U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
AND THE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

HEARING CHARTER

Continuing Oversight of the Nation's Weather Satellite Programs: An Update on JPSS and GOES-R

Wednesday, June 27, 2012
2:00 PM – 4:00PM
2318 Rayburn House Office Building

<u>Purpose</u>

The National Oceanic and Atmospheric Administration's (NOAA) polar-orbiting and geostationary weather satellites are a fundamental aspect of our Nation's forecasting abilities. The purpose of this hearing is to examine the recent Government Accountability Office (GAO) reports on both weather satellite programs. The GAO reports titled *Geostationary Weather Satellites, Design Progress Made, but Schedule Uncertainty Needs to be Addressed* (GAO-12-576) and *Polar-Orbiting Environmental Satellites, Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention* (GAO-12-604) will be released at the hearing. The Committee is interested in further understanding the cost, schedule, and performance capabilities associated with NOAA's weather satellite programs.

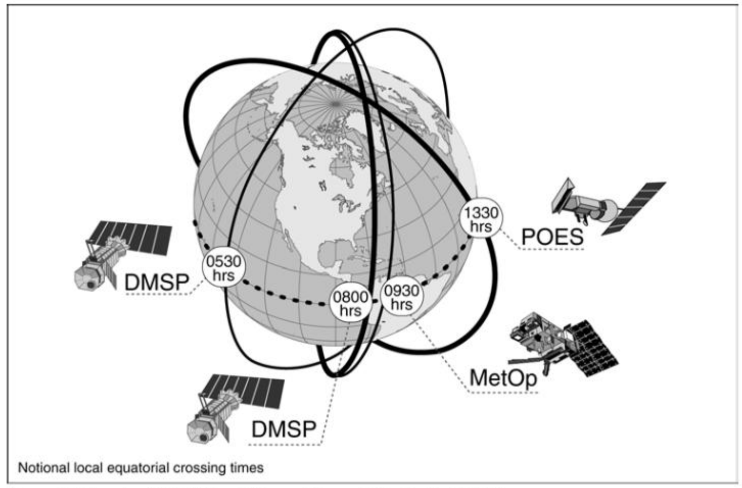
Since 2003, there have been over ten hearings before the Science, Space, and Technology Committee or its subcommittees on NOAA's weather satellites. During this time, the GAO has played an invaluable role in monitoring the program and providing regular briefings and yearly reports. Given the present austere and uncertain funding environment, the Committee believes it is important to maintain its oversight of NOAA's weather satellite programs, which the GAO has determined are at risk of exceeding cost and schedule targets.

<u>Background</u>

Types of Satellite Systems

Since the 1960s, the U.S. has operated two separate operational polar-orbiting meteorological satellite systems, the Polar-orbiting Operational Environmental Satellite (POES) managed by the National Oceanic and Atmospheric Administration (NOAA), and the Defense Meteorological Satellite Program (DMSP) satellites developed by the Air Force. Polar-orbiting satellites transverse the globe from pole to pole, with each orbit being defined by the time of day they pass over the equator: early morning, late morning, and afternoon. Unlike geostationary weather satellites that offer persistent coverage over an area, each polar-orbiting satellite makes approximately 14 orbits per day and is able to view the entire earth's surface twice per day. Currently, there is one operational POES satellite, the recently launched National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) satellite that has been renamed the Suomi National Polar-orbiting Partnership (S-NPP), two operational DMSP satellites, and a European satellite, called the Meteorological Operational (MetOp) satellite. Collectively, these satellites provide weather data to both the military services and NOAA's National Weather Service (NWS) that are normally no more than six hours old.

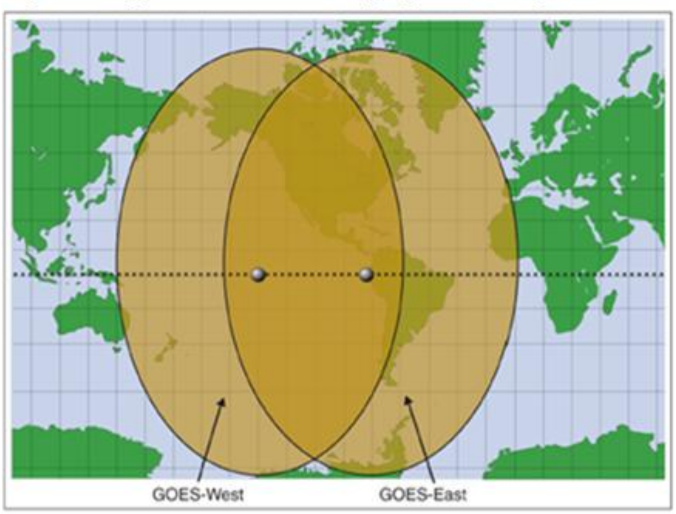
Figure 1: Configuration of Operational Polar Satellites



Sources: GAO, based on NPOESS Integrated Program Office and DOD data, MapArt (globe).

Polar-orbiting environmental satellites are equipped with an array of different sensors that collect a broad range of weather and climate data. The data is used to derive weather and climate products called environmental data records that include cloud coverage, temperature, humidity, ozone distribution, snow coverage, vegetation, sea surface temperature, sea ice and wave heights. In what has become familiar to most Americans, these environmental data records are used to produce such products as daily weather forecasts and weather prediction models.

Figure 2: Approximate GOES Geographic Coverage



Sources: NOAA (data), MapArt (map).

In addition to polar-orbiting satellites, NOAA also operates Geostationary Observational Environmental Satellites (GOES). NOAA's GOES satellites operate from a geosynchronous orbit 22,300 miles above the Earth, which means they orbit the equatorial plane of the Earth at a speed matching the Earth's rotation. This vantage point allows the satellites to essentially "hover" continuously over one position on the surface of the earth and serve as a fixed eye on the continental United States with limited coverage of the polar regions.

The GOES system operated by NOAA utilizes two satellites – one fixed on the eastern U.S. and the other on the western U.S. At any given time, the GOES system also includes a third on-orbit "spare" called into duty either as an emergency back-up to the primary satellites or naturally sequenced into operations once an older satellite's service has degraded. There has been a GOES satellite in orbit providing continuous coverage over the U.S. since 1976. Today, there are four GOES satellites in orbit – GOES-13 and GOES-15 are operational; GOES-14 is in orbit and available as a backup, while GOES-12 is nearing the end of its service life and is providing limited coverage to South America.

Polar Orbiting Satellites

National Polar-orbiting Operational Environmental Satellite System (NPOESS)

In 1994, as part of an attempt to streamline government programs, a Presidential Decision Directive required NOAA and the DOD to converge the civilian POES and military DMSP polar-orbiting satellite systems, creating one program. Originally estimated to cost $6.5 billion over 24 years, the goal was to reduce duplication, thereby saving $1.3 billion. NPOESS also offered the opportunity for NOAA and NASA to assure continuity of the climate data that both agencies were collecting, and to claim a small portion of the Peace Dividend.[1] Instead, the NPOESS program was fraught with significant inter-agency management problems, delays, inefficiencies and severe cost overruns such that in February 2010, the Office of Science and Technology Policy (OSTP) announced a fundamental reorganization of the program.

NPOESS was established in 1994 in order to design, develop, construct and launch satellites into polar orbits so that NOAA and DOD would continue to receive daily data necessary for civilian and military weather forecasting needs. To manage the program, DOD, NOAA, and NASA formed a tri-agency Integrated Program Office (IPO). Despite the operations of the IPO, each of the agencies had individual responsibilities for the program. Responsibility for the overall management of the system and satellite operations was assigned to NOAA. The DOD was responsible for acquisition of the sensors, bus, and launch vehicle, and NASA was responsible for facilitating the development and incorporation of new technologies. In order to reduce the risk involved with developing and deploying brand new sensor technologies, the program planned to launch a demonstration satellite called the NPOESS Preparatory Project (NPP) in May 2006. The idea behind NPP was to test the viability of the new sensor technology and to validate and calibrate the sensor data collected against the existing NASA, NOAA and DOD satellites prior to the launch of the first operational satellite planned for 2008.

The Science, Space, and Technology Committee began serious oversight efforts in 2003, helping to reveal major performance problems and schedule delays for the primary imaging instrument, which caused significant cost overruns, all tied to a management structure that delayed rather than fostered decisions at critical moments. At the time, the life-cycle cost for NPOESS was roughly $6.5 billion, with the first of six satellites expected to be launched in 2009.

In 2005, the growth in cost estimates exceeded statutory limits triggering a Nunn-McCurdy[2] recertification. The recertification resulted in the elimination of two satellites and removal or downgrading of sensor capabilities - decisions driven by the Pentagon. Throughout 2006, NOAA, DOD and NASA worked to realign priorities within the restructured satellite system.

[1] "NPOESS Lessons Evaluation," Aerospace Corporation, December 1, 2010.

[2] As set forth in the Memorandum of Agreement governing the NPOESS program, the Air Force managed the acquisition of the satellites. NPOESS was therefore subject to Department of Defense regulations for major defense programs. When such programs exceed approved baseline costs by more than 25 percent, recertification is required by 10 U.S.C. 2433 *et seq*.

Despite the similar goals of continuity of data and access to real-time weather information, NOAA and DOD differed when it came to climate-related sensors. NOAA wanted additional sensors; DOD did not consider these additional sensors a requirement, and they were removed as nonessential in the Nunn-McCurdy process. Only sensors that survived recertification would be equally funded by NOAA and DOD. Any additional sensors desired by NOAA required that full funding would come from NOAA's budget for development and incorporation of these climate sensors into the satellite system.

By 2009, the life-cycle estimate had grown to at least $14.9 billion for four satellites, the first of which would launch in 2014, and the DOD contracted with an Independent Review Team (IRT) to conduct an analysis of the chances of success of the NPOESS program. On June 1, 2009, the IRT issued a report with key findings about the program. The report determined that the current NPOESS program had an extraordinarily low probability of success.[3] The IRT also stated that although continuity of data was a critical priority for all agencies involved, it was at significant risk of gaps that could last for years. Finally, the IRT determined that NPOESS was being managed with cost as the most important parameter and not mission success. At a Science and Technology Committee hearing on June 17, 2009, witnesses testified before the Committee that program leadership had deteriorated to the point that only White House intervention would assure that there would ever be any NPOESS satellites at all.

Rather than trying to satisfy the needs of three agencies with one satellite design, the Administration instructed a "divergence" of the NPOESS program. Satellites flying in orbits to collect early-morning observations would be developed and launched by DOD and called the Defense Weather Satellite System (DWSS). NOAA would do the same to collect observations in the afternoon orbit. NOAA would operate all the satellites while in orbit,[4] and would manage the common data system to receive, store and share all data. The late morning orbit was completely abandoned to the Europeans; the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Polar System, which includes MetOp, is now responsible for this orbit.

JPSS

OSTP's announcement in February 2010 to split the NPOESS program included a new name for the program at NOAA, the Joint Polar Satellite System (JPSS). On March 12, 2010, OSTP issued a description of the implementation plan for the new program (see attachment A). The requirements for data to be collected did not change. NOAA will reimburse NASA to manage the JPSS program at the Goddard Space Flight Center.[5] In 2010, NOAA estimated that the life cycle costs of the JPSS program would be approximately $11.9 billion. The table below compares the planned costs, schedule and scope of the three programs over time.

Figure 3

[3] NPOESS Independent Review Team, Final Report, June 1, 2009.
[4] NOAA took on operating responsibility for Defense Meteorological Satellite Program (DMSP) satellites in 1998.
[5] It remains to be seen how effective NASA will be in managing JPSS, as GAO listed NASA Acquisition Management on its 2011 'High Risk' Series because of "persistent cost growth and schedule slippage in the majority of its major projects."

Comparison of NPOESS to JPSS					
Key Area	**NPOESS program before it was restructured (as of May 2006)**	**NPOESS program after it was restructured (as of June 2006)**	**NPOESS program prior to being disbanded (as of February 2010)**	**NOAA and DOD acquisition plans (as of May 2010)**	**Current status**
Life cycle range	1995-2020	1995-2026	1995-2026	JPSS: 1995-2024 DWSS: not determined	2012-2028 DOD: uncertain
Estimated life cycle cost	$6.4 billion	$12.5 billion	$13.95+ billion[a]	JPSS: $11.9 billion DWSS: not determined	JPSS: $12.9 billion DOD: uncertain
Number of satellites	6 (In addition to NPP)	4 (in addition to NPP)	4 (in addition to NPP)	JPSS: 2 (in addition to NPP) DWSS: 2	JPSS: 2 (in addition to NPP, and potentially 2 other free flyers) DOD: uncertain
Number of orbits	3 (early morning, midmorning, and afternoon)	2 (early morning and afternoon; would rely on European satellites for midmorning orbit data)	2 (early morning and afternoon; would rely on European satellites for midmorning orbit data)	JPSS: 1 (afternoon orbit) DWSS: 1 (early morning orbit) (European satellites would provide midmorning orbit)	JPSS: 1 (afternoon orbit) DOD: 1 (early morning orbit) (European satellites would provide midmorning orbit)
Launch schedule	NPP by OCT 2006 C1 by NOV 2009 C2 by JUN2011	NPP by January 2010 C1 by JAN 2013 C2 by JAN 2016 C3 by JAN 2018 C4 by JAN 2020	NPP no earlier than SEP 2011 C1 by MAR 2014 C2 by May 2016 C3 by JAN 2018 C4 by JAN 2020	JPSS: *NPP- no earlier than SEP 2011 *JPSS-1 by 2015 *JPSS-2 by 2018 DWSS: no earlier than 2018	JPSS: *NPP- launched OCT 2011 *JPSS-1 no later than 2Q FY2017 *JPSS-2 no later than 1Q FY2022 *Free Flyers uncertain DOD: uncertain (2 DMSP's ready for launch, follow-on needed by roughly 2026)
Number of sensors	11 sensors and 2 user service systems	NPP: 4 sensors C1: 6 sensors C2: 2 sensors C3: 6 sensors C4: 2 sensors	NPP: 5 sensors C1: 7 sensors[b] C2: 2 sensors C3: 6 sensors C4: 2 sensors	NPP: 5 sensors JPSS-1 and 2: 5 sensors[c] DWSS: 3 sensors	NPP: 5 sensors JPSS-1 and 2: 5 sensors Free flyers: uncertain DOD: uncertain

Source: GAO analysis of NOAA, DOD, and task force data (updated with NOAA data by Committee Staff)

[a] Although the program baseline was $13.5 billion in February 2010, GAO estimated in June 2009 that this cost could grow by about $1 billion. In addition, officials from the Executive Office of the President stated that they reviewed life-cycle cost estimates from DOD and the NPOESS program office of $15.1 billion and $16.45 billion, respectively.

[b] In May 2008, the NPOESS Executive Committee approved an additional sensor – the Total and Spectral Solar Irradiance Sensor – for the C1 satellite.

[c] The five sensors are ATMS, the Cloud and Earth Radiant Energy System (CERES), CrIS, OMPS, and VIIRS. NOAA also committed to finding an alternative spacecraft and launch accommodation for Total and Spectral Solar Irradiance Sensor, the Advanced Data Collection System, and the Search and Rescue Satellite-Aided Tracking System.

Following the decision to disband NPOESS, both NOAA and the DOD were directed to establish their own programs, establish requirements and transfer existing NPOESS contracts to the new programs. NOAA has established its JPSS program office but now plans to remove key requirements to keep the program within budget. The DOD established its DWSS program office but has now decided to terminate the program and reassess its requirements.

NOAA relies on NASA as the acquisition agency for its weather satellites. By 2011, NOAA and NASA had established separate but co-located JPSS program offices each with different roles and responsibilities delineated in an approved management control plan. NOAA is responsible for programmatic activities related to the JPSS satellite development, including managing requirements, budgets and interactions with the satellite data users. NASA is responsible for the development and integration of sensors, satellites and ground systems.

The joint NASA and NOAA JPSS team successfully launched the S-NPP satellite in October 2011 to provide data collection in the afternoon orbit. NOAA and NASA officials are currently working to complete the calibration and validation of the satellite's sensors by October 2013. According to the GAO, some issues have been encountered during this process that may lead to delays in developing satellite products.

JPSS will provide operational continuity of satellite-based observations and products for NOAA POES and the NASA Earth Observing System (EOS). The JPSS program includes five satellites, eight environmental sensors for weather and climate data, and a ground system for controlling the satellites and sensors in space as well as science data transmission and processing.

Figure 4: President's FY13 Budget Request ($ in millions)

	Prior	FY12	FY13	FY14	FY15	FY16	FY17	FY18-28	Total
FY13 PB Submit	3,380	924	917	956	959	944	921	3,889	12,890

Geostationary Satellites

GOES-R

The next-generation of GOES satellites, known as the GOES-R series, is currently under development. GOES-R is expected to significantly improve clarity and precision of environmental data and will be able to transmit that data at faster rates more frequently. Both improvements will enhance the quality and timeliness of information to the user.

In the original plan for the GOES-R program, NOAA estimated the life-cycle cost to be $6.2 billion for the period of 2007-2020 and an expected launch date in 2012. This would allow for the purchase of four satellites and included the development of two new major instruments, the Advanced Baseline Imager (ABI) and the Hyperspectral Environmental Suite (HES), as well as upgraded models of the space weather sensors. [6]

By September 2006, however, costs were escalating to a reported $11.4 billion. To reduce overall costs, NOAA significantly de-scoped the program by eliminating two of the four planned satellites and by cancelling the plans for the HES. The agency estimated the new program would cost $7 billion and would launch in December 2014.[7]

Once again in May 2007, NOAA changed its estimated life cycle cost to $7.67 billion – an increase of $670 million from the estimate reported not even a year prior. November 2007 brought more changes as many baseline program requirements were removed and treated as

[6] GAO, *Geostationary Weather Satellites: Design Progress made, but Schedule Uncertainty Needs to be Addressed* (GAO-12-576), June 2012, page 8.
[7] Ibid

contract options should funding allow. According to the GAO, the ABI instrument, which is designed to provide imagery and radiometric information of the Earth's surface, atmosphere and cloud cover, experienced technical issues primarily related to underestimating its design and development complexity. GAO went on to state:

> As a result, in September 2009, the program office rebaselined the cost and schedule targets of the Advanced Baseline Imager program. This increased contract costs from the most recent estimate of $375 million to $537 million, an increase of $162 million.[8]

In an effort to manage risks associated with the GOES-R program, significant capabilities were removed from ABI, which have resulted in an instrument that is significantly less capable than originally planned.

Most recently, NOAA decided to restore the program to the original four satellite procurement. Estimates for the GOES-R series now stand at $10.9 billion through 2036 – an increase of $3.2 billion over the previous cost estimate (for a two satellite system). The first of the series is currently scheduled to launch in October 2015.[9]

Figure 5: GOES-R Program Budget Profile

Prior Yrs ($M)	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FYTC	Total
2,792.9	615.6	802.0	950.8	844.7	781.7	706.3	578.7	2,787.6	10,860.3

The following table demonstrates key changes to the program since August 2006:

Figure 6: Key Changes to the GOES-R Program

	August 2006 (baseline program)	September 2006	November 2007	February 2011
Number of satellites	4	2	2	4
Instruments or instrument changes	• Advanced Baseline Imager • Geostationary Lightning Mapper • Magnetometer • Space Environmental In-Situ Suite • Solar Imaging Suite (which included the Solar Ultraviolet Imager, and Extreme Ultraviolet/X-Ray Irradiance Sensor) • Hyperspectral Environmental Suite	• Cancelled Hyperspectral Environmental Suite • De-coupled Solar Imaging Suite to the Solar Ultraviolet Imager and Extreme Ultraviolet/X-Ray Irradiance Sensor	No change	No change
Number of satellite products	81	68	34 baseline 31 optional	34 baseline 31 optional
Life cycle cost estimate (in then year dollars)	$6.2 billion—$11.4 billion (through 2034)	$7 billion (through 2028)	$7.67 billion (through 2028)	$10.9 billion (through 2036)[a]

Source: GAO analysis of NOAA data.

[8] Ibid
[9] Ibid

JPSS Issues

Development of JPSS is underway; critical decisions and milestones are pending

Despite the fact that NOAA has made considerable progress in transitioning from NPOESS to JPSS, the program still faces several challenges. For instance, "selected sensors are experiencing technical issues and the impact of these issues had not yet been determined."[10] The program also faces several uncertainties, as NOAA is planning to "upgrade selected parts of the ground system to increase availability and reliability."[11] Also, "[t]he free flyer project is still in a planning stage because NOAA has not yet decided which satellites will host the instruments or when these satellites will launch."[12] Similarly, the program has not decided on a launch vehicle, and the JPSS-1 spacecraft is on the critical path with a critical design review (CDR) coming in September 2012.[13] These challenges and uncertainties call for continued oversight to ensure program and mission success.

Lack of a Cost and Schedule Baseline

NOAA has not yet established an overall program baseline that delineates the cost, schedule, and content of the entire program.[14] Managing a program without a baseline makes it more difficult for program officials to make informed decisions, and for program overseers to understand if the program is on track to successfully deliver expected functionality on cost and schedule. Program officials acknowledge that the lack of a baseline is a risk, and they are tracking it through their risk management program. Under NASA's acquisition life cycle, a program baseline is due at a key milestone scheduled for July 2013; however NOAA plans to produce an overall program baseline by the end of 2012.[15]

NOAA has not established plans to mitigate an expected gap in satellite data continuity

At the Committee's last oversight hearing of JPSS in September of last year, GAO reported that NOAA was facing a gap in satellite data continuity. GAO is now reporting that the risk of that gap is higher today, despite NOAA receiving all of the funding it requested last year. When the NPOESS program disbanded in 2010, NOAA anticipated launching satellites in 2015 and 2018. Over the past year, NOAA made changes to the program to ensure that NPP stayed on schedule. In doing so, the launch dates for JPSS-1 and JPSS-2 have been pushed back to March 2017 and December 2022, respectively. This would leave a gap of between 17 months to three years. (See figure 7)[16]

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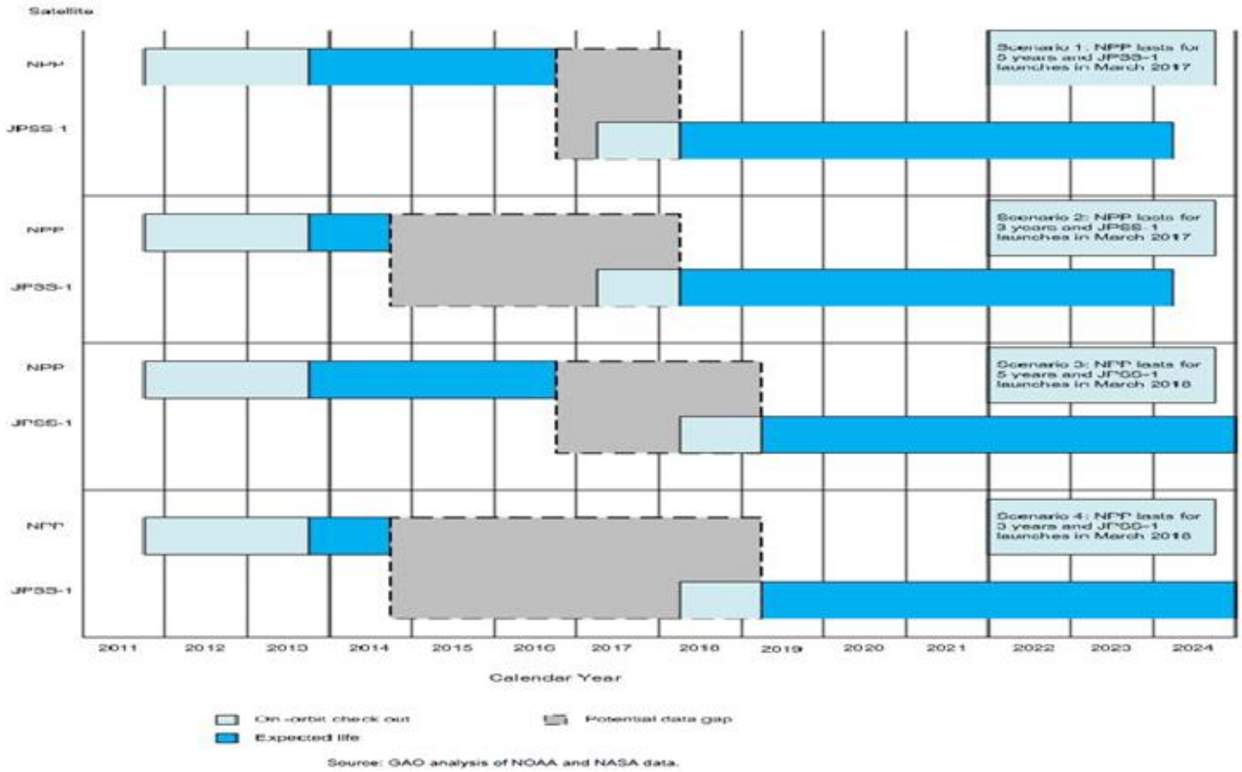
[10] GAO, *Polar-Orbiting Environmental Satellites: Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention*, GAO-12-604, June 2012, page 20.
[11] Ibid page 21
[12] Ibid page 19
[13] Ibid page 21
[14] Ibid page 23
[15] Ibid page 28
[16] Ibid page 26

Figure 7: Potential Gaps in Polar Satellite Data in the Afternoon Orbit



As stated above, the JPSS Program is working to mitigate the risks of a lack of a cost and schedule baseline, however, "NOAA has not established mitigation plans to address the risk of a gap in the afternoon orbit or potential satellite data gaps in the DOD and European polar satellite programs, which provide supplementary information to NOAA forecasts." As a result, GAO's JPSS report found that, "[b]ecause it could take time to adapt ground systems to receive alternative satellites' data, delays in establishing mitigation plans could leave the agency little time to leverage its alternatives."[17]

One of the main reasons the Administration has argued for full funding of the program is because of its importance to severe weather forecasting. Time and time again, the Administration indicated that insufficient funding would ensure a gap in data, which would in turn adversely affect the Nation's ability to predict extreme events such as "Snowmaggedon."[18] Even though NOAA received all of the funding it requested last year, the program's expected gap in coverage has grown. Despite NOAA's frequent warnings last year of a gap in data coverage, and their position that any gap could put lives, property, and critical infrastructure in danger, "the agency has not established plans to mitigate the gap."[19]

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[17] Ibid page 23

[18] Freedman, Andrew, "NOAA warns weather forecasts will suffer from budget cuts," Washington Post, March 31, 2011.

[19] See *supra* 10 page 27

GAO's report addresses this issue by stating, "[u]ntil NOAA identifies its mitigation options, it may miss opportunities to leverage alternative satellite data sources. Moreover, until NOAA establishes mitigation plans for a satellite data gap, it runs the risk of not being able to fulfill its mission of providing weather forecasts to protect lives, property, and commerce."[20] While NOAA has indicated that they will continue to use existing POES satellites as long as they can, and that there is no viable alternative to the JPSS program, GAO's report states that "it is possible that other government, commercial, or international satellites could supplement the data," but that it would take time to adapt NOAA systems to receive, process, and disseminate the data, "and that "[u]ntil NOAA identifies these options, it may miss opportunities to leverage these satellite data sources." [21]

NOAA has not established plans to mitigate the risk that the polar satellite constellation is becoming increasingly unreliable

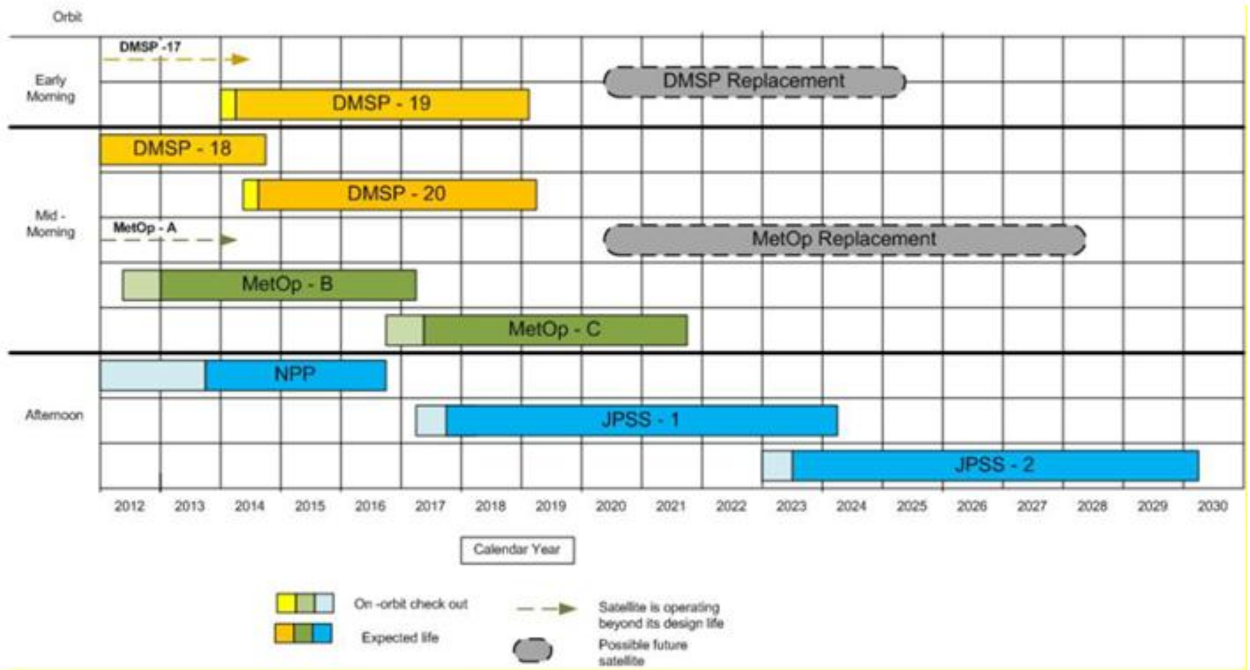
As mentioned in the background section, NPOESS was designed to operate a constellation of satellites in three separate orbits (early morning, midmorning, and afternoon) so that measurements are no more than six hours old. After the Nunn-McCurdy restructuring in 2006, the program decided to rely on the European satellites for the midmorning data, and after the 2010 divergence, the program decided to rely on DOD to provide the early morning data. (It is worth noting that the European and DOD satellites will likely not fly the same instruments or collect the same data as NOAA will with the JPSS program. With respect to the early morning orbit, the National Weather Service (NWS) uses very little data from DMSP for numerical predictions, and the DOD has no plans for a follow-on program at the moment.) With regard to the entire constellation, and not just NOAA's portion, GAO reports, "recent events have made the future of this constellation uncertain."[22] GAO assessed this situation based on the following findings.

- NOAA is facing a potential gap in the afternoon orbit of between 17 and 53 months.[23]
- DOD terminated the DWSS program in early FY12. While it is developing plans for a follow-on program, "there are considerable challenges in ensuring a new program is in place and integrated with existing ground systems and data networks in time to avoid a gap in this orbit."[24] DOD does have two satellites in storage available for launch when needed; however, "civilian and military satellite experts have expressed concern that the DMSP satellites are quite old and may not work as intended," which could lead to a gap in this orbit as early as 2014.[25]
- For the mid morning orbit, NOAA will continue to rely on the European MetOp satellites which Eumetsat plans to launch until 2021. After that, the Europeans are proposing a follow-on program called Eumetsat Polar System-2nd Generation. In 2011, NOAA informed European officials that "due to the constrained budgetary environment, they will no longer be able to provide sensors for the follow-on program." As GAO states in

[20] See *supra* 10 page 27
[21] Ibid
[22] Ibid
[23] See *supra* 10 page 28
[24] Ibid
[25] Ibid

its report, "[d]ue to the uncertainty surrounding the program, there is a chance that the first European follow-on satellite will not be ready in time to replace MetOp at the end of its expected life. In that case, this orbit, too, would be in jeopardy."[26]

Figure 8: Polar Satellite Constellation



Source: GAO analysis of NOAA, NASA, and DOD data.

DOD and the Early Morning Orbit

The now defunct NPOESS program was first conceived of as a way to create synergies, reduce duplication, and find efficiencies between the separate polar orbiting weather satellites being developed, acquired, and operated by DOD and NOAA. As history has shown, the experiment failed miserably. Despite this failure, the DOD and NOAA still incorporate data from each other's current operational systems. NOAA and the NWS use data and imagery from the DMSP satellites, particularly to assist in the imaging of Alaska and other regions not covered continuously by the GOES system, and to get additional data beyond what is provided by the POES satellites. Similarly, the DOD receives data from the POES satellite to complement data derived from the DMSP satellites. DOD also uses NOAA ground stations.

After the initial divergence of the polar-orbiting programs, DOD initiated the DWSS program. The Administration eventually cancelled the program altogether in early 2012. DOD is not under the same schedule pressure as NOAA, and it is not facing a similar gap in coverage, as they have two DMSP satellites already built and waiting to launch when needed. Concerns have been raised, however, about the reliability of the DMSP satellites that have not been launched,

[26] Ibid

because the longer they sit in storage, the less confidence managers have that they will meet their expected operation capability when launched.[27]

Despite the divergence, NOAA and DOD interests are still related. The program decisions that each agency makes will have a direct impact on not only the other agency's system, but also the Nation's weather monitoring and forecasting capabilities as a whole. What instruments DOD decides to procure not only has a direct impact on what data NOAA can use to supplement its own data, but also the costs of sensor acquisition for future satellites, as well as risk reduction. Additionally, continued coordination is required to be able to receive and use data from each system in a meaningful manner that maximizes the full potential of each sensor and satellite.

Finally, as GAO mentioned in its JPSS report, the health of the entire polar-orbiting constellation is at risk,[28] and a contributor to this risk is the uncertainty associated with the DOD's program.

Cost Growth

From January to December 2011, NOAA conducted an independent cost estimate and validated that the cost of the full set of JPSS functions from FY12 through FY28 would be $11.3 billion. After adding sunk costs of $3.3 billion, the program's life cycle estimate totaled $14.6 billion. This amount is $2.7 billion higher than the $11.9 billion estimate for JPSS after the divergence in 2010 due to a program extension of four years, the addition of free flyers, cost growth associated with transitioning contracts from DOD to NOAA, and the program's decision to delay work because of budget uncertainties in 2011.[29]

Cost Cap

The President's FY13 budget proposal to Congress included a lifecycle cost cap for the JPSS program. This cost cap for the program is separate from the baseline reporting requirements outlined in statute.[30] It is also worth noting that despite assurances from the Administration, this cost cap can be breached simply with a new budget proposal, or OMB approval. In its analysis, GAO notes that the $12.9 billion life cycle cost cap is $1.7 billion below the independent cost estimate conducted last year.[31] How that shortfall is addressed is a key concern, as it could mean the descoping of sensors, diminished capabilities, a schedule slip, or a cost increase.

Free Flyers

One of the largest uncertainties associated with the current JPSS program is what NOAA plans to do with the Free Fliers - those satellites and sensors not associated with JPSS-1 or JPSS-2, but originally part of the NPOESS program. These free flyers are included in the JPSS program budget and the life cycle cost cap, but it is uncertain what the exact manifests will be, what the

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[27] See *supra* 10, page 28
[28] See *supra* 10, page 29
[29] See *supra* 10 page 13
[30] P.L. 109-155, P.L. 110-161, and P.L. 112-55
[31] See *supra* 10 page 18

cost estimates will be for the bus or ride share contribution, what the sensor development or launch schedule is, what launch vehicle NOAA will use, or what mission they will "share."

Many of the sensors and instruments that are being considered for this portion of the program are subject to international agreements. The SARR and SARP instruments are part of the international Cospas-Sarsat system designed to detect and locate Emergency Locator Transmitters (ELTs), Emergency Position-Indicating Radio Beacons (EPIRBs), and Personal Locator Beacons (PLBs). These instruments are provided by France and Canada and are scheduled for delivery in January of 2015, even though one component of the system is five months late. A-DCS provides worldwide in-situ environmental data collection and Doppler-derived location service with the basic objective of studying and protecting the Earth environment. This system was developed by the French and is expected to be delivered in May 2013. Additionally, TSIS TIM and TSIS SIM are also being considered for free flyers. The TSIS instruments are environmental sensors that measure the solar radiation striking the Earth. TSIS was originally demanifested as part of the Nunn-McCurdy process, reinstated by the Bush Administration two years later, demanifested again with the Obama Administration's decision to break up the NPOESS program, and restarted again in last year's budget submission.

The uncertainty associated with the free flyer program complicates the definition of requirements for the entire program, which in turn calls into question cost estimates as well as schedule milestones. Until the free flyer portion of the program is further defined it could pose a significant risk to the overall program. With the Administration capping the overall cost of the program at $12.9 billion, and a gap in coverage limiting schedule flexibility, few options exist for program managers to react to unforeseen problems. The descoping or demanifesting of sensors from the free flyer portion of the program may be one of those few options.

Restoration of Climate Sensors

NOAA priorities for JPSS lean heavily towards the continuity of weather observations. This includes continuing mission operations and ground system sustainment for S-NPP; launching JPSS-1 as early as possible; flying CrIS and ATMS on JPSS-1 and JPSS-2, launching JPSS-2 no later than the first quarter of 2022; and flying VIIRS on JPSS-1 and JPSS-2. The next priority NOAA has is meeting its obligation to not exceed the life cycle cost cap of $12.9 billion. NOAA prioritizes all other mission needs after those two elements. NOAA defines other mission requirements as the accommodation of A-DCS by the first quarter of 2017; the accommodation of TSIS as soon as possible, but no later than the first quarter of 2015; flying CERES on JPSS-1; and flying an OMPS-Nadir capability on JPSS-1 and JPSS-2. TSIS, CERES, and OMPS are climate sensors. A-DCS is an environmental data collection sensor supplied by France. Collectively, the Administration's FY2013 budget request for climate sensors is $17 million in 2013 and $203 million over the life of the program (See figure 9). The $12.9 billion life cycle cost cap reflects the initial $11.9 billion lifecycle cost cap adjusted for four years of additional operations and the inclusion of the Restoration of Climate Sensor Programs into JPSS.

Figure 9. President's FY13 Budget Request ($ in millions)

	Prior	FY12	FY13	FY14	FY15	FY16	FY17	FY18-28	Total
JPSS	3,380	924	900	900	900	900	900	3,883	12,687
Climate			17	56	59	44	21	6	203
FY13 PB Submit	3,380	924	917	956	959	944	921	3,889	12,890

Senate Proposal to Move NOAA Satellite Programs to NASA

The Senate Appropriations Committee, in their FY13 appropriations bill funding NOAA and NASA, has created a new budget account at NASA called Operational Satellite Acquisition. The Senate proposal recommends transferring $1.64 billion from NOAA to NASA for the procurement of operational weather satellites. While the funding level for the four satellite programs matches the Administration's FY13 request the transition of funding from NOAA to NASA effectively ends NOAA's management of its satellite acquisitions. The following chart depicts the Senate's proposed budget for each of the affected satellite programs.

Figure 10: NOAA Satellite Funding

Satellite	Funding (in millions)
GOES-R Series	$746.7
JPSS	$842
Deep Space Climate Observatory	$30
Jason-3 altimetry mission	$22.3
Total	**$1,641**

Although NASA already is the acquisition agency for NOAA's operational satellites, the Senate proposal directs NASA to work with NOAA to incorporate NOAA's operational requirements, reduce the overall life-cycle costs of the satellite programs and transfer the satellites to NOAA once they are launched and have completed all system checks. The Senate Appropriations Committee estimates the transfer will result in a savings of $117 million in FY13.

Senator Barbara Mikulski**,** chairwoman of the Senate Appropriations Commerce, Justice, State, subcommittee, said, "Unfortunately, the Committee has lost confidence in NOAA's ability to control procurement costs or articulate reliable funding profiles. Therefore, we have taken the unprecedented step of transferring responsibility for building our Nation's operational weather satellites from NOAA to NASA,"[32]

The Administration has yet to issue an official Statement of Administration Policy (SAP) to Congress.

[32] Chamberlain, Kenneth, "NASA Budget Would Be More of the Same… on the Surface," National Journal, May 18, 2012.

GOES-R Issues

Milestones

In 2007, NOAA developed the GOES-R management control plan which outlined schedules for the preliminary design review (PDR) and the critical design review (CDR) - two important steps in the development and acquisition of a program. The management control plan indicated that the flight project's PDR was to take place in April of 2010, and the CDR was to take place in July 2010. Similarly, the ground projects PDR was scheduled for July 2010 and the CDR was scheduled for July 2011. While the program has demonstrated progress towards completing its design, having completed the program PDR and working toward the program CDR later this summer, no aspect of the program (flight, ground, and program) completed their PDRs on time. While some portions were as much as 17 months late, "NOAA still expects to meet an October 2015 launch date for the first satellite in the series by utilizing planned schedule reserves."[33]

Technical Challenges Remain for Flight Segment

Despite considerable progress on the flight portion of the program, GAO's report highlights that, "each of the instruments and the spacecraft has recently encountered technical challenges." While NOAA has worked to address many of these challenges, some remain, such as signal blurring on the Advanced Baseline Imager's infrared channels and Geostationary Lightning Mapper emissions that are exceeding specifications.[34]

Ground Requirements and Schedule Issues Led to Revised Development Plan

In early 2011, NOAA discovered that the "software design requirements had not progressed enough to conduct the ground system's preliminary design review."[35] GAO's report found that the "ground system's development schedule included software deliveries from flight project instruments that were not properly integrated."[36] In order to address these problems, NOAA significantly revised the Core Ground System's baseline development plan and schedule by modifying its software development delivery plans. This change will result in a cost increase of $85 million.[37] Similarly, the program has cancelled a Core Ground System contract option worth approximately $50 million that was previously part of its original baseline. NOAA has indicated that this work could be done in-house after GOES-R is launched, but it has no plan in place to do so.[38]

Rising Costs and Depleting Reserves

Although NOAA has not changed its program cost estimates for the development of GOES-R and GOES-S, contact costs for the instruments, spacecraft, and ground system are rising.

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[33] See *supra* 6 page 16.
[34] See *supra* 6 page 17
[35] See *supra* 6 page 18
[36] Ibid
[37] Ibid
[38] See *supra* 6 page 19

Specifically, contractor estimated costs for flight and ground project components grew by $757 million, or 32 percent between January 2010 and January 2012, with the majority of the increases occurring in the last year. (See figure 8)[39] This has directly impacted program reserves. As GAO's report points out, between January 2009 and January 2012, the program reported that its reserves fell from 1.7 billion to 1.2 billion, a roughly 30 percent reduction.[40]

Figure 11: Growth in Estimated Contract Cost for Major Program Components

Major Components	Original contract award date	Percent complete (Nov 2011)	Contractor estimate at completion (Jan 2010)[a]	Contractor estimate at completion (Jan 2011)[a]	Contractor estimate at completion (Jan 2012)[a]	2 year change (SM)	2 year change (%)
Advanced Baseline Imager	Sep 2004	83%	$524M	$581M	$672M	+$148M	+28%
Space Environmental In-Situ Suite	Aug 2006	54%	69	81	97	+28	+41%
Extreme Ultraviolet/ X-Ray Irradiance Sensor	Aug 2007	58%	72	81	81	+9	+13%
Solar Ultraviolet Imager	Sep 2007	62%	139	168	182	+43	+31%
Geostationary Lightning Mapper	Dec 2007	57%	157	209	252	+95	+61%
Spacecraft	Dec 2008	32%	711	743	862	+151	+21%
Core Ground System	May 2009	29%	704	792	976	+272	+39%
Antennas	July 2010	37%	Not applicable[b]	119	130	+11[c]	+9%
Totals			**2,376**	**2,774**	**3,252**	**+757[c]**	**+32%[c]**

Sources: GAO analysis of NOAA and contractor-reported data.

[a] Contractor reported most likely estimate at completion.

[b] The antenna contract was not awarded until July 2010.

[c] Total 2-year change includes the 1-year change in antenna contract costs.

This is cause for concern because "about two-thirds of the development remains for the program's two most expensive components - the spacecraft and the Core Ground System."[41] Because of this concern, "the program's independent review board recently raised questions about the sufficiency of the program's near-term remaining reserves."[42] NOAA maintains that its reserves are within acceptable thresholds based on planned remaining development costs, however the program is now entering a phase in its program when cost and schedule growth are common. Furthermore, as GAO points out, "While the program may be within accepted levels as of February 2012, the reserves may not be matched to remaining development. Although the program restored two satellites to its budget baseline in February 2011, thereby adding approximately $3.2 billion to its total budget, it did not correspondingly change its program reserves. As a result, GAO states, "there is limited assurance that the reserves are appropriate for each satellite's remaining development."[43]

Integrated Master Schedule and Some Subordinate Schedules are Unreliable - Could Impact Launch Schedule

GAO explains the importance of having accurate and up to date schedules in its report by stating,

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[39] See *supra* 6 page 20
[40] See *supra* 6 page 22
[41] Ibid
[42] See *supra* 6 page 23
[43] See *supra* 6 page 24

> "[t]he success in management of a large-scale program depends in part on having an integrated and reliable schedule that defines, among other things, when work activities and milestone events will occur, how long they will take, and how they are related to one another. Without such a schedule, program milestone may slip.[44]

In its findings, GAO concluded that, "[w]hile the GOES-R program has adopted certain scheduling best practices at both the program-wide and contractor levels, unresolved weaknesses also exist, some of which have contributed to current program milestone delays and a re-plan of the Core Ground System's schedule."[45] Similarly, GAO also stated that, "[w]ithout a proper understanding of current program status that a reliable schedule provides, managing the risks of the GOES-R program becomes more difficult and may result in potential delays in GOES-R's launch date."[46]

Although GOES-R has an Integrated Master Schedule (IMS) that is created manually once a month directly from contractor schedules, GAO believes that a dynamic IMS that automatically updates is appropriate for a program of GOES-R's size and complexity, and NOAA is in the process of developing such a schedule.[47] However, when GAO reviewed contractor level data to evaluate the reliability of the program-wide IMS, they found "weaknesses in each of the subordinate schedules when compared to the best practices and, when viewed in conjunction with manual program-level updates, [they] concluded that the program-level schedule may not be fully reliable."[48] In summarizing the state of the GOES-R program's schedule, GAO stated that, "[u]ntil the program implements a full set of schedule best practices, and uses it on succeeding schedule updates throughout the life of the program, further delays in the program's launch date may occur."[49]

Potential GOES Gap

According to GAO, "[t]he program recently determined that the likelihood of the first satellite meeting its planned October 2015 launch date is 48 percent. Based on this planned launch date, the program reports that there is a 37 percent chance of a gap in the availability of two operational GOES-series satellites." [50] With a likely gap in the afternoon orbit of the polar-orbiting program, and the possibility of gaps in all of the polar-orbits, any gap in geostationary coverage would be catastrophic.

[44] See *supra* 6 page 25
[45] Ibid
[46] Ibid
[47] See *supra* 6 page 26
[48] See *supra* 6 page 26
[49] Ibid
[50] See *supra* 6 page 32-33

Attachment A

Detailed Instrument Descriptions

CrIS

Cross-track Infrared Sounder (CrIS) is the first in a series of advanced operational sounders that will provide more accurate, detailed atmospheric temperature and moisture observations for weather and climate applications. This high-spectral resolution infrared instrument will take 3-D pictures of atmospheric temperatures, water vapor and trace gases. It will provide over 1,000 infrared spectral channels at an improved horizontal spatial resolution and measure temperature profiles with improved vertical resolution to an accuracy approaching 1 Kelvin (the absolute temperature scale). This information will help significantly improve climate prediction and both short-term weather "nowcasting" and longer-term forecasting. It will also provide a vital tool for National Oceanic and Atmospheric Administration (NOAA) to take the pulse of the planet continuously and assist in understanding major climate shifts. The CrIS instrument is developed by the ITT Corporation, Ft Wayne, Indiana.

OMPS

Ozone in the atmosphere keeps the Sun's ultraviolet radiation from striking the Earth. The Ozone Mapping and Profiler Suite (OMPS) will measure the concentration of ozone in the atmosphere, providing information on how ozone concentration varies with altitude. Data from OMPS will continue three decades of climate measurements of this important parameter used in global climate models. The OMPS measurements also fulfill the U.S. treaty obligation to monitor global ozone concentrations with no gaps in coverage. OMPS is comprised of two sensors, a nadir sensor and limb sensor. Measurements from the nadir sensor are used to generate total column ozone measurements, while measurements from the limb sensor generate ozone profiles of the along-track limb scattered solar radiance. The OMPS instrument is developed by the Ball Aerospace & Technologies Corporation, Boulder, Colorado.

VIIRS

Visible/Infrared Imager Radiometer Suite (VIIRS) will combine the radiometric accuracy of the Advanced Very High Resolution Radiometer (AVHRR) currently being flown on the NOAA polar orbiters with the high spatial resolution (0.56 km) of the Operational Linescan System (OLS) flown on DMSP. The VIIRS will provide imagery of clouds under sunlit conditions in about a dozen bands, and will also provide coverage in a number of infrared bands for night and day cloud imaging applications. VIIRS will have multi-band imaging capabilities to support the acquisition of high-resolution atmospheric imagery and generation of a variety of applied products including visible and infrared imaging of hurricanes and detection of fires, smoke, and atmospheric aerosols. VIIRS will also provide capabilities to produce higher-resolution and more accurate measurements of sea surface temperature than currently available from the heritage AVHRR instrument on POES, as well as provide an operational capability for ocean-color observations and a variety of derived ocean-color products. The VIIRS instrument is developed by the Raytheon Company, El Segundo, California.

ATMS

The Advanced Technology Microwave Sounder (ATMS) will operate in conjunction with the CrIS to profile atmospheric temperature and moisture. The ATMS is the next generation cross-track microwave sounder that will combine the capabilities of current generation microwave temperature sounders (Advanced Microwave Sounding Unit – AMSU-A) and microwave humidity sounders (AMSU-B) that are flying on NOAA's POES. The ATMS draws its heritage directly from AMSU-A/B, but with reduced volume, mass and power. The ATMS has 22microwave channels to provide temperature and moisture sounding capabilities. Sounding data from CrIS and ATMS will be combined to construct atmospheric temperature profiles at 1 degree Kelvin accuracy for 1 km layers in the troposphere and moisture profiles accurate to 15 percent for 2 km layers. Higher (spatial, temporal and spectral) resolution and more accurate sounding data from CrIS and ATMS will support continuing advances in data assimilation systems and NWP models to improve short- to medium-range weather forecasts. The ATMS instrument is developed by the Northrop Grumman Corporation, Azusa, California.

CERES

The CERES measurements seek to develop and improve weather forecast and climate models prediction, to provide measurements of the space and time distribution of the Earth's Radiation Budget (ERB) components, and to develop a quantitative understanding of the links between the ERB and the properties of the atmosphere and surface that define that budget. The observations from CERES are essential to understanding the effect of clouds on the energy balance (energy coming in from the sun and radiating out from the earth), which is one of the largest sources of uncertainty in our modeling of the climate.

TSIS

TSIS measures the variability in the Sun's total output using two sensors. The Total Irradiance Monitor (TIM) is a broadband measurement while Spectral Irradiance Monitor (SIM) measures the spectral distribution of the solar irradiance between 0.2 & 2.7 µm. There is no operational heritage, but this instrument suite will continue the capabilities from the research measurements of TSIS on NASA's SORCE mission.

SARSAT

The Search and Rescue instruments are part of the international Cospas-Sarsat system designed to detect and locate Emergegency Locator Transmitters (ELTs), Emergency Position-Indication Radio Beacons (EPIRBs), and Personal Locator Beacons (PLBs).

A-DCS

The Advanced Data Collection System (A-DCS) provides a worldwide in-situ environmental data collection and Doppler-derived location service with the basic objective of studying and protecting the Earth environment.