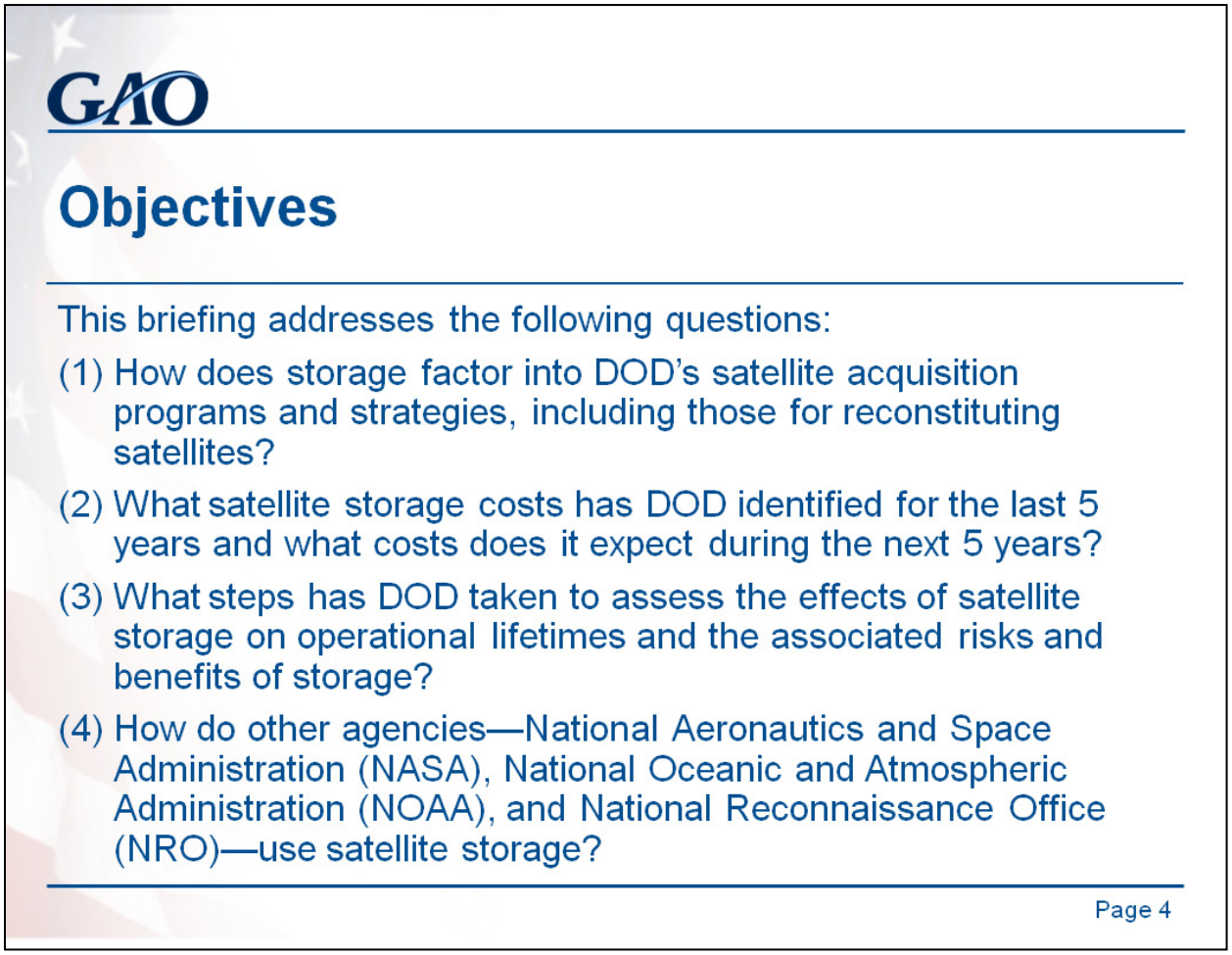
GAO
Objectives
This briefing addresses the following questions:
(1) How does storage factor into DOD's satellite acquisition programs and strategies, including those for reconstituting satellites?
(2) What satellite storage costs has DOD identified for the last 5 years and what costs does it expect during the next 5 years?
(3) What steps has DOD taken to assess the effects of satellite storage on operational lifetimes and the associated risks and benefits of storage?
(4) How do other agencies—National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and National Reconnaissance Office (NRO)—use satellite storage?
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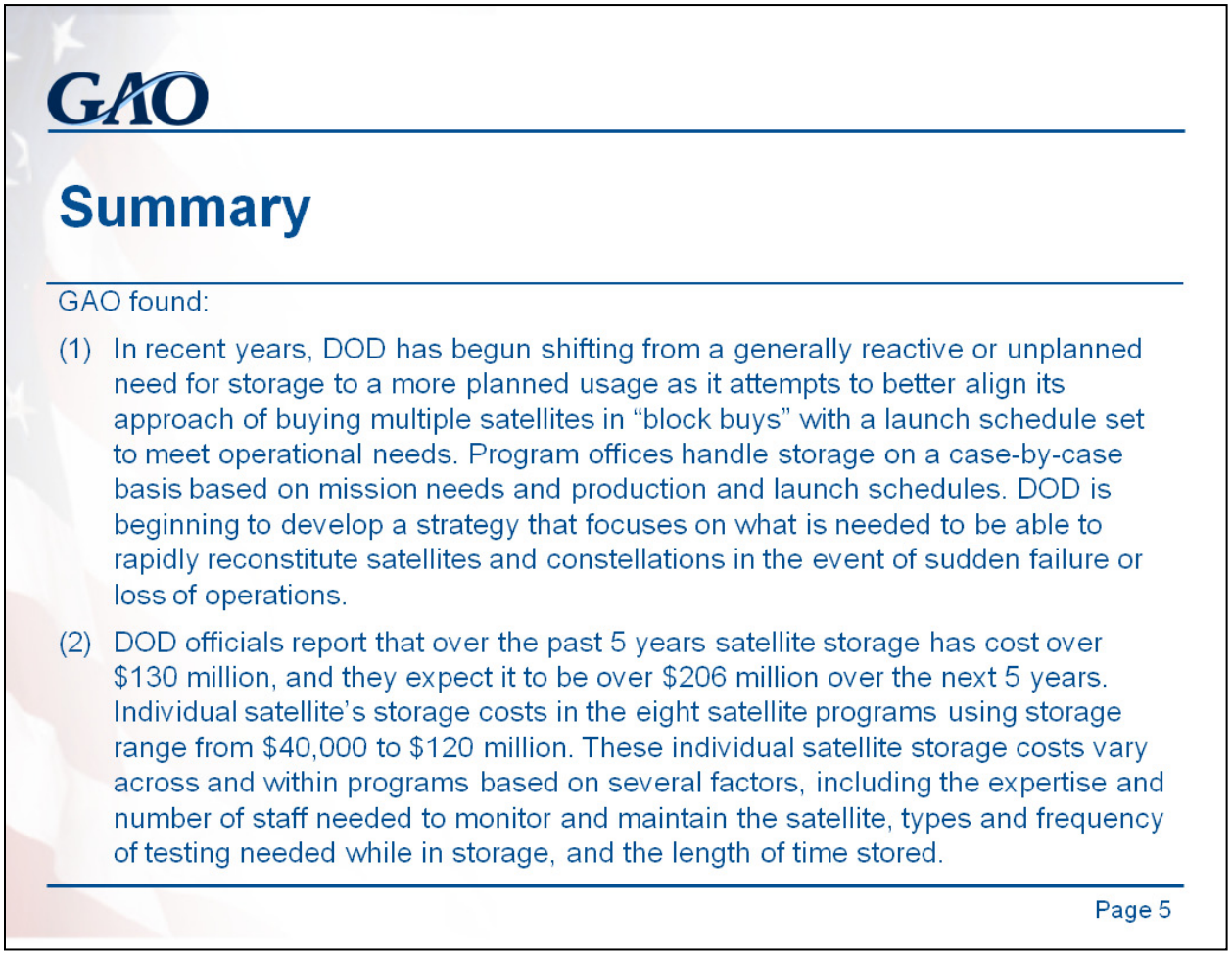
GAO
Summary
GAO found:
(1) In recent years, DOD has begun shifting from a generally reactive or unplanned need for storage to a more planned usage as it attempts to better align its approach of buying multiple satellites in "block buys" with a launch schedule set to meet operational needs. Program offices handle storage on a case-by-case basis based on mission needs and production and launch schedules. DOD is beginning to develop a strategy that focuses on what is needed to be able to rapidly reconstitute satellites and constellations in the event of sudden failure or loss of operations.
(2) DOD officials report that over the past 5 years satellite storage has cost over $130 million, and they expect it to be over $206 million over the next 5 years. Individual satellite's storage costs in the eight satellite programs using storage range from $40,000 to $120 million. These individual satellite storage costs vary across and within programs based on several factors, including the expertise and number of staff needed to monitor and maintain the satellite, types and frequency of testing needed while in storage, and the length of time stored.
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Summary, cont'd

GAO found:

(3) DOD and industry have a limited number of studies on the effects of storage on satellites. According to DOD officials and the studies, storage generally has a minimal impact on a satellite's operational lifetime. When stored on the ground, the most significant risks are the degradation of batteries and moving parts. When stored on orbit, the most significant risk is the harsh space environment, including space weather, solar radiation, and debris.

(4) NASA generally does not store satellites. NOAA stores some weather satellites on orbit as spares. According to NOAA officials, the on-orbit storage cost is minimal and is covered as part of program operations. NRO stores some satellites on the ground to minimize production costs with block buys.

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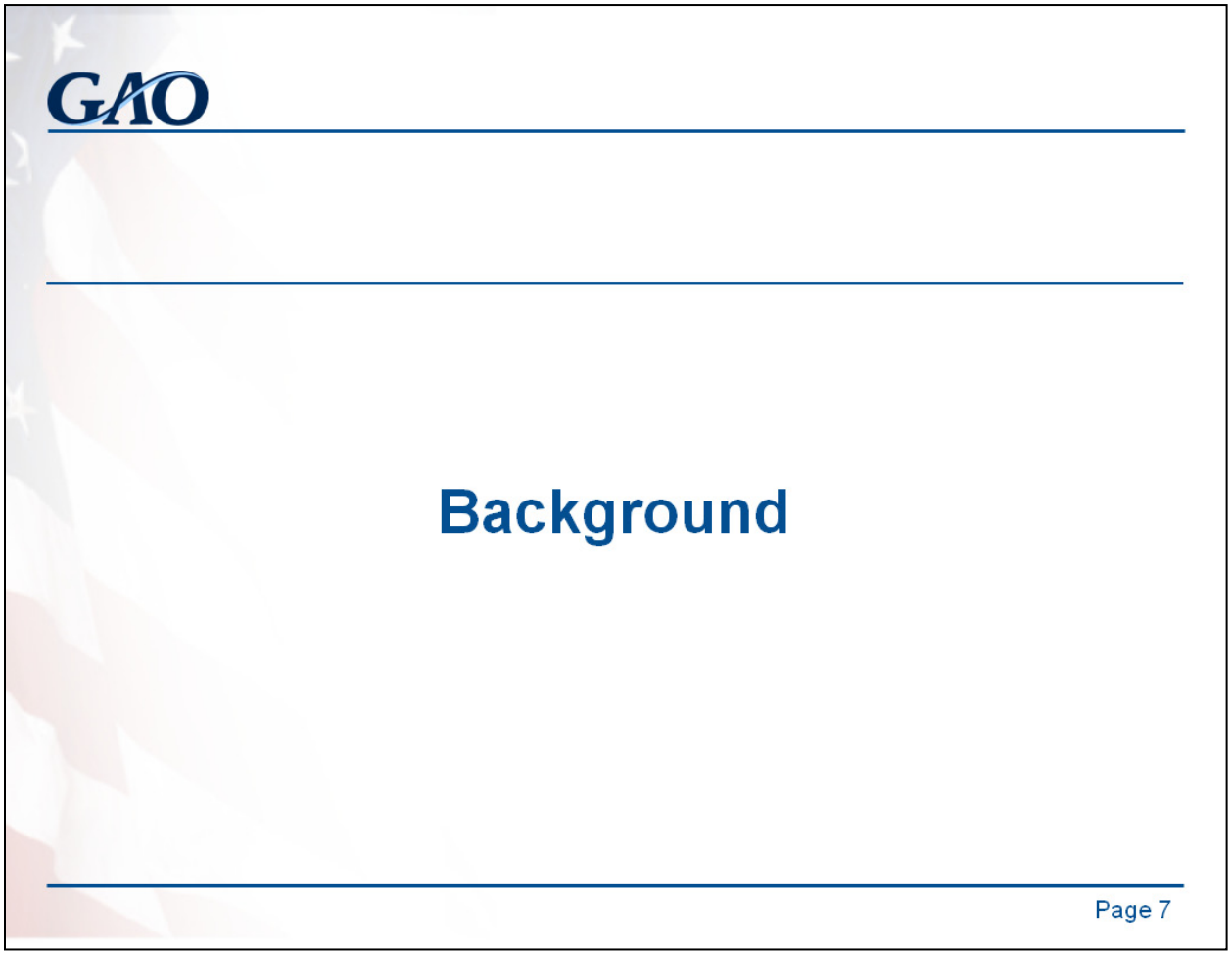
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Background
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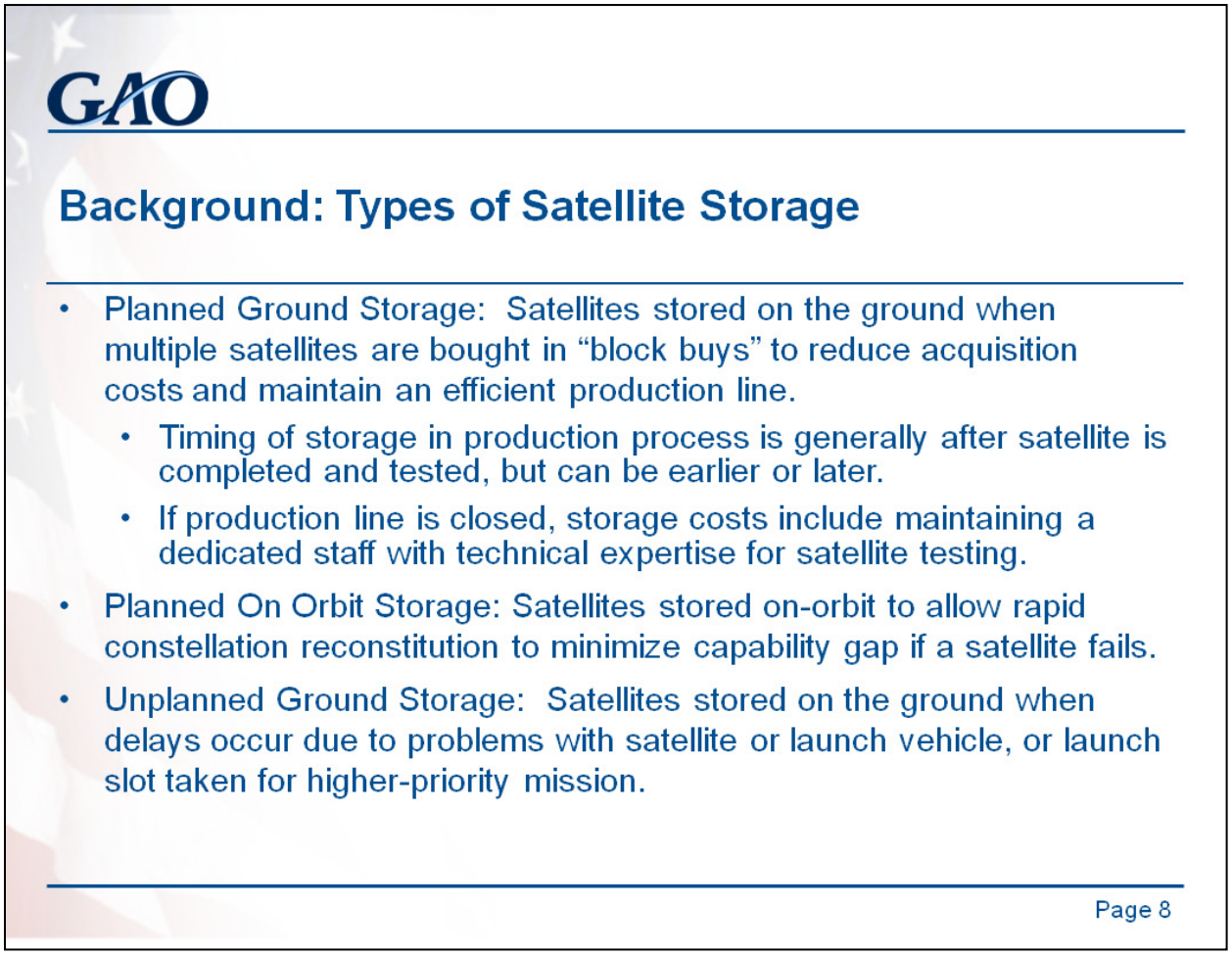
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Background: Types of Satellite Storage
• Planned Ground Storage: Satellites stored on the ground when multiple satellites are bought in "block buys" to reduce acquisition costs and maintain an efficient production line.
• Timing of storage in production process is generally after satellite is completed and tested, but can be earlier or later.
• If production line is closed, storage costs include maintaining a dedicated staff with technical expertise for satellite testing.
• Planned On Orbit Storage: Satellites stored on-orbit to allow rapid constellation reconstitution to minimize capability gap if a satellite fails.
• Unplanned Ground Storage: Satellites stored on the ground when delays occur due to problems with satellite or launch vehicle, or launch slot taken for higher-priority mission.
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Background: Satellite Storage Activities

While in storage on the ground:

- Maintain in secure and environmentally controlled clean room;
- Store battery separately to avoid using its limited life; and
- Periodically rotate reaction wheel assemblies to prevent lubricants from settling.

Source: Boeing. | GAO-15-97R

- Periodically perform tests to ensure satellite can operate in case of immediate need for launch:
  - Extend solar arrays to test solar panels; and
  - Recalibrate clocks and sensors.

Allows access to update satellite technology before launch.

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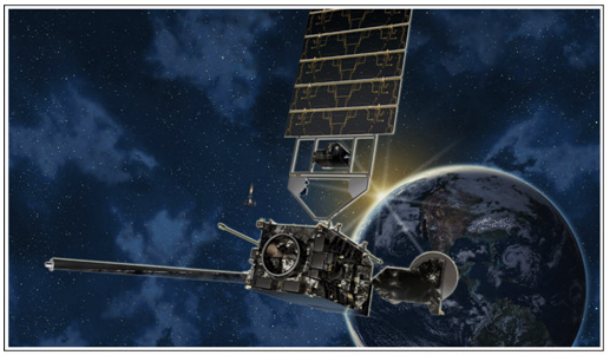
Background: Satellite Storage Activities, cont'd

While in storage on orbit:

- Periodically power up and test to ensure satellite can operate; and
- Testing done by staff operating constellation.



Source: National Oceanic and Atmospheric Administration. | GAO-15-97R

Allows potential to fill a constellation capability gap in days rather than in months or years if a satellite fails or additional capacity is needed; if not positioned close to where needed, requires fuel consumption to relocate.

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Background: Programs Storing Satellites

- DOD identified eight programs that stored or will store satellites on the ground or on orbit during the past five years or next five years

Table 1: DOD Satellite Programs Reporting Storage

	Satellite program	Mission	Number of satellites being procured	Total acquisition cost (in millions)
	Advanced Extremely High Frequency (AEHF) Satellite System	Provides survivable, global, secure, protected, jam-resistant communications for military community	6 satellites	$13,161.1
	Defense Meteorological Satellite Program (DMSP)	Generates earth and space weather data for military and civilian communities worldwide	10 satellites	$2,493.3
	Global Positioning System (GPS) — GPS-IIF model	Delivers position, velocity, and timing data to military and civilian communities worldwide	12 satellites	$7,995.8[a]

Source: DOD program office for data; Boeing for GPS-IIF, SBSS, and WGS photos; Lockheed Martin for AEHF, DMSP, GPS-III, MUOS (© 2007), and SBIRS (© 2007) photos; GAO presentation. | GAO-15-97R

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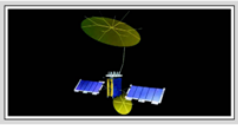
Background: Programs Storing Satellites, cont'd

	Satellite program	Mission	Number of satellites being procured	Total acquisition cost (in millions)
	Global Positioning System (GPS) — GPS-III model (new generation satellite)	Delivers position, velocity, and timing data to military and civilian communities worldwide	8 satellites	$4,504.5
	Mobile User Objective System (MUOS)	Provides ultra-high frequency communications for military community	6 satellites	$7,265.0
	Space Based Infrared Systems (SBIRS)	Provides data for missile early warning and defense systems for the military community	6 satellites and 2 sensor payloads on host satellites	$16,980.8[b]

Source: DOD program office for data; Boeing for GPS-IIF, SBSS, and WGS photos; Lockheed Martin for AEHF, DMSP, GPS-III, MUOS (© 2007), and SBIRS (© 2007) photos; GAO presentation. | GAO-15-97R

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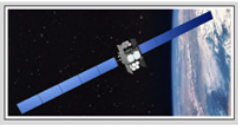
Background: Programs Storing Satellites, cont'd

	Satellite program	Mission	Number of satellites being procured	Total acquisition cost (in millions)
	Space Based Space Surveillance (SBSS)	Provides data on man-made orbiting objects for the space community	1 satellite	$917.7
	Wideband Global SATCOM (WGS)	Provides X and Ka band communications for the military community worldwide	8 satellites	$3,731.8[c]

Source: DOD program office for data; Boeing for GPS-IIF, SBSS, and WGS photos; Lockheed Martin for AEHF, DMSP, GPS-III, MUOS (© 2007), and SBIRS (© 2007) photos; GAO presentation. | GAO-15-97R

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Notes: [a]GPS-IIF total acquisition cost includes GPS-IIR and GPS-IIR-M model satellites, modernizing user equipment, and the ground portion.
[b]SBIRS total acquisition cost includes the ground portion.
[c]WGS total acquisition cost does not include the funding from international partners for two satellites.

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Objective 1:
DOD's Storage Approach and Acquisition Strategy
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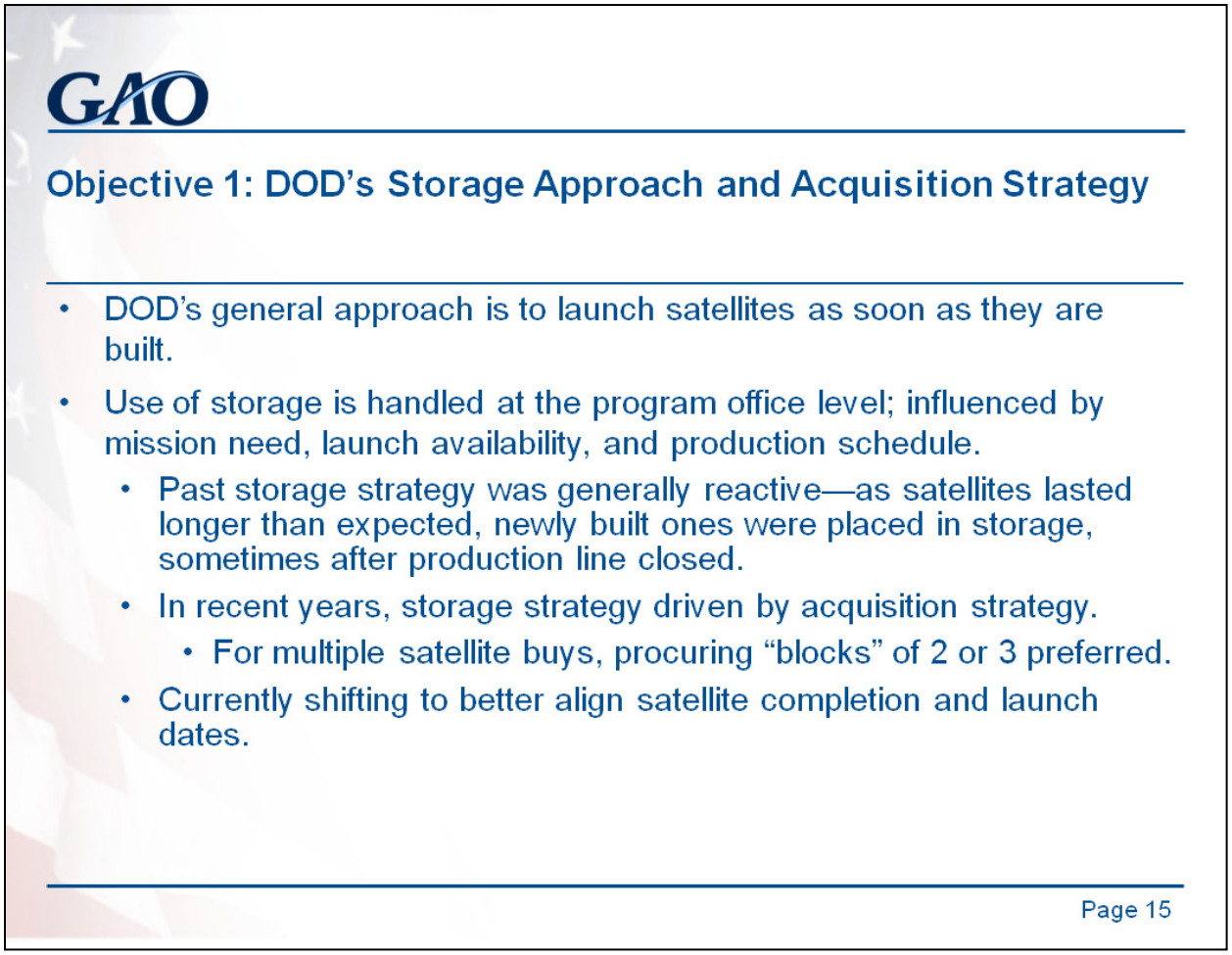
GAO
Objective 1: DOD's Storage Approach and Acquisition Strategy
• DOD's general approach is to launch satellites as soon as they are built.
• Use of storage is handled at the program office level; influenced by mission need, launch availability, and production schedule.
• Past storage strategy was generally reactive—as satellites lasted longer than expected, newly built ones were placed in storage, sometimes after production line closed.
• In recent years, storage strategy driven by acquisition strategy.
• For multiple satellite buys, procuring "blocks" of 2 or 3 preferred.
• Currently shifting to better align satellite completion and launch dates.
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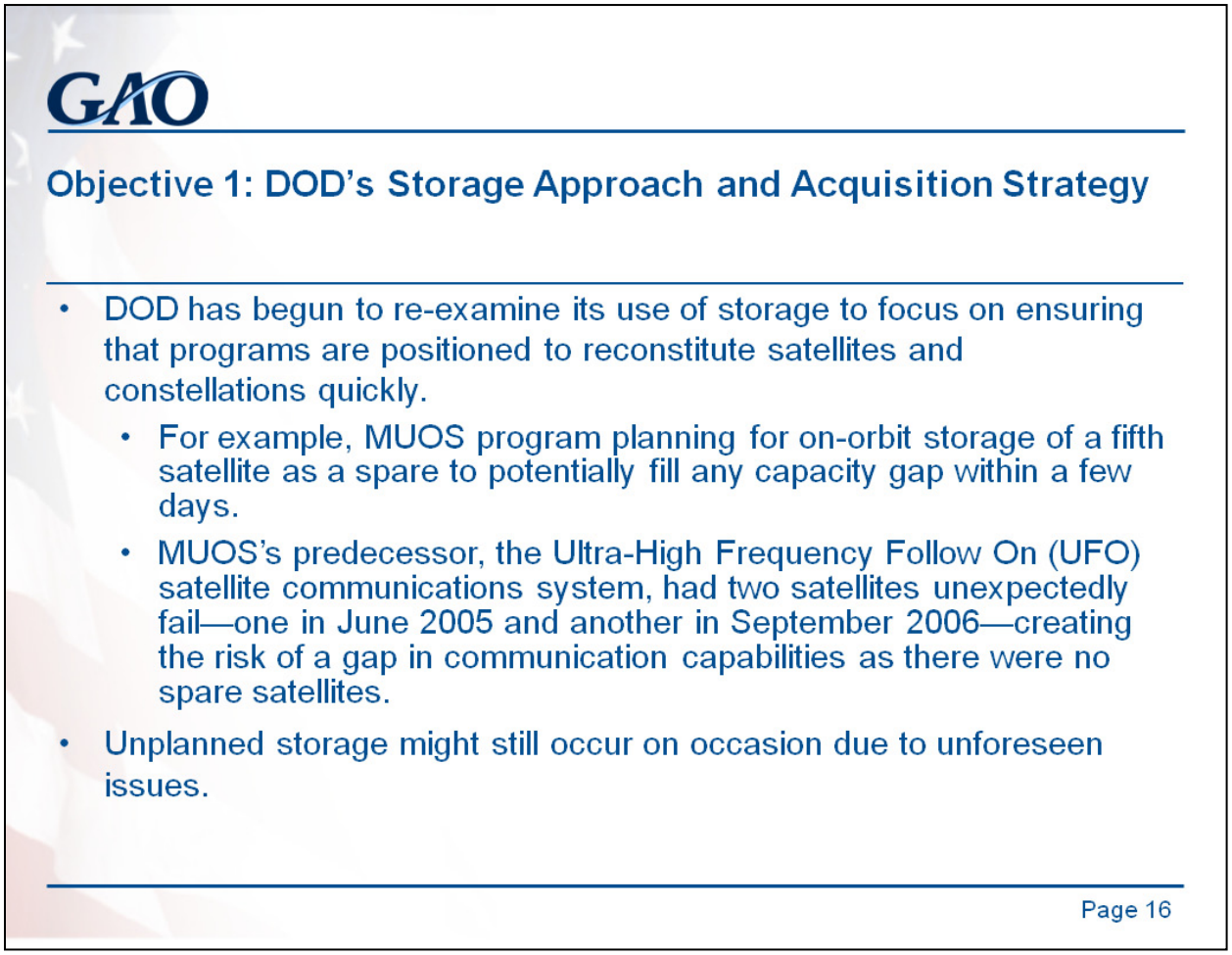
GAO
Objective 1: DOD's Storage Approach and Acquisition Strategy
• DOD has begun to re-examine its use of storage to focus on ensuring that programs are positioned to reconstitute satellites and constellations quickly.
• For example, MUOS program planning for on-orbit storage of a fifth satellite as a spare to potentially fill any capacity gap within a few days.
• MUOS's predecessor, the Ultra-High Frequency Follow On (UFO) satellite communications system, had two satellites unexpectedly fail—one in June 2005 and another in September 2006—creating the risk of a gap in communication capabilities as there were no spare satellites.
• Unplanned storage might still occur on occasion due to unforeseen issues.
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Objective 1: DOD's Storage Approach and Acquisition Strategy —Contracting Considerations

- No specific DOD or service acquisition policies issued regarding how and when to contract for satellite storage.
- Air Force satellite production contracts generally did not include storage until last 5 years:
  - Program officials said they are currently negotiating long-term storage in block buys for incremental periods at fixed cost.
  - Programs studying actual storage costs from early cost reimbursement contracts to evaluate current fixed-price proposals.
  - Recent contractor proposals for storage deemed high; contract awarded without storage, which will be negotiated separately.
- Navy satellite production contract included limited long-term storage.
- Launch and On-Orbit Support contracts typically include short-term storage of 3 to 4 months to cover launch window.

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Objective 1: DOD's Storage Approach and Acquisition Strategy —Contracting Considerations, cont'd

- DCAA officials said they have not reviewed storage costs for the eight programs we reviewed.
  - Could provide insight regarding cost-reasonableness for use in evaluating other storage cost proposals.
- DCMA officials said they did not review storage cost proposals for the eight programs we reviewed.
  - DCMA does not review proposals unless requested by the program office.

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Objective 1: DOD's Storage Approach and Acquisition Strategy —Contracting Considerations, cont'd

- Current storage contracting efforts:
  - GPS-IIF program officials said they re-negotiated storage using contractor production line staff to also maintain all satellites in storage while finishing upgrades.
  - GPS-III program officials said they are negotiating storage for GPS-III space vehicle-2.
  - SBIRS program officials said they are negotiating GEO-3 storage.

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Objective 2:
DOD's Satellite Storage Costs
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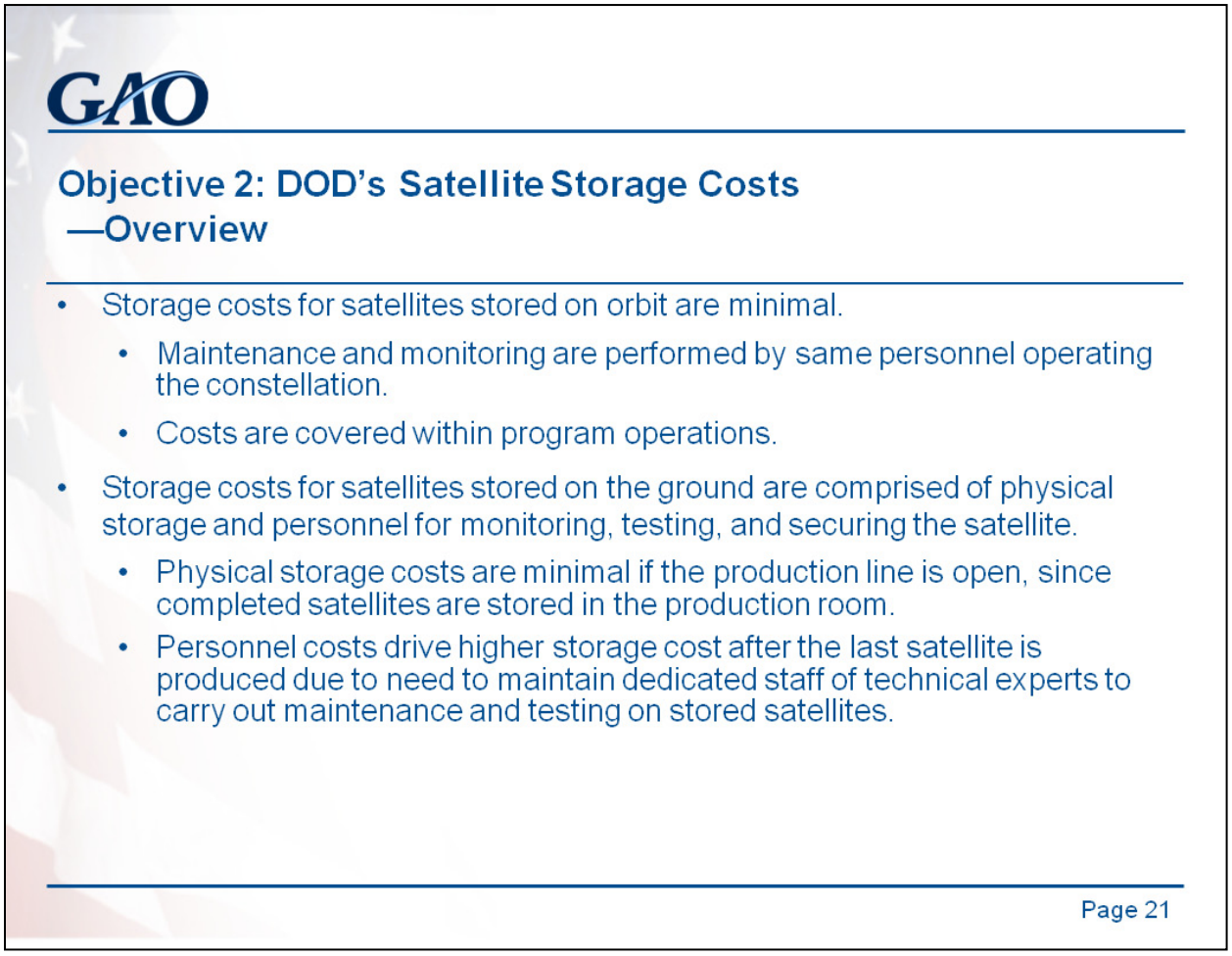
GAO
Objective 2: DOD's Satellite Storage Costs —Overview
• Storage costs for satellites stored on orbit are minimal.
• Maintenance and monitoring are performed by same personnel operating the constellation.
• Costs are covered within program operations.
• Storage costs for satellites stored on the ground are comprised of physical storage and personnel for monitoring, testing, and securing the satellite.
• Physical storage costs are minimal if the production line is open, since completed satellites are stored in the production room.
• Personnel costs drive higher storage cost after the last satellite is produced due to need to maintain dedicated staff of technical experts to carry out maintenance and testing on stored satellites.
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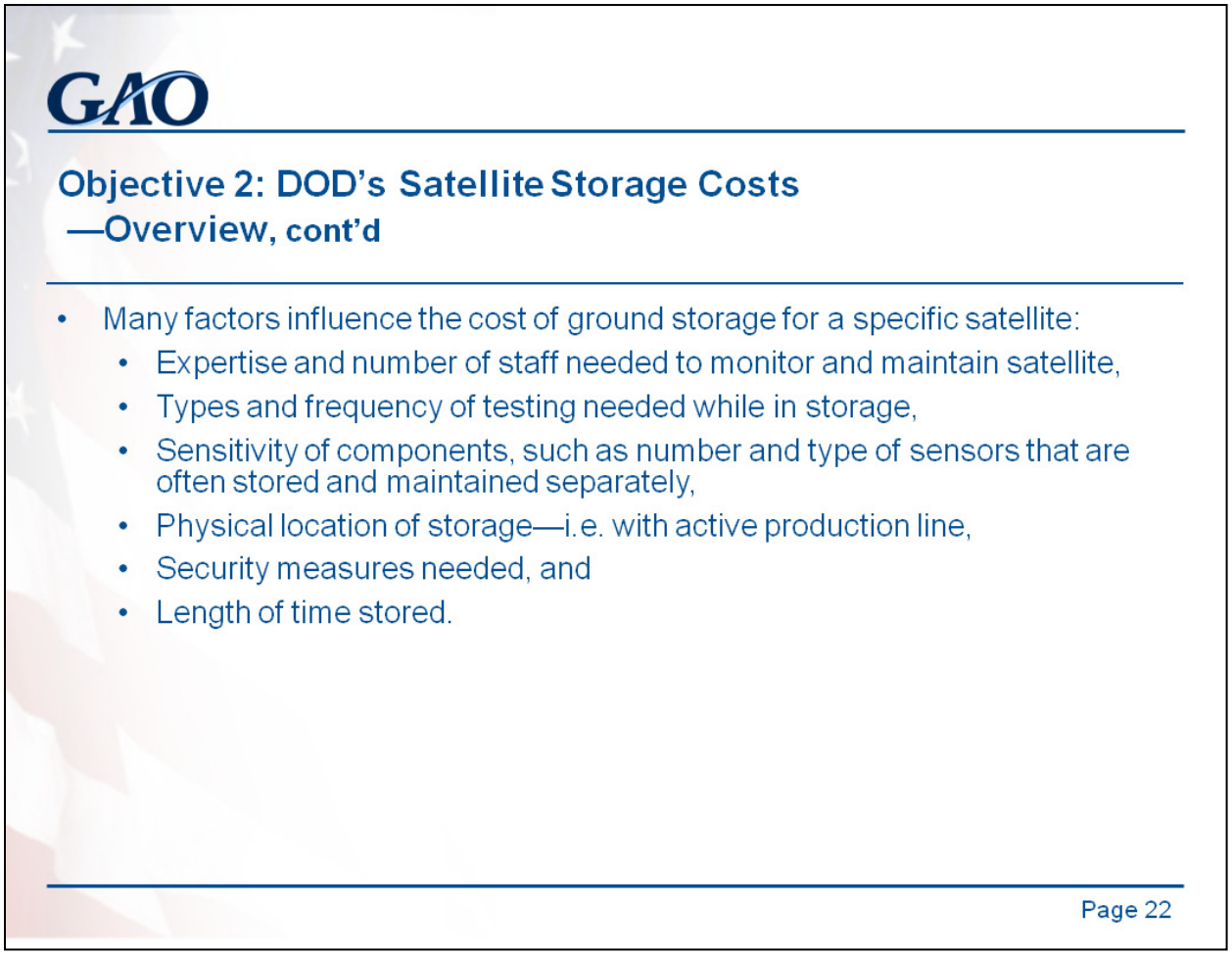
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Objective 2: DOD's Satellite Storage Costs
—Overview, cont'd
• Many factors influence the cost of ground storage for a specific satellite:
• Expertise and number of staff needed to monitor and maintain satellite,
• Types and frequency of testing needed while in storage,
• Sensitivity of components, such as number and type of sensors that are often stored and maintained separately,
• Physical location of storage—i.e. with active production line,
• Security measures needed, and
• Length of time stored.
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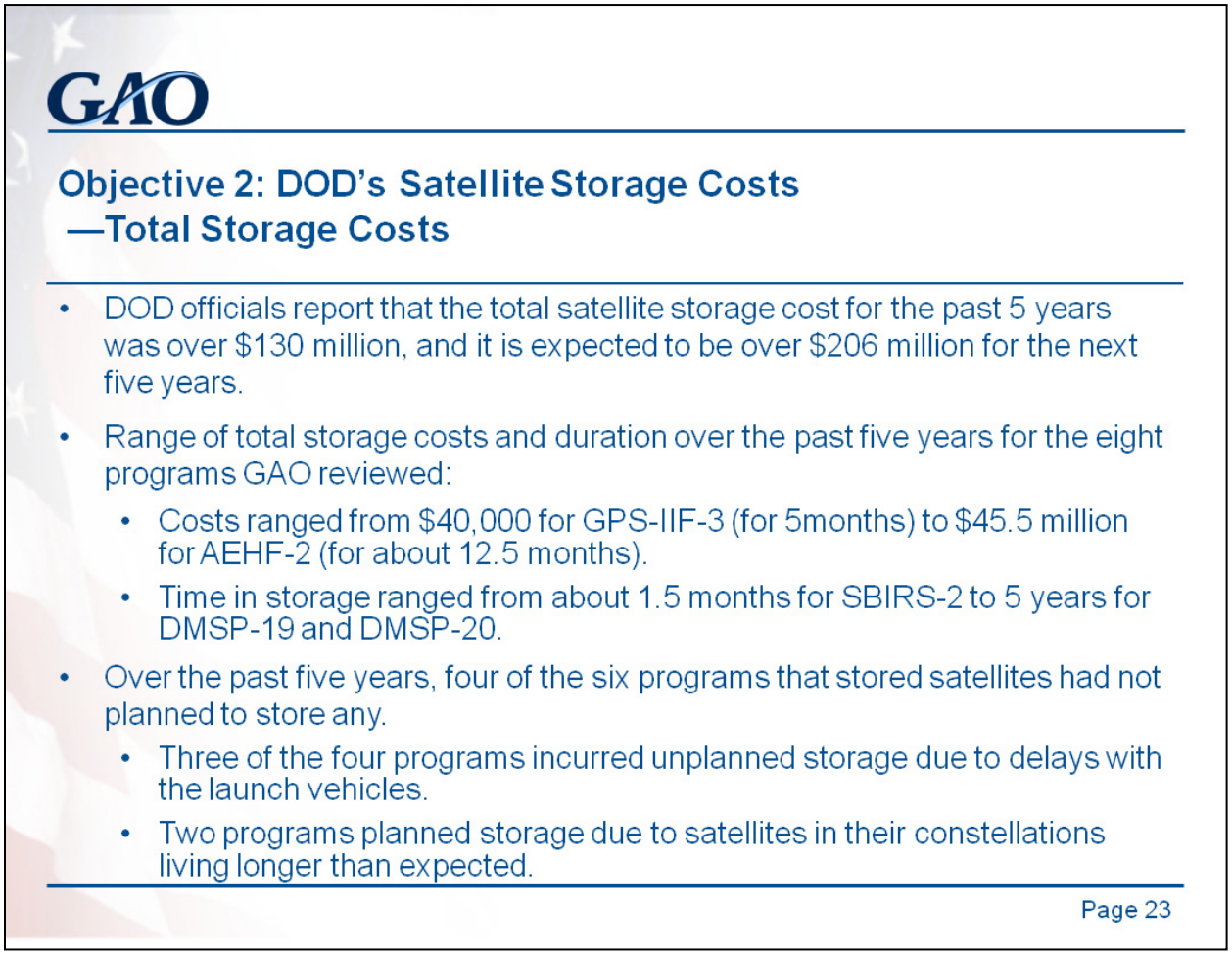
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Objective 2: DOD's Satellite Storage Costs —Total Storage Costs
• DOD officials report that the total satellite storage cost for the past 5 years was over $130 million, and it is expected to be over $206 million for the next five years.
• Range of total storage costs and duration over the past five years for the eight programs GAO reviewed:
• Costs ranged from $40,000 for GPS-IIF-3 (for 5months) to $45.5 million for AEHF-2 (for about 12.5 months).
• Time in storage ranged from about 1.5 months for SBIRS-2 to 5 years for DMSP-19 and DMSP-20.
• Over the past five years, four of the six programs that stored satellites had not planned to store any.
• Three of the four programs incurred unplanned storage due to delays with the launch vehicles.
• Two programs planned storage due to satellites in their constellations living longer than expected.
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Objective 2: DOD's Satellite Storage Costs —Reported Costs of Ground Storage for 2010 through 2014

Table 2: DOD Reported Costs of Ground Storage—2010 through 2014

Satellite program	Satellite number	Planned or unplanned storage	Time in storage (months)	Total cost (millions)
AEHF	2	unplanned	12.5	$45.5
AEHF	3	unplanned	7.5	23.4
DMSP	19	planned	60.0	0.0[a]
DMSP	20	planned	60.0	0.0[a]
GPS-IIF	3	planned	5.0	0.0[b]
GPS-IIF	4	planned	8.0	0.1
GPS-IIF	5	planned	20.0	4.3
GPS-IIF	6	planned	20.0	3.8
GPS-IIF	7	planned	21.0	3.9

Source: DOD program data; GAO calculations and presentation. | GAO-15-97R

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Objective 2: DOD's Satellite Storage Costs —Reported Costs of Ground Storage for 2010 through 2014

Table 2: DOD Reported Costs of Ground Storage—2010 through 2014, cont'd

Satellite program	Satellite number	Planned or unplanned storage	Time in storage (months)	Total cost (millions)
GPS-IIF	8	planned	19.0	$2.3
GPS-IIF	9	planned	24.0	3.8
GPS-IIF	10	planned	20.0	2.6
GPS-IIF	11	planned	18.0	1.9
GPS-IIF	12	planned	16.0	1.3
SBSS	1	unplanned	7.0	4.8
SBIRS	2	unplanned	1.5	0.0[c]
WGS	3	unplanned	12.0	28.5
WGS	5	unplanned	9.0	4.0
				Total: $130.2

Source: DOD program data; GAO calculations and presentation. | GAO-15-97R

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Notes: [a] Storage costs for DMSP satellites 19 and 20, which were being upgraded while in storage were not available.
[b] Storage cost for the third GPS-IIF satellite was $0.04 million.
[c] Storage cost for SBIRS satellite 2 was not available.

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Objective 2: DOD's Satellite Storage Costs —Expected Ground Storage Costs for 2015 through 2019

Table 3: DOD Reported Costs of Expected Ground Storage—2015 through 2019

Satellite program	Satellite number	Time in storage (months)	Total cost (millions)
DMSP	20	36.0	$120.0
GPS-IIF	10	9.0	1.6
GPS-IIF	11	14.0	3.0
GPS-IIF	12	21.0	6.0
GPS-III	2, 3, 4, 5, 6, 7, 8	28.0	2.8
MUOS	5	6.2	0.0[a]
SBIRS	3	31.0	18.7
WGS	7	3.0	5.7
WGS	9	12.0	24.0
WGS	10	12.0	24.4
			Total: $206.2

Source: DOD program data; GAO calculations and presentation. | GAO-15-97R

Note: [a]Storage for MUOS satellite 5 will be at no cost to the government.

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Objective 2: DOD's Satellite Storage Costs —Variations Among Programs for Monthly Costs

- According to DOD data across the eight programs with incurred or planned storage, the average monthly storage costs range from a low of $0.01 million on a GPS-IIF satellite to $3.64 million for an AEHF satellite.
- Examples of variations in storage costs:
  - GPS-IIF planned storage after production as predecessor satellites lifespan lasted longer than expected; ten satellites were stored with costs rising from about $8,000 per month to $213,000 per month—increasing as fewer satellites remained in storage since there was a fixed price for annual storage of all satellites regardless of number.
  - SBIRS-2 had unplanned storage for 1.5 months, during which the satellite was also upgraded, at an average of $7.7 million per month. SBIRS-3 has planned storage for 31 months at an average of $0.6 million per month not including potential upgrades.

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Objective 2: DOD's Satellite Storage Costs —Variations Among Programs, cont'd

- Storage for DMSP is unique case:
  - Satellites stored or being upgraded for more than 15 years.
  - Air Force reports no separate storage costs for past several years due to service life extension programs to upgrade the satellites.
  - DMSP-20 expected to go into storage for 36 months at $120 million.

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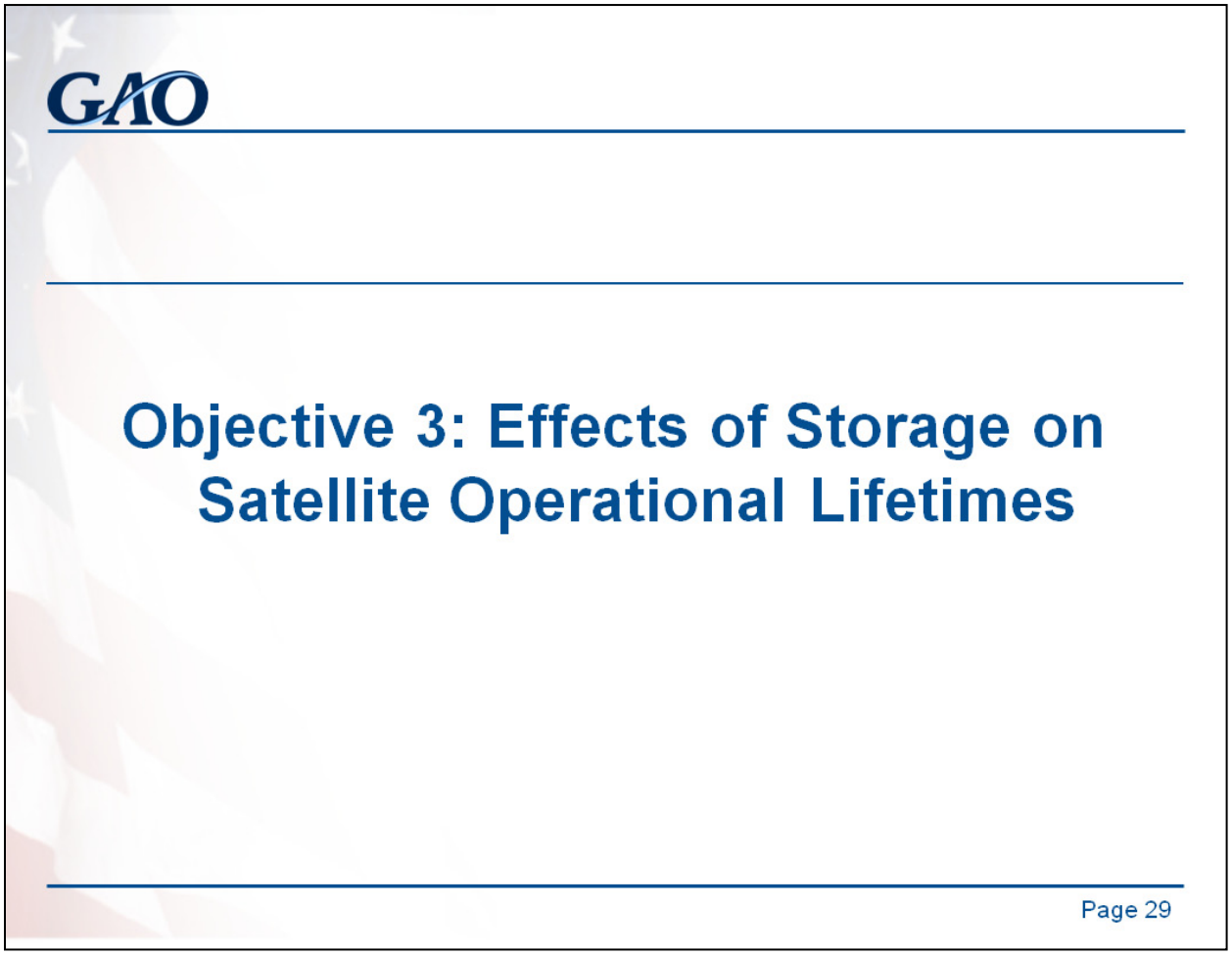
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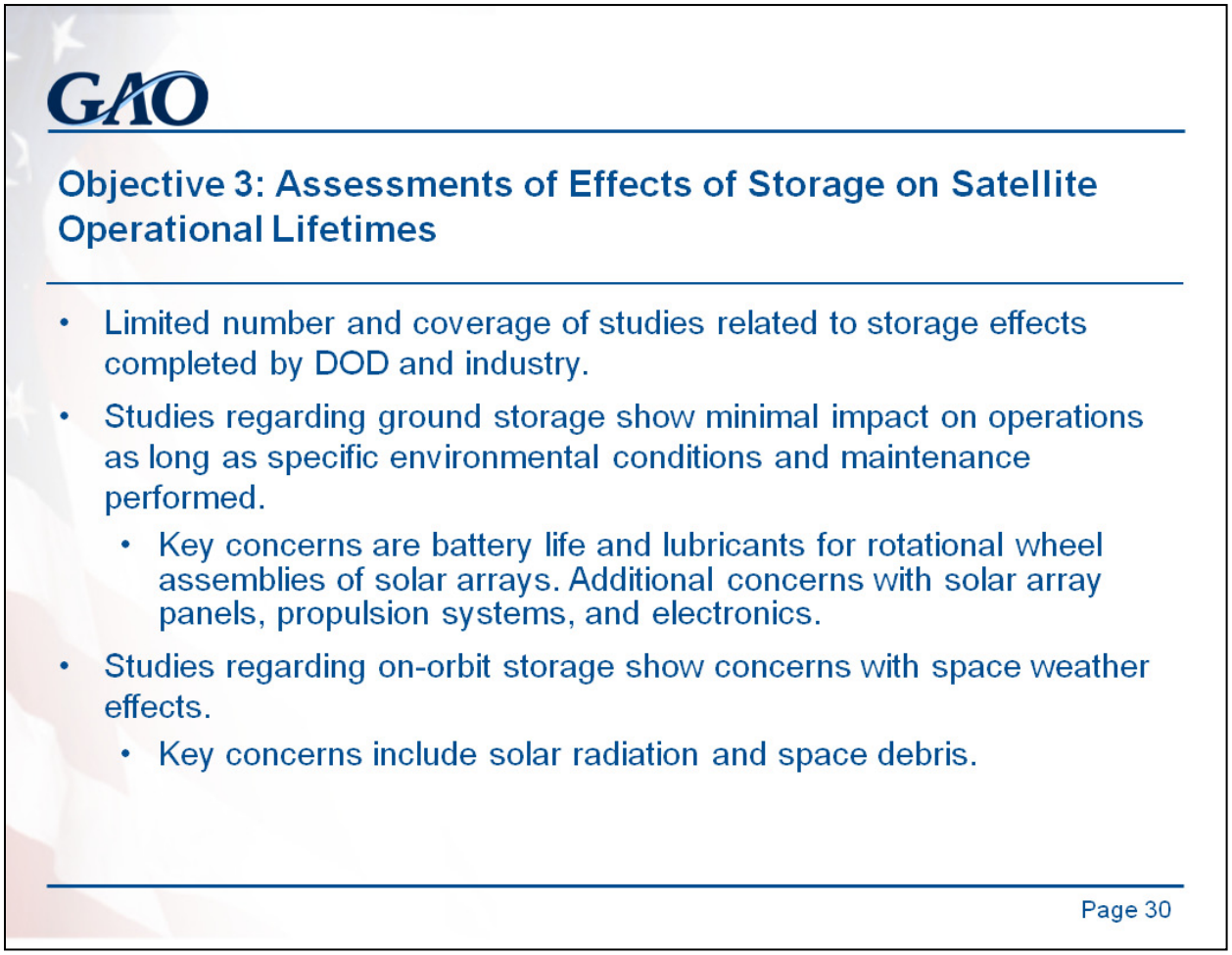
Objective 3: Effects of Storage on Satellite Operational Lifetimes
Page 29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Objective 3: Assessments of Effects of Storage on Satellite Operational Lifetimes
• Limited number and coverage of studies related to storage effects completed by DOD and industry.
• Studies regarding ground storage show minimal impact on operations as long as specific environmental conditions and maintenance performed.
• Key concerns are battery life and lubricants for rotational wheel assemblies of solar arrays. Additional concerns with solar array panels, propulsion systems, and electronics.
• Studies regarding on-orbit storage show concerns with space weather effects.
• Key concerns include solar radiation and space debris.
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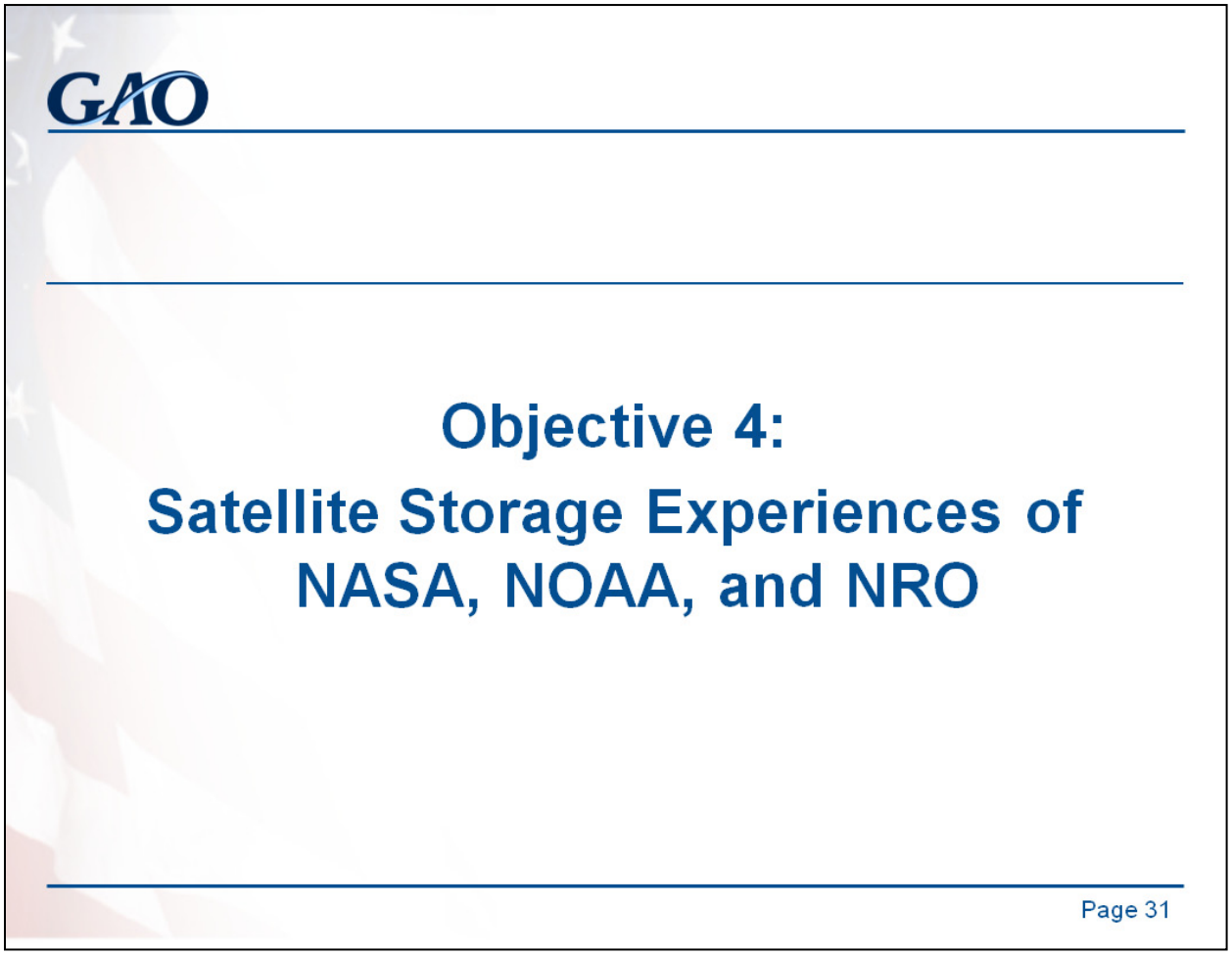
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Objective 4:
Satellite Storage Experiences of NASA, NOAA, and NRO
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Objective 4: Satellite Storage Experiences of NASA, NOAA, and NRO

- NASA generally builds and launches immediately as one-time missions.
  - One small satellite was placed in ground storage due to cancellation of its mission, according to agency officials.
    - Triana satellite stored for 10 years at total cost of about $100,000.
    - Recently re-purposed as Deep Space Climate Observatory (DSCOVR) with planned launch in early 2015.
- NOAA generally builds and launches immediately; some weather satellites are stored on orbit as spares.
  - One satellite was stored on orbit for the past 5 years, according to agency officials.
    - Geostationary Operational Environmental Satellite 14 (GOES-14), the current spare satellite, is storing on orbit at no additional cost as costs are absorbed within operations of the constellation.
    - Brought on-line periodically for testing, and on occasion for short-term use, such as Hurricane Sandy support.

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Objective 4: Satellite Storage Experiences of NASA, NOAA, and NRO, cont'd

- NRO generally builds and launches immediately; sometimes satellites are stored on ground as part of block buys to minimize production costs.
  - NRO reported that over the past 5 years satellite storage cost $105 million, and it is expected to be $90 million over the next 5 years.

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Scope and Methodology
We obtained information from the Office of the Under Secretary of Defense:
• Policy, Washington, District of Columbia
• Acquisition, Technology, and Logistics, Washington, District of Columbia
• Cost Assessment and Program Evaluation, Washington, District of Columbia
We obtained information from Air Force officials from:
• Office of the Assistant Secretary of the Air Force, Acquisition, Washington, District of Columbia
• Launch Services, Space Command, Peterson Air Force Base, Colorado Springs, Colorado
• Space and Missile Systems Center, Los Angeles Air Force Base, El Segundo, California
• Commander
• Launch Systems Directorate
• Program Offices—AEHF, DMSP, GPS-IIF, GPS-III, SBSS, SBIRS, WGS
We obtained information from Navy officials from:
• Program Executive Officer for Space Systems, Chantilly, Virginia
• MUOS Program Office, San Diego, California
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Scope and Methodology, cont'd

We obtained information from agency officials from:

- National Aeronautics and Space Administration, Washington, District of Columbia
- National Oceanic and Atmospheric Administration Washington, District of Columbia
- National Reconnaissance Office, Chantilly, Virginia
- Defense Contract Audit Agency , Denver, Colorado
- Defense Contract Management Agency, Space & Missile Sector, California

We obtained information from contractor officials from:

- Lockheed Martin Space Systems Company, Waterton, Colorado
- Boeing Space and Intelligence Systems, El Segundo, California
- Ball Aerospace & Technologies Corp., Boulder, Colorado

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Scope and Methodology, cont'd

To determine how storage factors into DOD's satellite acquisition process and strategies for reconstituting satellites:

- We interviewed DOD, Air Force, and Navy policy, acquisition, and space program officials to obtain an overview of their strategies and policies regarding the use of storage in satellite acquisition programs.
- We interviewed DOD officials from the eight satellite programs DOD identified as currently storing or planning to store satellites regarding their approach to using storage, including if it is used to aide in being able to rapidly reconstitute a satellite or constellation.

To determine DOD's satellite storage costs incurred for the past 5 years (2010-2014) and expected for the next 5 years (2015-2019):

- We obtained the storage costs incurred and planned from the eight satellite programs and discussed the facilities and activities associated with the storage time period for each satellite.
- We reviewed the associated satellite contracts to identify the contract terms and conditions related to satellite storage for each program.

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Scope and Methodology, cont'd

To determine what steps DOD has taken to assess the effects of storage on satellite operational lifetimes and the risks and benefits of storage:

- We analyzed relevant industry and government studies examining the effects of long-term storage on the components and operational lifetimes of satellites.
- We discussed the effects of satellites storage with the officials from the eight satellite programs to identify the steps DOD has taken to mitigate the potential degradation of satellite components and risks impacting the operational lifetimes.
- We interviewed contractor officials to discuss the steps taken to minimize the effects of storage on satellites and observed the facilities and selected processes.

To determine how the satellite storage experiences of NASA, NOAA, and NRO compare to those of DOD:

- We interviewed NASA, NOAA, and NRO agency officials to discuss the agency's overall strategy for using storage and the storage experienced over the past five years or planned in the next five years.

We obtained technical comments from DOD to ensure the accuracy of these slides, and incorporated changes as appropriate.

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Enclosure II: Comments from the Department of Defense

ASSISTANT SECRETARY OF DEFENSE
3600 DEFENSE PENTAGON
WASHINGTON, DC 20301-3600

ACQUISITION

Ms. Christina Chaplain
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

NOV 26 2014

Dear Ms. Chaplain:

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-15-97R, "Space Acquisitions: DOD Needs More Guidance On Decisions to Store Satellites," dated October 23, 2014 (GAO Code 121173). Detailed comments on the report recommendations are enclosed.

Sincerely,

Katharina McFarland

Enclosures:
As stated

GAO DRAFT REPORT DATED OCTOBER 23, 2014
GAO-15-97R (GAO CODE 121173)

"SPACE ACQUISITIONS: DOD NEEDS MORE GUIDANCE ON DECISIONS TO STORE SATELLITES"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

RECOMMENDATION: The GAO recommends that the Secretary of Defense provide guidance regarding when and how to use storage in the acquisition process, and establish mechanisms so that more detailed data is maintained for use in evaluating the reasonableness of contractors' storage cost proposals and informing DOD's oversight of satellite acquisitions.

DoD RESPONSE: CONCUR: The DoD agrees it is important to develop guidance regarding the use of satellite storage in the acquisition process. The DoD also agrees it is important to establish mechanisms such that more detailed data is available to evaluate storage cost proposals, as well as inform DoD's oversight of satellite acquisitions.

(121173)