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# **GLOBAL POSITIONING SYSTEM: Challenges in Sustaining and Upgrading Capabilities Persist**

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Briefing for the PNT Advisory Board  
October 15, 2010

# Congressional Requester and Objectives

- The House Subcommittee on National Security and Foreign Affairs asked GAO to:
  - Perform a follow-on review to *Global Positioning System: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities* (GAO-09-325); and
  - Address the following objectives:
    - The status of the Air Force's efforts to develop and deliver new GPS satellites, the availability of the GPS constellation, and the potential impacts on users if the constellation availability diminishes below its committed level of performance;
    - Efforts to acquire the GPS ground control and user equipment necessary to leverage GPS satellite capabilities;
    - The GPS interagency requirements process; and
    - Coordination of GPS efforts with the international PNT community.

## What GAO Found

- Best practices continue to be adopted, but the Air Force still faces challenges to launching its IIF and IIIA satellites as scheduled.
- The GPS constellation availability has improved, but a delay in the launch of GPS IIIA satellites could reduce the size of the constellation to fewer than 24 satellites.
- Multiyear delays in the development of GPS ground control systems are extensive.
- The GPS interagency requirements process remains relatively untested and civil agencies continue to find the process confusing.
- The Department of State continues to be engaged internationally in pursuit of civil signal interoperability and military signal compatibility.

# Best Practices Identified in GAO Reports that Space Programs Can Benefit From

**Table 1: Highlights of Commercial Best Practices Identified in GAO Reports That Space Programs Can Benefit From**

## During Program Development

- Use quantifiable data and demonstrable knowledge to make go/no-go decisions, covering critical facets of the program such as cost, schedule, technology readiness, design readiness, production readiness, and relationships with suppliers.
- Do not allow development to proceed until certain thresholds are met—for example, a high proportion of engineering drawings completed or production processes under statistical control.
- Empower program managers to make decisions on the direction of the program and to resolve problems and implement solutions.
- Hold program managers accountable for their choices.
- Require program managers to stay with a project to its end.
- Hold suppliers accountable to deliver high-quality parts for their product through such activities as regular supplier audits and performance evaluations of quality and delivery, among other things.
- Encourage program managers to share bad news, and encourage collaboration and communication.

Source: GAO.

(GAO-08-552T)

# Key Risks to Launching IIF and IIIA

- Key risks include:
  - Uncertainty of how the IIF will perform on-orbit and how well positioned the program is to address any on-orbit problems.
    - There is little margin to address potential on-orbit performance issues;
    - Air Force has launched the remaining IIR-M satellites; and
    - Half of the IIF satellites will be produced within almost a year of the first launch.
  - Ambitious GPS IIIA schedule that could be affected by risks, such as:
    - A 3.5 years shorter contract award period compared to the IIF;
    - Contractor to follow military standards and specifications;
    - IIIA is dependent on a ground system that will not be completed until after the first IIIA launch; and
    - No major satellite program undertaken by DOD in the past decade has met its schedule.
  - Launch delays due to launch vehicles and pad availability issues.

# Multiyear Delays in the Development of GPS Ground Control Systems

- Air Force continued to experience delays upgrading the capabilities of the current ground system and delivering the OCX ground system.
  - Key OCX capabilities associated with the IIIA satellites will not be operational until September 2016 – over 2 years after the first IIIA launch.
  - About a 10 month delay in awarding the OCX contract awarded about 10 months later than planned.
  - OCX delivery schedule extended by 16 months.

**Table 2: Delays in Delivery of New GPS Ground Segment Capabilities**

Capability enabled	Originally planned delivery date	Delivery date reported by GAO in 2009	Delay in months	Current delivery date	Delay in months
Selective Availability Anti-Spoofing Module	September 2005	September 2009	48	January 2010	52
Second civil signal	September 2007	September 2012 or 2013	60-72	August 2015	95
Military Code	September 2007	September 2012 or 2013	60-72	September 2016	108
Third civil signal	September 2007	September 2012 or 2013	60-72	September 2016	108
Fourth civil signal	May 2013	Not previously reported on	N/A	September 2016	40

Source: GAO analysis of GPS Wing data.

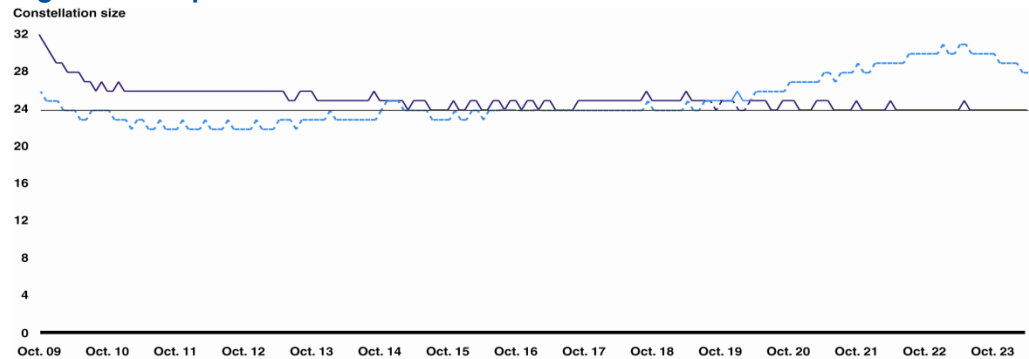
## Delays in the Development of GPS User Equipment

- No program of record for military GPS user equipment, so difficult to forecast when enough user equipment will be in place to utilize the M-code capabilities.
  - Military services will contract separately with commercial GPS providers rather than develop entirely new, customized user equipment.
  - Air Force plans to develop a common module, for commercial providers to use, along with interface control documents, to produce military user equipment.
- The development of GPS receiver cards has slipped about a year, due to technical challenges.
- DOD has taken steps to coordinate GPS segments, but these steps will unlikely ensure that all GPS segments are synchronized to the maximum extent possible.
- DOD has not established a single authority to ensure all GPS segments are synchronized, which we recommended last year.

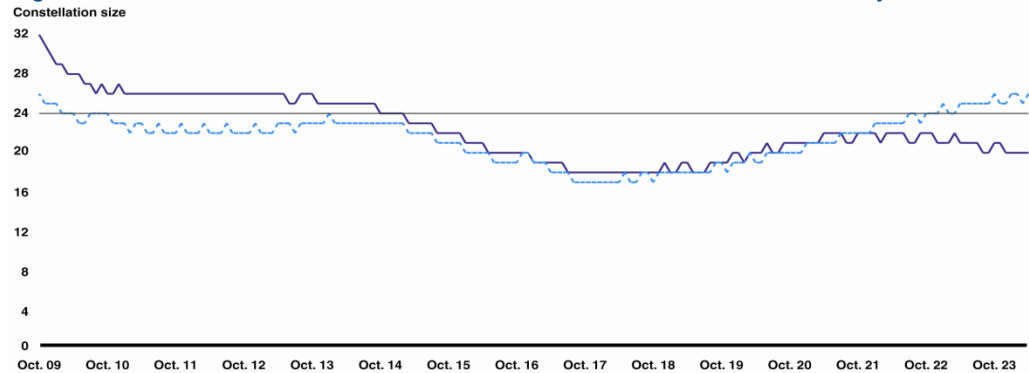
# A Delay in GPS III could affect GPS Constellation Performance

- Near-term constellation availability has shown considerable improvement since last year.
- A delay in GPS III could still affect GPS constellation availability

**Figure 1: Comparison of Predicted Size of GPS Constellation**



**Figure 2: Predicted Size of GPS Constellation Based on a 2-Year GPS III Launch Delay**



— Committed size of satellite constellation (95 percent confidence level)  
 - - - Predicted size of constellation (95 percent confidence level) - parameters approved in March 2009  
 — Predicted size of constellation (95 percent confidence level) - parameters approved in December 2009

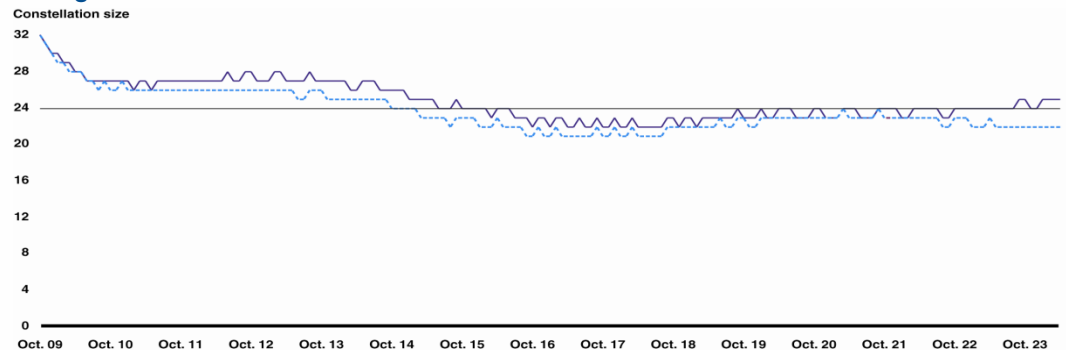
Source: GAO analysis of DOD data.



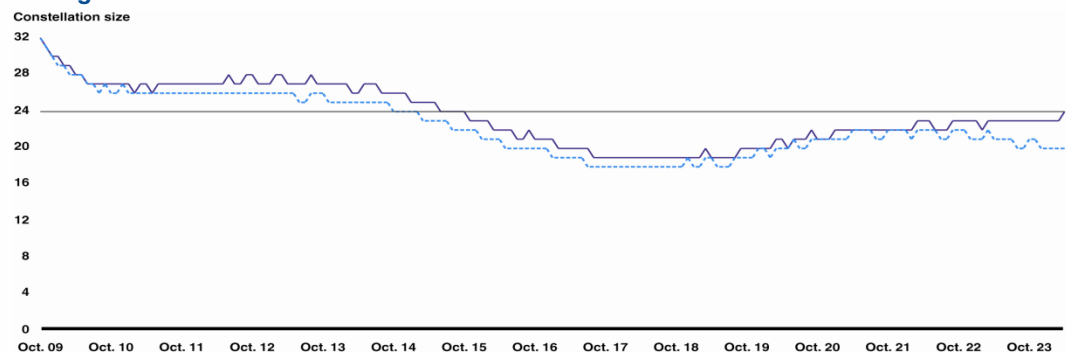
# Power Management Would Mitigate the Impact of a Delay in Launching GPS III

- Employment of power management would mitigate the impact of a delay in GPS III, but the effect would be relatively small.

**Figure 3: Predicted GPS Constellation Size Based on a 1-YR GPS III Launch Delay and Power Management**



**Figure 4: Predicted GPS Constellation Size Based on a 2-YR GPS III Launch Delay and Power Management**



— Committed size of satellite constellation (95 percent confidence level)  
 - - - Predicted size of constellation (95 percent confidence level) - current management parameters approved in December 2009  
 — Predicted size of constellation (95 percent confidence level) - power management parameters approved in December 2009

Source: GAO analysis of DOD data.

## The GPS Interagency Requirements Process Remains Relatively Untested and Confusing

- GPS interagency requirements process remains relatively untested.
  - DASS and SLR had made some progress, but no final decision on whether these requirements will be included.
- Lack of detailed guidance contributes to confusion, disagreement among agencies involved, and inconsistent implementation.
  - Explanations of key terms
  - Documentation standards
  - Approval requirements
  - Steps in the process
  - Funding
- Approach to identify civil requirements does not identify PNT needs across agencies.

## State Department Engaged in Pursuit of Civil Signal Interoperability and Military Signal Compatibility

- Coordination of GPS activities with international community continues, and some challenges have been addressed.
  - State Department officials stated that the level of DOD technical experts needed for international discussions was sufficient.
  - While European Commission has published information on licensing intellectual property rights related to Galileo, U.S. GPS industry representatives remain concerned about the lack of information from the European Commission.

## GAO Recommendations

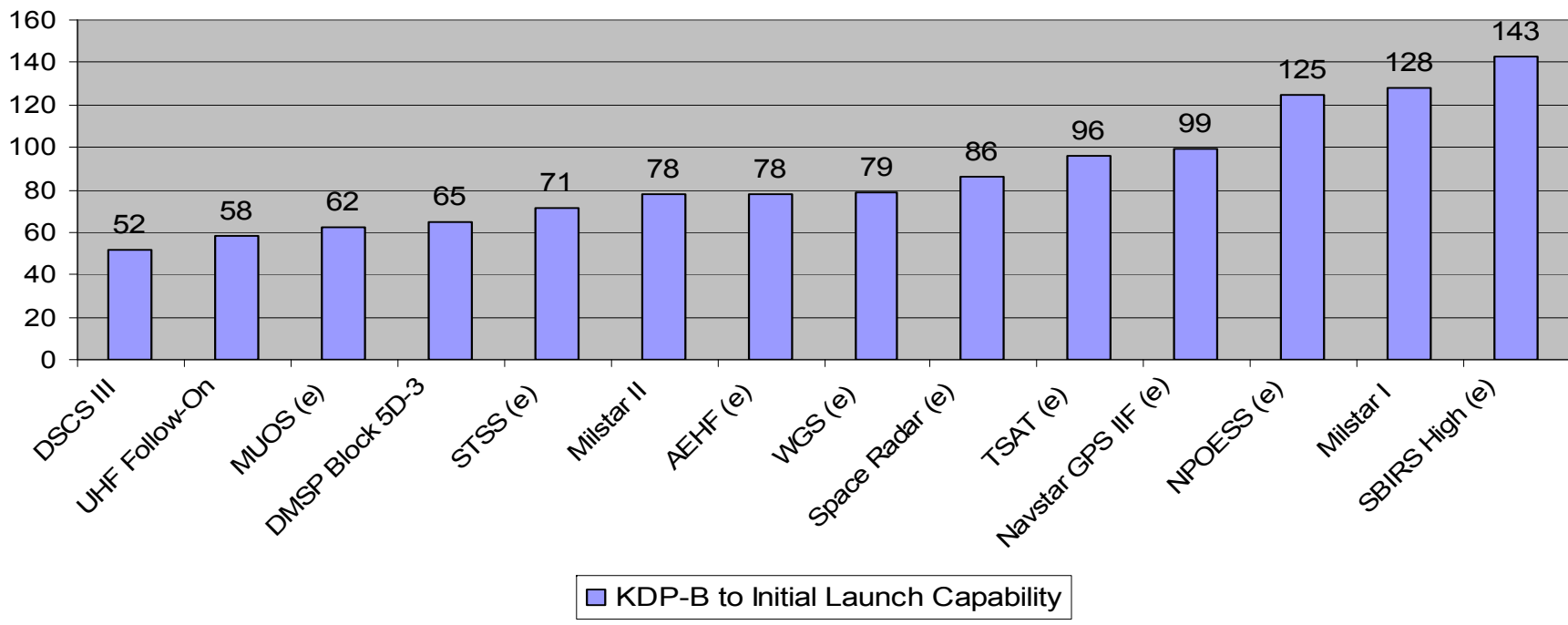
- Secretary of Defense appoint a single authority to oversee the development of GPS to ensure that the program is well executed and resourced and that potential disruptions are minimized.
- Secretaries of Defense and Transportation should develop more comprehensive guidance for the GPS interagency requirements process, including:
  - Explanation of key terms,
  - Documentation expectations,
  - Process steps,
  - Requirements approval, and
  - Funding commitments.

## Points of Contact

- For more information, contact Cristina Chaplain at 202-512-4841 or [chaplainc@gao.gov](mailto:chaplainc@gao.gov) or Art Gallegos at 303-572-7368 or [gallegosa@gao.gov](mailto:gallegosa@gao.gov).

# Back up Slide: Milestone Analysis (Key Decision Point B to Initial Launch Capability—Planned)

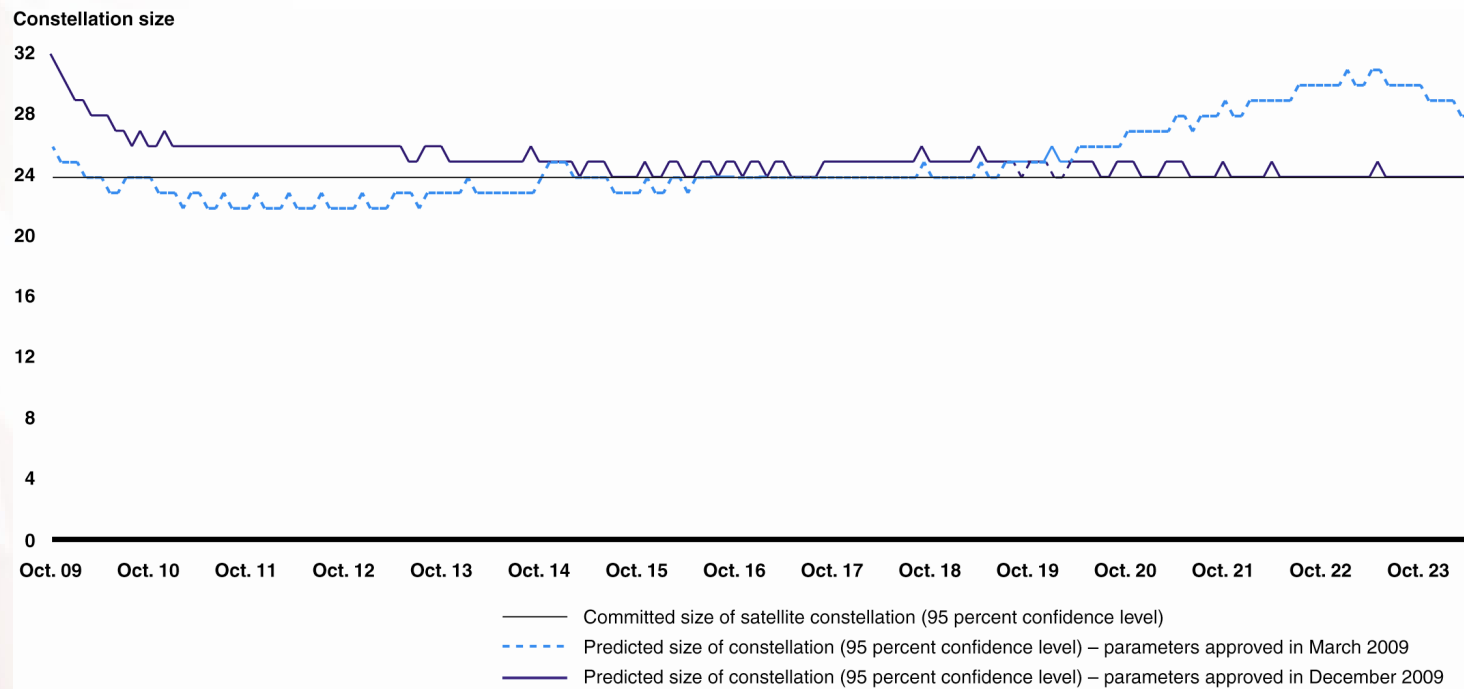
**Space program schedules from KDP-B to Initial Launch Capability (months)**



## Appendix: Methodology for Predicting Constellation Size

- To assess the availability of the GPS constellation, we conducted our own analysis based on GPS reliability data provided by the Air Force and assessed the implications of potential schedule delays. Specifically we:
  - Obtained reliability parameters from the Air Force for 79 GPS satellites—each of the 32 operational (on- orbit) satellites, 44 future GPS satellites, and 3 residual satellites—as a function of their time on orbit.
  - Obtained current launch schedule and probability of launch success from the Air Force for each unlaunched satellite.
  - Developed a Monte Carlo simulation to calculate the probability of maintaining a constellation of 24 satellites as a function of time.
  - Used this model to predict the impact of a 1-year and a 2-year slip to GPS III launch dates.

# Figure 1: Comparison of Predicted Size of GPS Constellation

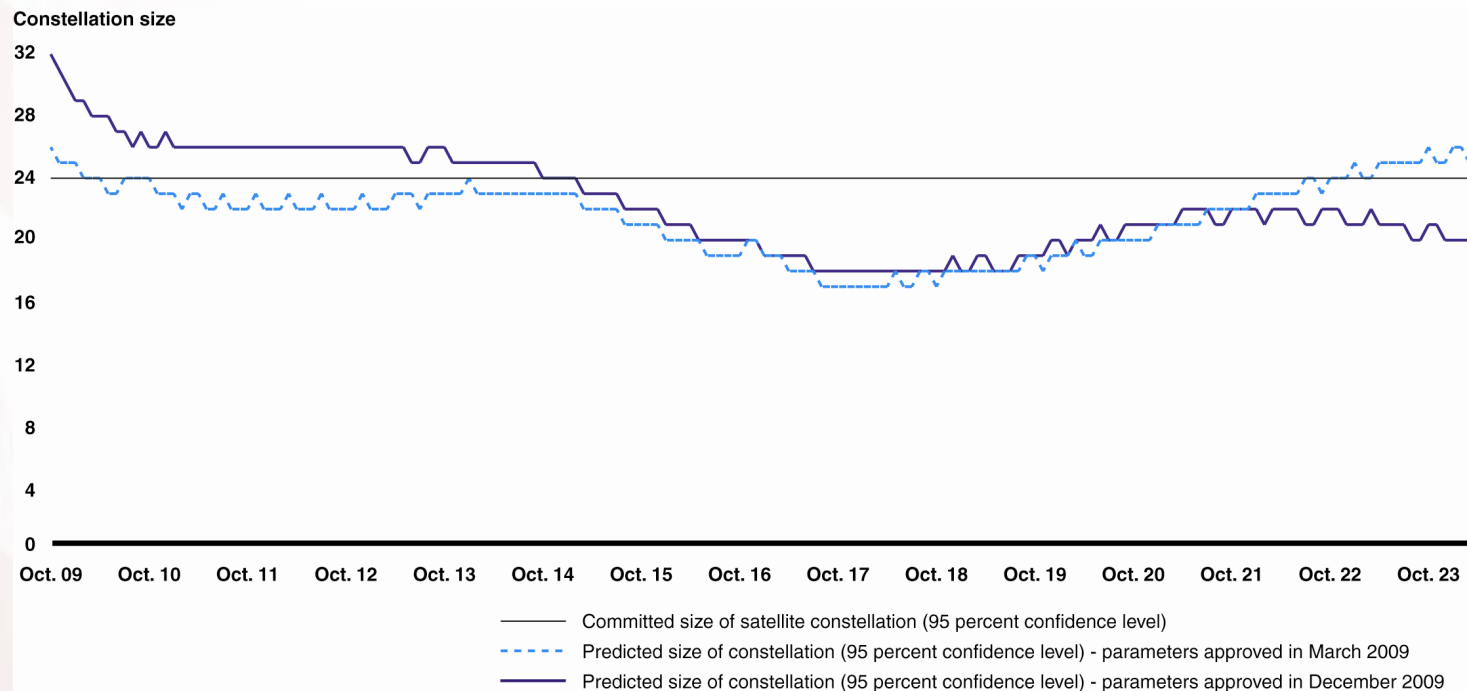


Source: GAO analysis of DOD data.

Prediction made at the 95 Percent Confidence Level and based on reliability data and launch schedules as of March 2009 and December 2009.



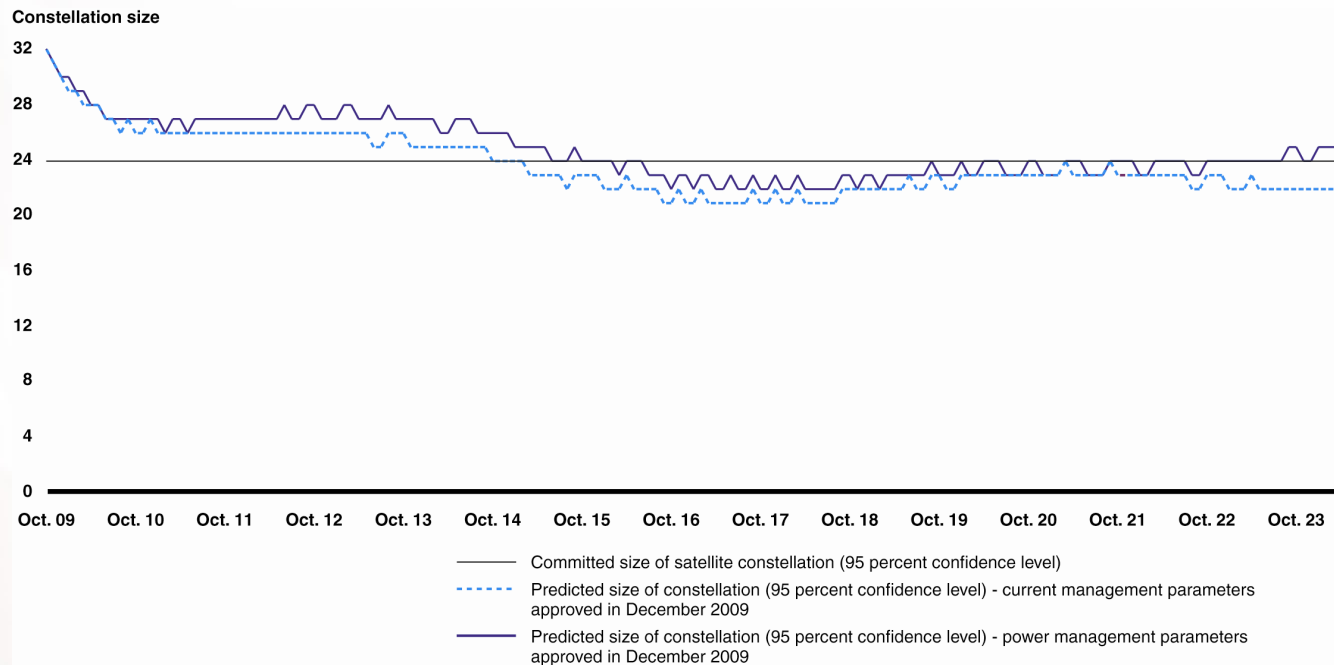
## Figure 2: Predicted Size of GPS Constellation Based on a 2-Year GPS III Launch Delay



Source: GAO analysis of DOD data.

Prediction made at the 95 Percent Confidence Level and based on reliability data and launch schedules as of March 2009 and December 2009.

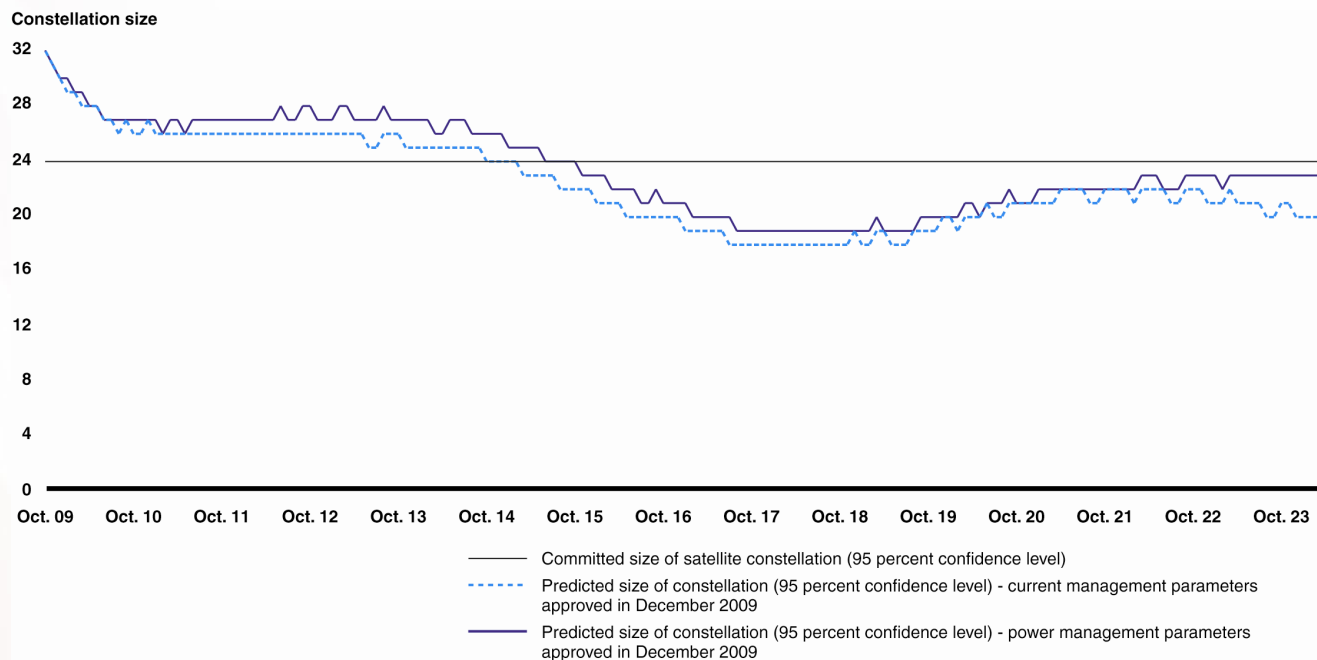
## Figure 3: Predicted Size of GPS Constellation Based on a 1-Year GPS III Launch Delay and Power Management



Source: GAO analysis of DOD data.

Prediction made at the 95 Percent Confidence Level and based on current management and power management reliability data and launch schedules as of March 2009 and December 2009.

## Figure 4: Predicted Size of GPS Constellation Based on a 2-Year GPS III Launch Delay and Power Management



Source: GAO analysis of DOD data.

Prediction made at the 95 Percent Confidence Level and based on current management and power management reliability data and launch schedules as of March 2009 and December 2009.