

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)
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Operational Analysis
FY 2009

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	6
2.1 GOES GS Helps to Achieve Strategic Goals	6
2.2 Business Results	6
2.2.1 Program Management and Controls	6
2.2.2 Monitoring Cost, Schedule and Performance	7
2.3 Reviews	7
2.4 Security	7
2.5 Performance Measures	8
3.0 Financial Performance	9
3.1 Current Performance vs. Baseline	9
3.2 Performance Measures	10
3.3 Cost Benefit Analysis	10
3.4 Financial Performance Review	11
4.0 Innovation to Meet Future Customer Needs	12
4.1 Number and Types of Users	12
4.2 Improving Technology and Meeting User Needs	12
4.2.1 GOES Ground System Enterprise Consolidation	12
4.2.2 Support for New GOES Channel 6 IR Detectors	12
4.2.3 Initiation of Common Enterprise Services	12
4.3 Funding Levels	12

Executive Summary

As a single entity, the Geostationary Operational Environmental Satellites (GOES) Ground System (GS) supports the 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. 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.

Major accomplishments during FY09, include:

- Upgrades to allow migration to an Enterprise based ground systems architecture (i.e., the "Replacement Product Monitor" subsystem was migrated from discrete servers to Opteron based blades and shared (SAN) storage system, the process of migrating the Sensor Processing System (SPS) to Enterprise architecture was initiated.
- GOES-14 was launched in June 2009
- GOES GS Risk Management Plan updated.
- The GOES GS completed a program review in April 2009.
- GOES contingency plan was tested in September 2009.
- Updated performance measures to reflect 2009 actual results
- Updated financial performance to reflect Current Performances vs. Baseline
- Consolidated common services, like system backups, inventory control, user authentication, etc., into a common infrastructure that could be used across the enterprise).

Projects that will be implemented in FY2010 to address future challenges, to better meet customer needs, make better use of technology, and lower operating costs, include:

- GOES GS added the capability to support higher resolution spacecraft detectors
- GOES-P will be launched in March 2010

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, and Innovation.

This report focuses on the operational state of the program as of September 30, 2009, and is based on guidance developed by the Department of Commerce. The GOES GS program directly facilitates Department of Commerce Goal 3.1 to "Advance understanding and predict changes in the Earth's environment to meet America's economic, social and environmental needs" and NOAA's Strategic Goal to "Serve society's needs for weather and water information". The current program meets established cost, schedule and performance parameters.

1.0 Customer Results

The Office of Systems Development (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). The 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.

1.1 Customer Requirements

The GOES GS develops and tests systems that are delivered to OSO to be 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. The impact of environmental satellite data and products are documented in the Economic Statistics for NOAA.

The current edition of Economic Statistics for NOAA, 6th Edition, April 2008 is produced by the Office of the NOAA Chief Economist – Program, Planning, and Integration (PPI) and is available at

<http://www.economics.noaa.gov> or

http://www.ppi.noaa.gov/PPI_Capabilities/Documents/2008_06_04_EconStatsFinal.pdf

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 GOES GS 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 Ground Systems Division (GSD) procedures provide an orderly transition from the system development stage, to operational stage. GOES GS provides a year of maintenance, extensive system training, additional subject matter training, and a complete set of hardware spares.

1.2 Performance Measures

The GOES GS performance measures align with the “Customer Results Measurement Area” of the Performance Reference Model developed by the Federal Enterprise Architecture Program Management Office (FEA-PMO). Table 1 summarizes the customer results performance measures.

Table 1: Customer Results Performance Measures

Measurement Area	Indicator	FY09 Baseline	FY09 Actual Result	Comments
Customer Results	Image Navigation and Registration (INR) 3 sigma accuracy at nadir (smaller radius is better)	95%	98.67%	+3.67% over baseline as of 9/30/2009
Processes and Activities	Percent of GOES data delivered meeting quality / timeliness requirements (includes dropouts)	98.5%	99.50%	+1% over baseline as of 9/30/2009

Sources: IT Dashboard version of the GOES-GS Exhibit 300 dated October 17, 2009, Section I.D Performance Information, the Federal Enterprise Architecture (FEA) Performance Reference Model (PRM) table and OSO FY2009 September Monthly Review briefing, dated 10/20/09, see OSO ORF Activities page 9.

The GOES ground system is now successfully supporting three operational spacecraft (GOES-10, GOES-11, GOES-12), one stored spacecraft (GOES-13), and GOES-14, which is undergoing Post-Launch Testing (PLT). GOES-10 is supporting the Earth Observation Partnership of the Americas (EOPA) initiative providing geostationary environmental satellite data to South America. GOES GS staff developed, tested, and implemented the Extended GOES High –Inclination (VGOHI) remapping of data which extends the useful life of older satellites and therefore provides additional geostationary environmental satellite capabilities available to support new international programs such as EOPA.

In September 2009 a plan was released for the following changes to occur in early FY10: de-orbit GOES-10, utilize GOES-12 for South America coverage, activate GOES-13 (currently in storage) as the GOES– East satellite and continue to use GOES-11 as GOES-West through December 2011. After GOES-14 has completed Post Launch Testing, it will be placed in storage and periodically tested to maintain its readiness to replace GOES-11 in 2011. Thus, a stand-by satellite is available as a replacement if any of the operational spacecraft experience serious problems, and the GOES environmental satellites high levels of 24/7 performance are maintained.

The GOES GS program is meeting its goals and objectives per the GSD 5 Year Plan and GOES OMB Exhibit 300. Program management and controls are in place to ensure that the program continues to meet its goals and objectives and monitor how well the GOES GS program performs.

Figure 1 shows the areas of the earth that are observed by the GOES-West and GOES-East geostationary environmental satellites. The GOES satellites capture at least 48 images of the same locations every day. Figure 2 is one of the products created from GOES satellite data.

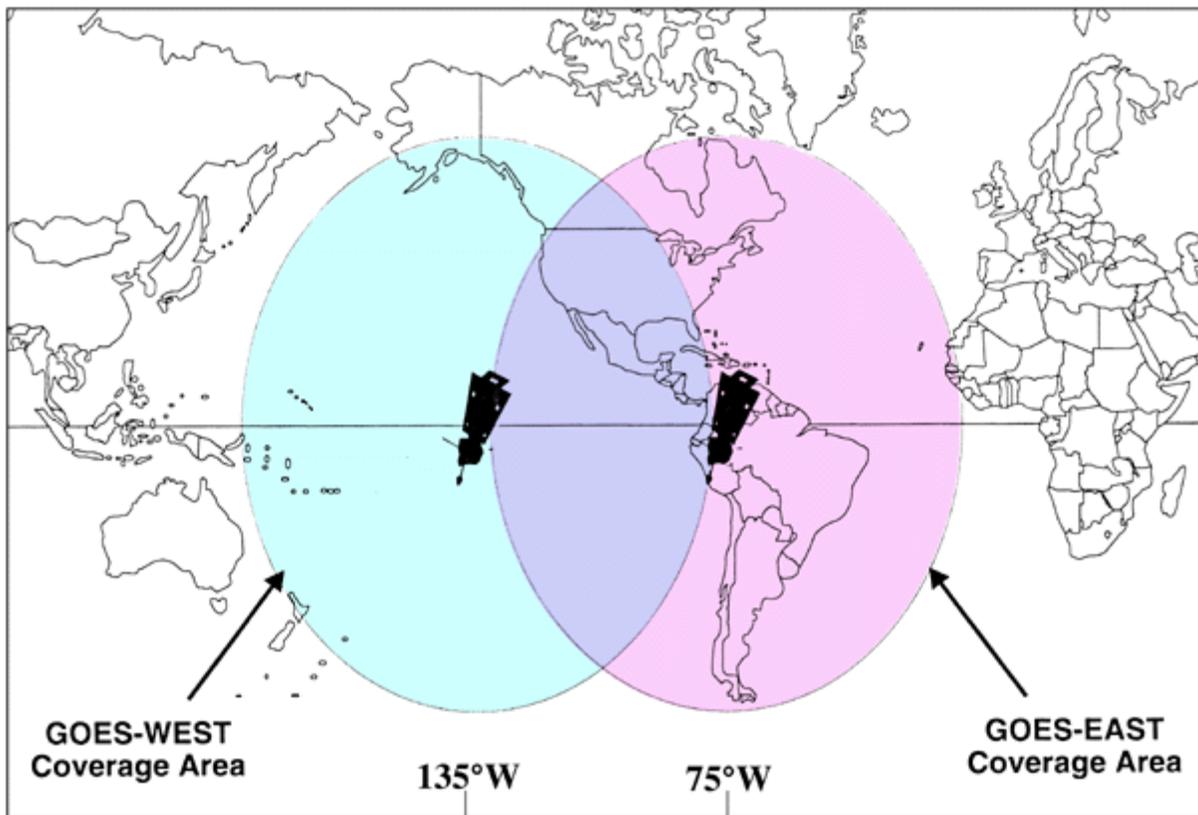


Figure 1 GOES Coverage Areas

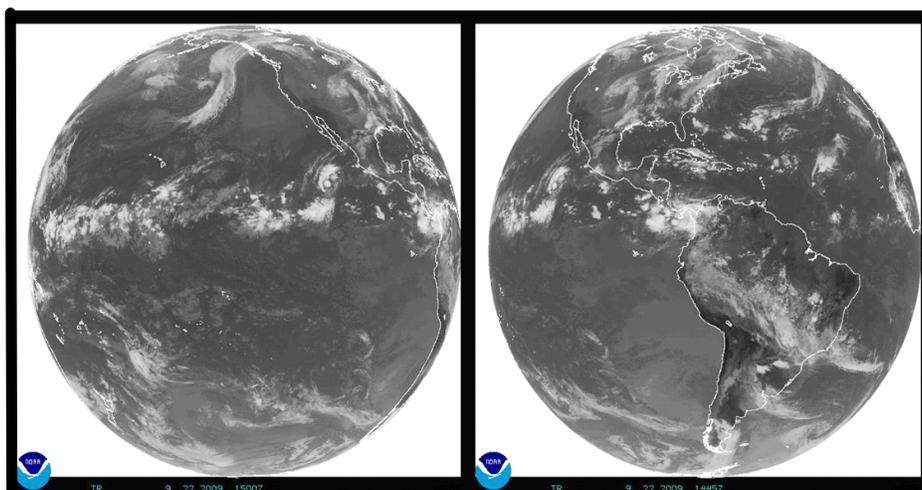


Figure 2 GOES-West and GOES-East Full Disk Images

2.0 Strategic and Business Results

2.1 GOES GS Helps to Achieve Strategic Goals

In line with the NOAA Strategic Plan for FY2007-FY2011, the OSD GOES program directly supports the NOAA mission goal (#3) to serve society's needs for weather and water information. 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) 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. 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.

Given that the OSD GOES GS 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 OSD Ground System Division's Five Year Plan.

The OSD Ground Systems Division (GSD) has recently conducted a review of management practices within the Division, and produced a new set of management templates to be adopted by all major projects. These include templates for Risk Management Plans, Communication Plans, etc. The GOES Ground System has recently updated the Project's Risk Management Plan to conform to this new template.

The OSD Ground Systems Division (GSD) is implementing infrastructure improvements to facilitate group collaboration. A Microsoft SharePoint system is being implemented to facilitate project communication and team collaboration. These tools will begin to be used in the FY '10 budget year, when they will be phased into use across all GSD projects.

The GOES Ground System Project has completed its assessment of management and analysis tools for use in the near-term for on-going project management. The team has adopted "@Risk" as its risk management / decision

making toolset. The intention is to improve the risk estimating process by incorporating more quantitative measures and analysis.

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, and work plan.

2.3 Reviews

As part of the NOAA program structure, the GOES GS program is reviewed on an annual basis. The last review took place as part of the Ground System Division's (GSD) FY09 budget cycle and was completed in April 2009.

All program metrics are at or above expectations (see Table 2). The program supports 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. 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 September 2009.

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 GOES GS program Strategic and Business Results performance.

Table 2: Business Results Performance Measures

Measurement Area	Indicator	FY09 Baseline	FY09 Actual Result	Comments
Mission and Business Results	Number of landmarks in spec as a percent of total landmarks	95%	99.00%	+4% over baseline as of 9/30/2009
Technology	System availability 24/7 and % GOES Total data recovered	95%	99.99%	+4.99% over baseline as of 9/30/2009

The GOES GS also added the capability to support the new higher resolution spacecraft detectors. GOES-O (now GOES-14) was successfully launched in June of this year.

3.0 Financial Performance

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

3.1 Current Performance vs. Baseline

GOES GS program costs include contract staff and support to GOES GS subsystems in the following ten GSD budget categories; antennas, radio frequency systems, telemetry and command (T&C) instruments, product generation and development (PG&D), special projects (including security), communications systems, facilities and infrastructure, systems engineering, IT refresh, and program management.

GOES GS includes interfaces with NESDIS archive/access systems and POES GS infrastructure components such as both internal and external communications systems.

GOES GS supports ground systems maintenance at Wallops, Fairbanks, and NSOF.

GOES GS is a mixed life cycle investment and therefore NOAA OSD GSD PAC funds support the GOES GS operational components described in this operational analysis.

The GOES GS cumulative monthly planned costs and actual costs for FY09 are shown in Figure 1. The dollars on the Y-axis are in thousands.

The financial operational analysis includes only Steady State IT dollars for fiscal year 2009.

The total GOES GS planned and actual Steady State IT expenditures for Fiscal Year 2009 were \$19,452K. This is consistent with the FY09 summary of spending table in the GOES GS OMB Exhibit 300 Capital Asset Plan.

FY09 GOES Ground System IT Steady State Funds

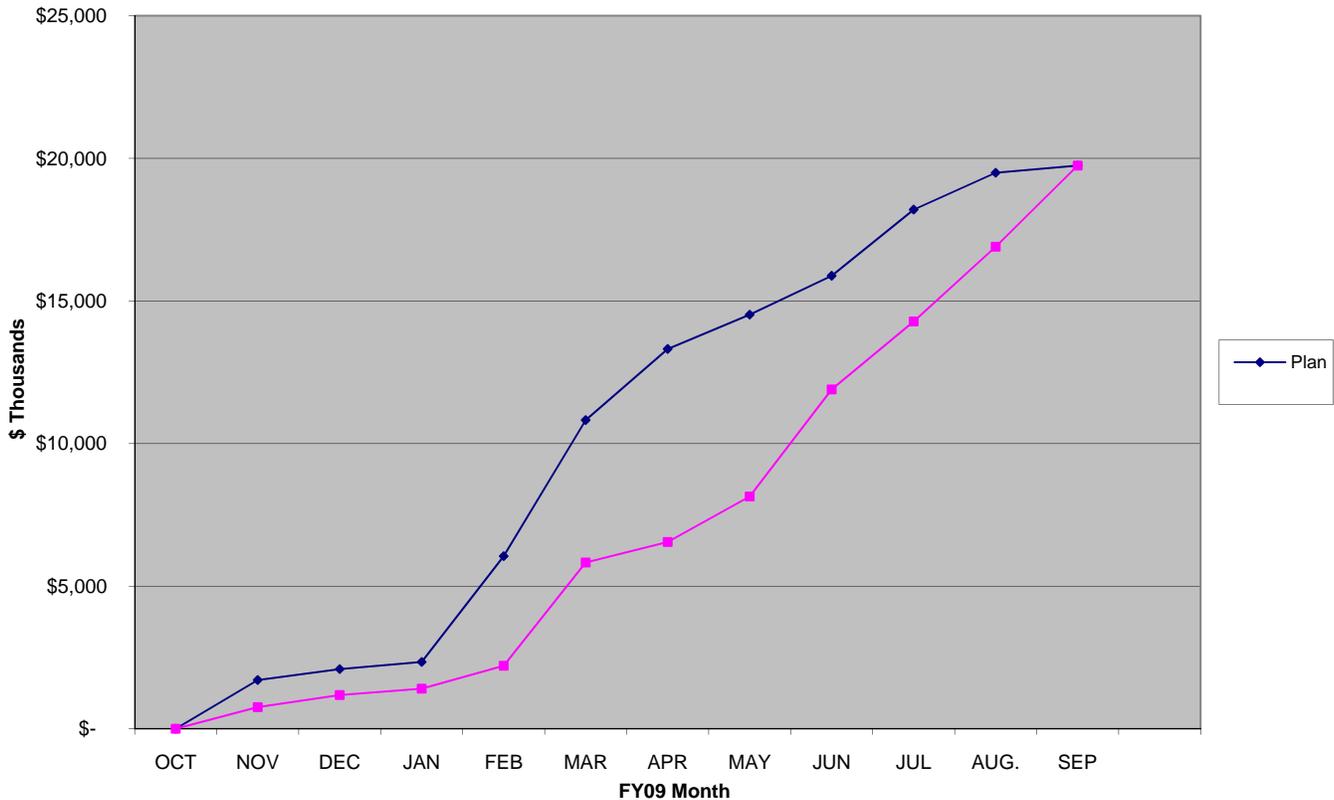


Figure 1: GOES GS FY09 Cumulative Monthly Planned and Actual IT Steady State Funds

Source: GOES GS budget records adjusted to include only Operations and Maintenance Funds and the GOES GS IT Dashboard (ITDB) Summary of Spending Table as of September 30, 2009. Note that FTE costs are not included in the GOES GS system budget.

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 hardware, software, and systems engineering contracts. GOES GS financial performance measurements and system performance measurements are briefed and analyzed at the monthly Ground Systems Division program managers briefings. In FY09, GOES GS operational expenditures remained within the 10% monitoring threshold of the work plan budget.

3.3 Cost Benefit Analysis

The GOES GS cost and benefits analysis of the incremental technology refreshment approach used by GOES GS is included in the alternatives analysis (April 2006) in the GOES GS ITDB version of the OMB Exhibit 300 in section II.A. Incremental IT refreshment allows for the deliberate, planned upgrade of the components of the GOES Ground System as needed; when a component's life cycle has been completed, new technology becomes available at a competitive price, or changes are needed to ensure mission continuity with new satellite instruments and data

streams. This is a fiscally conservative approach that provides for maximum positive ROI while satisfying all program requirements. The quantification of budgeted cost savings from using GOES weather satellites to meet NOAA's data needs from FY02 through FY11 are included in the GOES GS IT Dashboard version of the Exhibit 300.

In addition, the NESDIS OSD GSD Environmental Satellites Ground System Five Year Plan, which is updated annually by the Ground System Division, documents the future proposed benefits and planned budgets for both the GOES and POES Ground Systems. The GSD Five Year Plan for FY11-15 is currently being written.

GOES GS develops and tests, and provides IT refresh and systems engineering support for the IT hardware and software, antennas, and telecommunications systems that are operated by OSO to navigate and calibrate spacecraft instrument data, and to collect the environmental data that is sent to the Environmental Satellite Processing Center (ESPC) for further processing. The ESPC uses the data to generate products which impact all economic sectors of the nation.

The economic analysis and impacts of the availability of environmental satellites data and products are documented in Economic Statistics for NOAA 6th Edition, April 2008 produced by the Office of the NOAA Chief Economist – Program Planning and Integration and available at <http://www.economics.noaa.gov> or http://www.ppi.noaa.gov/PPI_Capabilities/Documents/2008_06_04_EconStatsFinal.pdf

Economic Statistics for NOAA summarizes recent research studies of the economic value created by NOAA and the breadth of economic activities including the general economic and social impacts (including reducing the property losses, death and injuries, and health impacts from storms and climate change), the contribution to U.S. income, employment and production, and the management of natural resources that are all impacted by NOAA programs.

3.4 Financial Performance Review

Financial performance is 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 FY2009, or are being implemented in FY2010 to address future challenges, better meet customer needs, make better use of technology, and lower operating costs.

4.1 Number and Types of Users

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.

4.2 Improving Technology and Meeting User Needs

4.2.1 GOES Ground System Enterprise Consolidation

The GOES Ground System Project began to implement major upgrades in the first phase of a migration to an enterprise based ground system architecture. The “Replacement Product Monitor” subsystem, which calculates landmarks to aid in the navigation of GOES spacecraft, was migrated from discrete servers to Opteron based blades, and a shared (SAN) storage system. In addition, the process of migrating the Sensor Processing System (SPS) to an Enterprise architecture was initiated. These migrations are part of an on-going migration effort to decrease life-cycle maintenance costs, improve reliability, and to improve the performance of major GOES ground system components.

4.2.2 Support for New GOES Channel 6 IR Detectors

The GOES-14 spacecraft, which was successfully launched in June of this year, contained an additional “Channel 6” infrared (IR) detector, with increased resolution over the previous series of spacecraft. The addition of the 13.3 um band allows for previously unavailable cloud top pressure determination, thus aiding cloud detection algorithms. The additional of the new detector required upgrades to the product processing systems, and additional testing to verify its proper implementation. The additional detector is also being carried on the GOES-P follow-on spacecraft that is scheduled to be launched in March 2010.

4.2.3 Initiation of Common Enterprise Services

To further reduce life-cycle operation and maintenance costs, and to ensure the security and availability of critical subsystem components, the GOES Ground System project has initiated a plan to consolidate common services like system backups, inventory control, user authentication, etc. into a common infrastructure that could be used across the enterprise. The first phase of this initiative includes the development, testing, and deployment of a common “Enterprise Backup System” (EBS) that would serve the entire GOES ground system. This system would replace a number of disparate ground system elements (tape drives and storage units) with a single schedule driven backup and recovery system. The system would virtually guarantee the recovery of mission critical files in the event of a major subsystem failure.

4.3 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.