

National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
Office of Systems Development (OSD)
Geostationary Operational Environmental Satellite Ground System (GOES GS)
006-48-01-15-01-3208-00-104-010
Operational Analysis
FY 2007

Table of Contents

Executive Summary	2
1.0 Customer Results.....	3
1.1 Customer Requirements	3
1.2 Performance Measures	4
2.0 Strategic and Business Results	5
2.1 GOES GS Helps to Achieve Strategic Goals	5
2.2 Business Results.....	5
2.2.1 Program Management and Controls.....	5
2.2.2 Monitoring Cost, Schedule and Performance	6
2.3 Reviews	6
2.4 Security.....	7
2.5 Performance Measures	7
3.0 Financial Performance.....	8
3.1 Current Performance vs. Baseline.....	8
3.2 Performance Measures	9
3.3 Cost Benefit Analysis	9
3.4 Financial Performance Review	9
4.0 Innovation to Meet Future Customer Needs	10
4.1 Support for Low Fuel GOES Satellites	10
4.2 Support for higher resolution sensor data to be present on GOES-O and GOES-P.....	10
4.3 Final Delivery of the GOES NOP Ground System	10
4.4 Funding Levels.....	11

Executive Summary

The Geostationary Operational Environmental Satellite (GOES) Ground System (GS) supports the National Environmental Satellite, Data and Information Service (NESDIS) GOES mission.

NESDIS operates GOES satellites to provide data for short-term weather warnings and forecasts. These satellites orbit the Earth at 22,600 miles above the equator. Two GOES satellites remain operational at all times; one providing coverage for the eastern United States and most of the Atlantic Ocean, and the other providing coverage for the western United States and Pacific Ocean basin. GOES satellites provide images of the entire United States every 15 minutes. NESDIS can also acquire GOES images as frequently as every minute to monitor the development of severe weather. The National Weather Service (NWS) uses GOES temperature and water vapor data in powerful numerical prediction models to form the basis of local weather forecasts. More than 120 NWS Forecast Offices use GOES images to provide local weather forecasts and warnings of severe weather events. GOES imagery is utilized daily, across the Nation, by the public and private industry for business, education, awareness and planning. GOES images are converted to videotape for use on all the national television weather shows.

The GOES Ground System is a real-time "System-of-Systems" that comprises the end-to-end framework for collecting, processing, and disseminating critical environmental data and information from the GOES satellites. It supports the launch, activation, and evaluation of new satellites and the in-depth assessment of satellite data. Moreover, the health and safety of these national resources are monitored around the clock to ensure that any identified anomalies are resolved as soon as possible. Data from the satellites are received at ground facilities, where the data are processed to monitor and control the satellite and to generate products that are used by NOAA, its users, and the World Meteorological Community. The GOES Ground System consists of components at the Satellite Operations Control Center (SOCC) at Suitland, MD; Command and Data Acquisition (CDA) facilities at Wallops, VA and Fairbanks, AK; Space Weather Prediction Center (SWPC) at Boulder, CO; and Wallops Backup (WBU) facility, at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. Operational elements are located at Fairbanks, Alaska; Wallops, Virginia; Suitland, Maryland; and Greenbelt, Maryland. GOES GS contains components of the following major sub-systems: (SOCC/CDA), Office of Research and Applications (ORA), and the NOAA National Data Centers (NNDC).

This operational analysis (OA) is an annual, in-depth review of the GOES GS program's performance based on the following:

- Customer Results
- Strategic and Business Results
- Financial Performance
- Innovation

This report focuses on the operational state of the program as of September 30, 2007, and is based on guidance developed by the Department of Commerce (DOC). The GOES GS program directly facilitates DOC Goal 3.1 to "Advance understanding and predict changes in the Earth's environment to meet America's economic, social and environmental needs." The current program meets established cost, schedule and performance parameters.

1.0 Customer Results

The NESDIS Office of Systems Development (OSD) GOES GS program is fully meeting the customer's needs and the program is delivering the services that it is intended to deliver as outlined in the NOAA and NESDIS operational plans. The OSD GOES GS program primarily serves internal NESDIS customers, i.e. the Satellite Operations Control Center (SOCC), as well as Wallops and Fairbanks Control and Data Acquisition Stations (CDAs) within the NESDIS Office of Satellite Operations (OSO). Other customers in FY2007 included NASA Goddard Space Flight Center (GSFC) who used the system to control the GOES-13 satellite and collect data during the Post Launch Testing in order to verify that the GOES program meets NESDIS requirements.

The GOES GS systems provided to OSO are used to command and control the GOES constellation of satellites. In addition, delivered systems also navigate and calibrate spacecraft instrument data, and collect data that is delivered to the Environmental Satellite Processing Center (ESPC) for further processing. The ESPC is used to generate products which impact all economic sectors of the nation. Descriptions of the GOES satellites, current satellite status and navigation, available products and real-time images are available at www.goes.noaa.gov, www.osd.noaa.gov/GOES, and www.oso.noaa.gov/GOES. The GOES product server is available to the public to view and download GOES products and imagery at <http://gp16.ssd.nesdis.noaa.gov>.

The impact of these data and products are documented in the Economic Statistics for NOAA. This document is available from the following websites:

- Economic Statistics for NOAA 5th Edition at http://www.economics.noaa.gov/library/documents/economic_statistics_and_methodology/NOAAEconomicStatistics-May2006.pdf
- Economics of Global Earth Observation at www.pco.noaa.gov/documents/economics_ofEarthObs.doc

1.1 Customer Requirements

The primary customer for the GOES GS program is the NESDIS Office of Satellite Operations (OSO). Secondary customers include NASA Goddard Space Flight Center (GSFC), and its contractors. More specifically, delivered systems include systems to command, control, and navigate GOES satellites, as well as process GOES instrument data for distribution to NESDIS and outside users.

Requirements for the systems to be delivered are developed during the initial project planning process, and proceed through formal Preliminary Design Reviews (PDRs), Critical Design Reviews (CDRs), and subsequent Technical Interchange Meetings (TIMs). In addition, formal Configuration Control Boards (CCBs) track the status of developmental and operational systems, allowing maintenance of developed systems to proceed in an ordered fashion. Once a system is handed over to a user, new user requirements or the failure of a system to meet customer requirements is tracked in an incident reporting system.

OSD works to provide an orderly transition from the system development stage, to operational stages. GOES GS provides a year of maintenance, extensive system training, additional subject matter training, and a complete set of hardware spares.

The current GOES GS program supports the customer’s requirements. GOES GS tracks the quality, timeliness and accuracy of the GOES program performance by:

- (1) Controlling the on orbit assets, and
- (2) Supporting the launch, orbit raising, and check out of new GOES spacecraft,
- (3) Maintaining and testing GOES spacecraft in storage orbits to assure their capability to be back-ups in case of problems with the operational satellites

Due to GOES GS constant system monitoring, the customers have successfully used the GOES ground system with only minor incident reports. During 2007, the operational GOES-12 (GOES-East) satellite’s software experienced a major on-orbit anomaly and had go out-of-service to be repaired. The older GOES-10 satellite was successfully moved from storage to on-orbit status, made operational, and successfully worked temporarily as the operational GOES-East satellite. GOES-13 was also prepared to be brought out of storage. GOES-12 was repaired and put back into service. This is just one example of OSD and OSO working together to provide excellent customer service and to meet customer needs and requirements. GOES GS had developed and implemented the Secure Remote Access Server (SRAS) software used by the GOES spacecraft engineer to monitor the maneuver from an off-site location and the eXtended GOES Operations at High Inclination (XGOHI) software which improved the imagery capabilities of GOES-10 and allowed this older GOES satellite to operate successfully as GOES-East. During this GOES excellent service to the National Weather Service and their other customers was maintained during this period. NESDIS Director Mary Kicza noted this effort as a major accomplishment of 2007.

1.2 Performance Measures

The performance measures evaluate ability of the delivered GOES GS to provide accurate and timely data transmitted from the GOES satellites to our primary and end-user customers. Table 1 summarizes the performance measures.

Table 1: Customer Results Performance Measure

Measurement Area	Indicator	FY2007 Baseline	2007 Actual Result	Comments
Customer Results	Image Navigation and Registration (INR) 3 sigma accuracy at nadir (smaller radius is better)	Plus or minus a radius of 8km	98.82%	Reduced very slightly due to a single event GOES-12 post-maneuver anomaly
Mission and Business Results	Number of landmarks in spec as a percent of total landmarks	Greater than 95% of total landmarks	99.43%	Reduced very slightly due to a single event GOES-12 post-maneuver anomaly
Processes and Activities	Percent of GOES data delivered meeting quality / timeliness requirements (includes dropouts)	98% of GOES data	99.53%	
Technology	System availability 24/7	95%	99.97%	

Performance measures of the GOES GS can also be evaluated using the information in the Incident Reports (IRs). These are tracked using a severity classification to show the importance to operations ranging from a 1 (Spacecraft (SC) in danger) to a 4 of very minor issue. Enhancement requests are

tracked as a 5. Using number of open IR's as a tracking measure shows that the GOES GS is meeting user expectations.

2.0 Strategic and Business Results

The GOES GS program is meeting its own goals and objectives as well as those of the agency. Program management and controls are in place to ensure the program continues to meet its goals and objectives and monitor how well the GOES GS program performs.

2.1 GOES GS Helps to Achieve Strategic Goals

In line with the current NOAA Strategic IT Plan for FY2008-FY2015, the OSD GOES program directly supports the NOAA Mission Goal #3 to serve society's needs for weather and water information. GOES GS also supports Mission Goal #5 Mission Support Goal, specifically Sub-Goal 5.2 Satellite Services within Modeling and Observing. Today there are significant demands on virtually all of NOAA's programs to provide information to the Nation and the World community on the health of the environment in real-time. SOCC/CDA provides 24x7 support for each NOAA geostationary (GOES) and polar orbiting (POES) environmental spacecraft and actively prepares for and participates in new spacecraft launch operations. Hence, OSD GOES GS supports the reception and processing of the data which is required to meet the NOAA mission strategy of Monitor and Observe. In addition, the OSD GOES supports the Department of Commerce (DOC) theme to Observe, Protect, and Manage the Earth's Resources to Promote Environmental Stewardship

Within the NOAA Enterprise Architecture, GOES GS supports NOAA's "Ingest/Process Satellite Observations" component: "allows data & observations to be acquired from both NOAA and non-NOAA satellite sources and processed to a level necessary to prepare the data to be further refined into the required product sets".

2.2 Business Results

2.2.1 Program Management and Controls

The OSD GOES GS program is guided by the Office of Management and Budget (OMB), DOC, and NOAA guidelines and policies. Oversight is provided by NESDIS, including the NESDIS Information Resources Management Team (IRMT) formerly the Information Technology Architecture Team (ITAT), and the NESDIS Chief Information Officer (CIO). A baseline of annual activity is contained in the matrix annual operating plan which is approved by the line office.

OSD performs extensive, continuous OA on the performance of its systems under development. This ensures that the system resources and the ancillary supporting infrastructure (security, training, facilities, etc.) as well as labor resources remain optimally functional and configured to suit the NESDIS/NOAA's goals. OSD's OA covers a hybrid of system and non-system components.

OSD conducts an objective measurement of resource and performance metrics of the OSD GOES elements. For all IT components, performance thresholds have been established and performance is measured. Key performance issues and risks are identified through these reviews and tracked by OSD management.

Given that the OSD GOES development environment includes a large IT component, OSD must keep abreast of changes in technology that would impact later operations. These changes identify risks in addition to identifying viable alternatives for improving systems and processes within OSD. The results of this analysis are considered in the annual OSD Ground System Division's Five Year Plan.

2.2.2 Monitoring Cost, Schedule and Performance

Cost – OSD Ground System Division (GSD) conducts a variety of budget analyses throughout the fiscal year. Obligations and expenditures are tracked on a monthly basis. Variances to budget plans are analyzed monthly by both GSD and the GOES GS Program Manager. Significant variances are reported to OSD Management as well as NESDIS management. A Needs Analysis is conducted annually in conjunction with the Planning, Programming, Budgeting and Execution System (PPBES) and Ground System budget review processes. Key budget issues and risks are identified through these reviews and tracked by GSD and OSD management.

Schedule – The matrix annual operating plan is used to track key milestones. The final matrix annual operating plan for OSD includes the significant GOES Ground System milestones. The majority of activities are below the threshold for reporting with the annual operating plan. These tasks are tracked through Microsoft Project and Excel. Schedules are developed by GSD in coordination with OSD.

Performance – Contract performance, when applicable, is monitored to support both budget and performance measurements. Typically, the integration of new hardware is conducted by either government staff or contract staff supervised by a government manager. As required, support can be secured through existing O&M contracts or through the vendors. Hardware maintenance contracts are reviewed on a semi-annual basis for technology advances impacting system maintainability, reliability, and interoperability.

Through the GOES GS, OSD provides NESDIS-wide support for various tasks, including IT Security, Program Management, Business Continuity Planning, Systems Engineering and Budgeting. These contracts are Time and Materials. For these contracts, OSD receives monthly status reports and meets at least quarterly with contract managers to review performance, priorities, lessons learned, and work plan.

2.3 Reviews

As part of the NOAA program structure, the GOES GS program is reviewed on an annual basis. GOES GS was included in the GSD Director's Satellite Ground Systems briefing to the Commerce Information Technology Review Board (CITRB) on September 27, 2006. The last review took place as part of the Ground System Division's (GSD) FY08 budget cycle and was completed in April 2007. The next GSD budget review of GOES GS will be held in February/March 2008.

The GOES Ground System project continues to fully meet the customer's needs and the program is delivering the services that it is intended to deliver. All program metrics are at or above expectations. The program continues to effectively and efficiently support NOAA's Strategic Goal to "Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs."

2.4 Security

The GOES Ground System investment contains two steady state systems, one for the GOES I-M satellites and the other for GOES NOP satellites. The GOES GS systems are certified and accredited to the relevant OMB and NOAA requirements, which are based upon FIPS 200 and NIST 800-53 standards. System Security Plans, Risk Assessments, and Contingency Plans were certified and approved for GOES GS in January and May 2005. Management, operational, and technical security controls are adequate to ensure the confidentiality, integrity and availability of information. The GOES GS contingency plan was tested in May 2007. The GOES GS Security Control Testing was completed in August 2007.

OSD is working with OSO to begin recertification of the GOES system, which is scheduled for May of 2008. A draft C&A package is being assembled, including a Facilitated Risk Assessment (FRA), System Security Plan (SSP), and Security Test and Evaluation (ST&E). System scans, as well as penetration tests have been completed, and are being analyzed at this writing. A complete POA&M list is being compiled, and contractual resources are being applied to mitigate identified vulnerabilities.

The contractors help maintain system operations. The required security clauses are inserted in the two IT services contracts by the Contracting Officer and independently verified by the Information Technology Security Officer. Upon contract award, contractor employees required to access this system must be approved for a NOAA badge and undergo the appropriate background check to ensure employee trustworthiness. The Contractor Officer's Technical Representative verifies the identity of each contractor employee and submits appropriate forms to the NOAA Security Office for a background check and employee badge. A personnel security professional within the NOAA Security Office ensures that all information provided by the Contractor Officer's Technical Representative is correct and initiates a security background check for the contractor employee through the Office of Personnel Management.

After OPM performs the contractor employee's background check, the NOAA Security Office is notified and a personnel security specialist reviews the results of the background check and subsequently approves issuance of a NOAA badge.

2.5 Performance Measures

The performance measures in Table 2 show the GOES GS program's performance with respect to Strategic and Business Results.

Table 2: Business Results Performance Measures

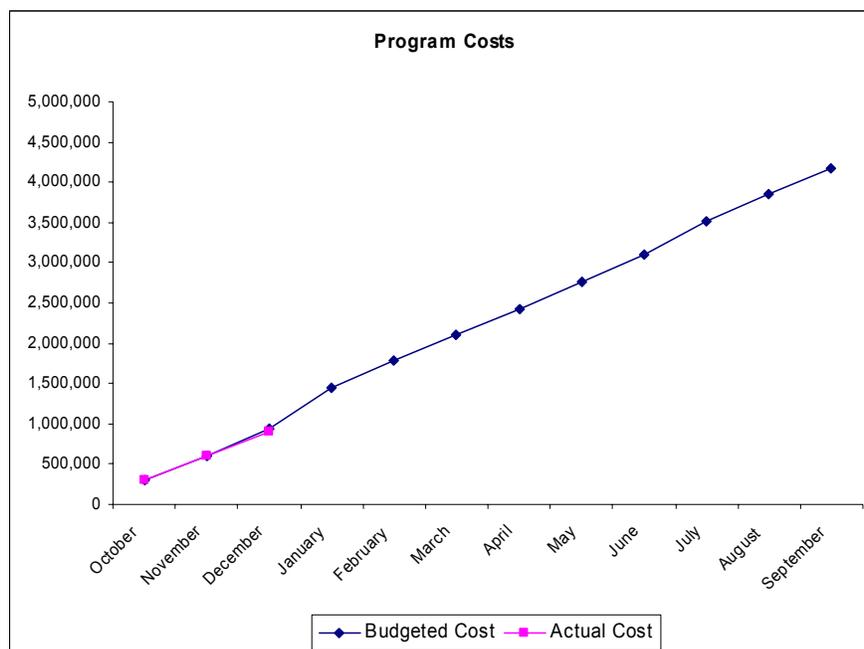
Measurement Area	Indicator	2007 Baseline	2007 Actual Result	Comments
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The GOES GS also added the capability to support the new higher resolution spacecraft detectors that will be first flown in the GOES O mission satellite which is presently scheduled for launch in August 2008.

3.0 Financial Performance

3.1 Current Performance vs. Baseline

The program costs and are shown in Program of contract dedicated to activities. In these funds relevant sub-systems,



planned actual costs Figure 1. costs consist staff GOES GS addition, support GOES GS i.e. antennas,

telemetry/command and archive/access systems and POES GS infrastructure components such as both internal and external communications. NOAA PAC funds support the operational components of the GOES GS reported in this operational analysis.

The dollars on the Y-axis are in thousands. The financial operational analysis includes only Steady State IT dollars for fiscal year 2007. The total GOES GS planned and actual Steady State IT expenditures for Fiscal Year 2007 were \$20,953K.

FY07 GOES Ground System IT Funds

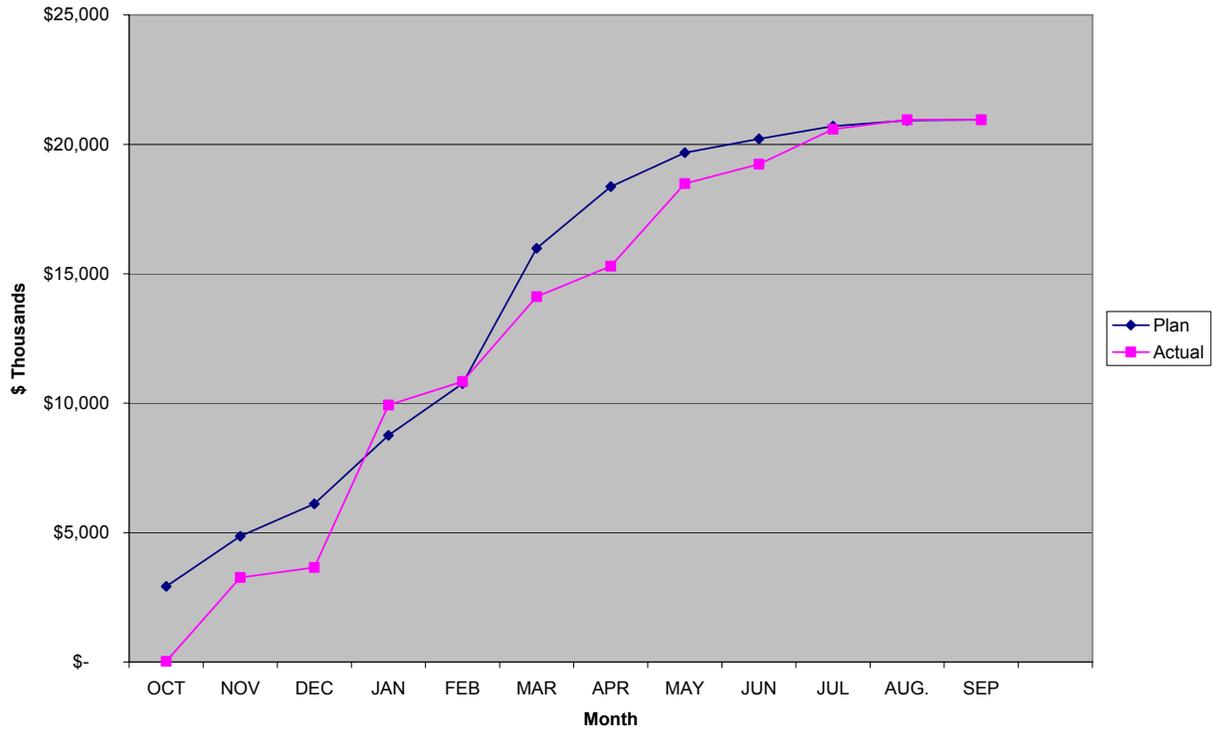


Figure 1: Budget and Actual Costs

The GOES GS program plans and executes budget based upon a fiscal year calendar.

3.2 Performance Measures

The current OSD GOES financial performance is based on a pre-established cost baseline (e.g., annual spend plan). Program costs consist of labor and benefits for full time permanent staff dedicated to OSD, travel, communications, supplies and equipment, contracts, and corporate overhead. GOES GS financial performance measurements and system performance measurements are briefed and analyzed at the monthly Ground Systems Division program managers briefings.

3.3 Cost Benefit Analysis

References and links to two NOAA economic analysis studies of the environmental satellites program are contained in Section 1.0 of this report. In addition the NESDIS OSD Ground System Five Year Plan, which is updated annually by the Ground System Division, documents the benefits and costs of the GOES and POES Ground Systems.

3.4 Financial Performance Review

Financial performance is typically subjected to a periodic review for reasonableness and cost efficiency. Monthly budget reviews are held with the program manager, CORs and contract managers to ensure contracts are within cost and on schedule. Monthly reports from contractors are required to ensure the Government has the information it needs to evaluate cost performance. A detailed review of work and priorities is undertaken if cost is significantly above base lined values. Also, any necessary corrective actions are also identified and implemented.

4.0 Innovation to Meet Future Customer Needs

The following projects have been implemented in FY2007, or are being implemented in FY2008 to address future challenges, better meet customer needs, make better use of technology, and lower operating costs.

4.1 Support for Low Fuel GOES Satellites

The GOES IM satellites are running out of fuel while the instruments are still working correctly. When a geostationary satellite runs out of fuel to perform North-South maneuvers the result is that it no longer remains at a constant relative location over the equator but instead drifts in a figure eight with the sub-satellite point drifting North and South a few degrees. This results in data that is not acceptable to the users. OSD developed modifications to the ground processing software to remap the sensor data so that it appears to be coming from a stationary GOES satellite. This system was delivered to the OSO in July of 2007, and made operational in October 2007. The system is serving to extend the life of the GOES IM satellites. As a result, the GOES-10 satellite is currently being operated under an international agreement (GEOSS) to provide weather data to South America. In addition, the system was able to replace GOES-12 for two weeks, after GOES-12 failed over the East Coast (since recovered).

4.2 Support for higher resolution sensor data to be present on GOES-O and GOES-P

The GOES-O and GOES-P satellites incorporate a new sixth channel to support the generation of more detailed vertical profiles. Detectors for the new channel are 4km in resolution, as opposed to 8km for the channel that is being replaced. Components of the present GOES ground system are being upgraded to support those additional detectors. This includes the ability to ingest, calibrate, and perform QC monitoring. The GOES-O satellite is currently scheduled for launch in August 2008.

4.3 Final Delivery of the GOES NOP Ground System

The GOES NOP ground system was delivered on schedule October 23, 2007, 18 months after the May 2006 launch of GOES-N (GOES 13). The system is COTS based and was used first by Boeing and NASA and now is used by NESDIS OSO to operate and adjust the GOES-13 satellite. During 2007 a three satellite compatibility test was conducted to prove that this ground system can support multiple satellites. This NOP ground system will support the GOES-O and GOES-P satellites when they are launched in 2008 and 2011, respectively.

4.4 Funding Levels

Recent trends in government spending indicate that agencies should not expect significant increases in their budgets. This, coupled with the requirement to incorporate evolving technology, will force the program to find efficiencies and to do more with the same amount of resources.