National Oceanic and Atmospheric Administration
NWS
Weather and Climate Operational Supercomputer System WCOSS
Operational Analysis
FY2009

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Executive Summary

This report focuses on the operational state of the Weather and Climate Operational Supercomputer System (WCOSS) program as the end of the fiscal year 2009, and is based on guidance developed by the Department of Commerce. This annual operational analysis report is a status review in terms of financial performance, customer results and performance measures. It details financial and technical performance against established baselines/requirements and evaluates customer results. The program continues to meet established cost, schedule and performance parameters and directly facilitates NOAA's strategic goals to "Serve Society's Needs for Weather and Water Information," to "Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation," and to "Provide Critical Support for NOAA's Mission."

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

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

1.0 Customer Results

The WCOSS program is fully meeting the customer's needs and the program is delivering the services intended. As described under Performance Measures, this project is exceeding the terms of the contract. Our customers demand on-time product generation and the WCOSS has exceeded NWS requirements while simultaneously support improvements in model accuracy. During 2009, the WCOSS program directly contributed to the NOAA/NWS mission and was critical in supporting the issuance of weather watches and warnings that protect both life and property. The value of this program in terms of lives saved and property protected as well as service to the public mandates a continued need for this investment.

1.1 Customer Requirements and Costs

The WCOSS investment interfaces with three NOAA weather data systems as part of its data assimilation activities, and these system interfaces are critical to the modeling and delivery of the suite of operational forecasts that are generated for customers in the weather and climate community: (1) NWSTG, National Weather Service Telecommunications Gateway. The NWSTG shares information with other NWS networks such as the Automated Field Operations & Services (AFOS) network; (2) NEXRAD, Next Generation Weather Radar.NEXRAD is used to warn the public about dangerous weather and its location. Meteorologists can now warn the public to take shelter with more notice than any previous radar. There are 158 operational NEXRAD radar systems deployed throughout the United States and at selected overseas locations. The maximum range of the NEXRAD radar is 250 nautical miles. The NEXRAD network provides significant improvements in severe weather and flash flood warnings, air traffic safety, flow control for air traffic, resource protection at military bases, and management of water, agriculture, forest, and snow removal; and (3) AWIPS, Advanced Weather Interactive Processing System.AWIPS gathers, assimilates, and analyzes vast quantities of data for weather professionals.This powerful data processing system receives a wide variety of meteorological data from Doppler radar, weather satellites, and observation systems, and receives forecasting model data from the WCOSS. The data received is graphically displayed by AWIPS in a geographic weather display and on the the NCEP centers use the NAWIPS application for geographic weather display and forecasting support.

1.2 Performance Measures

The current performance of the system is documented in the table below

Fiscal Year	Strategic Goal(s) Supported	Measurement Area	Measurement Category	Measurement Grouping	Measurement Indicator	Baseline	Target	Actual Results
2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Customer Results	Service Quality	Accuracy of Service or Product Delivered	1-day Precipitation Forecast threat score: the forecast accuracy of this score is critical for flood and snowfall planning purposes as well as for agricultural planning	29	Increase forecast accuracy to a score of 29	33

2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Customer Results	Service Quality	Accuracy of Service or Product Delivered	Seasonal Heidke Temperature skill score: a categorical climatology skill score that measures the improvement in accuracy over the reference forecast	18	Improve skill score to 19	26
2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Mission and Business Results	Environmental Management	Environmental Monitoring and Forecasting	48-Hour Hurricane Tracking Forecast: this is a critical forecast that gauges the accuracy of the hurricane storm track over a 2-day period and is used by the public and emergency management agencies for evacuation and planning purposes 48-hr Hurricane tracking intensity Forecast	Track error of 126 nautical miles First year of goal	Improve track error to 109 nautical miles 14 knots	TBD TBD
2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Processes and Activities	Cycle Time and Resource Time	Timeliness	On-time generation of forecast products: measures the percentage of the time that weather and climate forecasts produced as scheduled, to be available to the weather and climate community	99.66%	Improve to 99.92%	99.73
2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Technology	Reliability and Availability	Availability	Supercomputing System Availability: : a critical measure of the uptime for the supercomputer assets used to run and generate the climate and weather forecasting models	99.0%	Maintain 99.0% availability	99.96
2009	3.1 Advance understanding and predict changes in the Earth's environment to meet America's economic, social, and environmental needs.	Technology	Reliability and Availability	Reliability	Automatic Switch-over time to backup system: in an event of a failure of the primary computer this is a business continuity testing measure that gauges the amount of time necessary to revert all operational forecasts over to the back up	30 minute cut-over to full operational backup	Maintain 30 minute cut-over	10 minutes

					supercomputer			

2.0 Strategic and Business Results

- During 2009, due to the upgrade of the operational supercomputers to the new IBM Power6 configuration, there was a forced moratorium on new model improvements for most of the year.

2.1 WCOSS Helps to Achieve Strategic Goals

NOAA upgraded it operational supercomputing environments to run two IBM Power6 Cluster systems in August 2009. The Primary system, normally used for NOAA operations, is located at current vendor's facility in Gaithersburg, MD. The Backup system, a functional clone of the Primary, is located at NASA's IV&V facility in Fairmont, WV. The Backup typically handles a research and development workload but is designed to handle NOAA operations under continuity of operations concept. Under NOAA's OCCS contract, the Primary and Backup systems became operational on August, 2009. The two discrete computers are managed independently such the Primary runs operational (time-critical) work and the Backup runs primarily development work but is immediately available for business continuity Backup functions. They are functionally symmetrical. The configuration as presented below describes the combined two-computer system. A general estimate of theoretical peak performance of NOAA's IBM Power6 system is about 63 TFLOPS. The compute node technology throughout is IBM's Power6 1H nodes running at 4.7 GHz and configured with 32 CPUs per node, each node having 128 GB of memory. Other highlights include: 156 nodes total (142 compute nodes) and 4,992 total processors (4,544 compute processors).
Consequently, this investment will provide enhancements in sustained performance capability increases in processor capacity, and will alleviate any risks of system saturation and degradation in production generation (e.g., in terms of quality and timeliness of NWS products).
Complementary supercomputer infrastructure includes storage devices and interconnects, communications hardware interfaces, software (operating system, file system, and compilers), networking equipment, system maintenance, support services, and necessary infrastructure enhancements.

2.2 Business Results

Some of the qualitative benefits generated by this investment from various climate and weather models include the following: (1) Global Model: model guidance used by the commercial airlines sector facilitates navigational planning and reduces fuel consumption for international flights. (2) Eta Model: The Eta model is the primary guidance used for short-range basic North American weather, severe weather forecasting, regional forecasts and domestic aviation forecasts. (3) Hurricane Model: this model contributes to the forecasts of hurricane tracking and intensity and is the primary modeling tool used by the National Hurricane Center (NHC) forecasters. The guidance provided by this model helps reduce the costs associated with evacuations, estimated to be approximately $1 million per mile of evacuated area. As the fidelity and accuracy of this operational model is improved with more advanced computational resources, the NHC forecasters are able to reduce the size of the warning area used for posting hurricane evacuations. (5) Nested Threats WRF Model: This model will replace the current Year-Round Threats Model and will provide detailed guidance for small-scale severe weather, high winds and heavy precipitation, particularly where topography is important. An additional performance measure will be added in the future. This model will also be used to provide the

meteorological input at a very fine scale to support the incident meteorologists and Fire Behavior Analysts to project the spread of fire through environments with structures. (6) Year-Round Threats Model: This model is composed of runs of the GFDL hurricane model whenever there are tropical cyclones threatening and of runs of various fixed and selectable nested Meso domains at all other times throughout the year. (7) Climate Model: This model represents a group of models based upon the Global Model coupled to the Ocean Model and land surface model. It is used to develop the NWS's seasonal outlooks and is directly responsible for the U.S. Seasonal Temperature performance measure. (8) WRF /RUC: This model is an enhanced Rapid Update Cycle (RUC) model and provides guidance to the domestic aviation sector. This model provides guidance to the commercial airline sector for route planning (e.g., storm tracking, jet stream effects) thereby helping to reduce fuel consumption costs on domestic flights.

2.2.1 Program Management and Controls

- 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. Weekly budget meetings were conducted by senior staff to oversee and manage the expenditure of funds for IT hardware and software investments. A NCEP integrated IT spending plan was formulated at the beginning of the year and was executed was reported on by the NCEP centers on a monthly basis to NCO senior level management. Monthly Status reports prepared by Project Manager - each report contains a detailed summary of achievements by each individual within each of the 7 tasks items. Monthly Meeting held the Third Tuesday of each month between the PM and COTRs to review the Monthly Status report and to address any outstanding items or issues on the contract (staffing, metrics, etc). Monthly Invoices are mailed to contracting officials and reviewed by them for accuracy. They have a checklist of items they review to verify charges such as labor costs, support staff, and miscellaneous ODC charges. COTRs receive a courtesy copy of the monthly invoices which COTRs review to determine if hours charged are within range, etc. COTRs notify contracting officials when the invoice is accepted, but they are responsible for authorizing payment.

2.2.2 Monitoring Cost, Schedule and Performance

Cost – This is a fixed price contract. The COTR monitors monthly invoices to ensure they correspond to the baseline. Contract modifications are reviewed by the COTR, Program Manager and Contracting Officer prior to implementation and weekly during routine status meetings.

Schedule – This contract provides the principal supercomputing resource for the National Weather Service and as such it is in operational mode 7X24X365. Service delivery is non-stop except during planned upgrades or unscheduled outages. Daily operational status meetings are conducted at NCEP/NCO and attended by Government and IBM personnel engaged in Production Suite support.

Weekly status meetings are conducted by NCEP/NCO with participation by NCEP, IBM, facility managers and others (such as communications support personnel) as required.

Performance – CCS program status (cost, schedule and performance) is summarized on monthly Quad charts. Performance-based measurements such as on-time product generation, system reliability and run time variability are verified daily. Computational speed, numerical reproducibility and Input/Output performance are verified quarterly via benchmark tests. Additionally, the NCEP High Performance Computing Allocation Board meets on a quarterly basis to review the requests for and allocations of the operational high performance supercomputing resources to ensure efficient use of those resources.

2.3 Reviews

FY09-11funding requests covered in this investment were reviewed as part of the ongoing NOAA PPBES process and by the NITRB and the NWS CFO, as well as by the NOAA programs this investment supports.

2.4 Security

The WCOSS system is accredited under requirements spelled out in DOC Information Technology (IT) security program (08/30/08) that are based on OMB and NIST guidance. System Security Plans, Risk Assessments, and Contingency Plans were certified and approved for WCOSS program in August 2009. A next recertification effort will be completed by 09/30/2012. Annual contingency testing and FISMA self assessment were completed September 2009. Management, operational, and technical security controls are adequate to ensure the confidentiality, integrity and availability of information.

2.5 Performance Measures

The current performance of the system is documented in the table below

Measurement Area	Indicator	2009 Baseline	Calendar Year 2009	Comments
Customer Results	1-day Precipitation Forecast threat score	29	33	
Customer Results	Seasonal Heidke Temperature skill score:	19	26	
Mission and Business Results	48-Hour Hurricane Tracking Forecast	109 miles	TBD	Not posted yet
	48-hr Hurricane tracking intensity Forecast	14 knots	TBD	Not posted yet
Processes and Activities	On Time Product Generation	99.6%	99.73%	

Technology	System Availability	99%	99.96%	
Technology	Time to Switch to Backup System	30 min.	10.00 min	No switch required for six months.

2.6 Other

3.0 Financial Performance

3.1 Current Performance vs. Baseline

The WCOSS financial performance for 2009 shows no variance, lease costs followed the contractual baseline. The WCOSS lease packages hardware, software, maintenance, support (including on-site personnel, training and travel) costs under a single invoice. Planned for 2009 was base: $20,344,000. Expenditures for 2009 were $20,344,000.

3.2 Performance Measures

The IT capital investment for the WCOSS centers on redundant supercomputer systems. The system procurements will follow the general approach and guidelines established by the Department of Commerce (DOC) Consolidated Operations (CONOPS) process. This methodology is intended to improve the acquisition process between the Government and contractor community, and aims to achieve economies of scale through consolidation of system requirements and fewer acquisitions.With respect to CPIC process, NOAA NWS/NCEP WCOSS is a steady state project with periodic technology refreshment (e.g., maintenance costs) required to improve capability and satisfy increasing computational requirements.Since the supercomputer assets are comprised of commercial off-the-shelf (COTS) equipment that is delivered and installed according to contract specifications within short timeframes (days or weeks), there is no development phase.The contract specifies guaranteed delivery at a firm fixed price and therefore there is no risk of cost over-runs.

A monthly quad chart, prepared by the COTR, has been reported to NOAA/NWS senior level management describing the ongoing status of schedule and cost performance as well as identifying issues and project risks.

3.3 Cost Benefit Analysis

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.

This project is authorized by the NOAA Chief Information Office (CIO), the Assistant Administrator for Weather Services, and has been reviewed by the DOC IT Review Board (CITRB).It is identified as a requirement for the National Centers for Environmental Prediction (NCEP), the organization tasked with

the oversight and operation of state-of-the-art high performance computing systems that execute environmental models to meet the nation's requirements for weather and climate forecast information.The acquisition of the primary and backup high performance computing systems undertaken by this project requires a Delegation of Procurement Authority (DPA) from the DOC.

4.0 Innovation to Meet Future Customer Needs

NCEP completed the IBM Power 6 upgrade to the high performance supercomputer systems. The Primary system, normally used for NWS operations, is located at current vendor's facility in Gaithersburg, MD. The Backup system, a functional clone of the Primary, is located at NASA's IV&V facility in Fairmont, WV. The Backup typically handles transition to operations, designed to handle NWS operations under continuity of operations concept. They are functionally symmetrical. A general estimate of theoretical peak performance of NCEP's new IBM Power6 system is 63 TFLOPS. The compute node technology throughout is IBM's Power6 1H nodes running at 4.7 GHz and configured with 32 CPUs per node, each node having 128 GB of memory. Other highlights include: 156 nodes total (142 compute nodes) and 4,992 total processors (4,544 compute processors). This represents an increase in computing power over the current IBM Power5 configuration.
Along with the increase in computational performance the contractor will deliver a balanced system with increased memory, I/O bandwidth and disk storage. This upgrade positions NCEP to meet the needs of the next generation models with increased spatial and temporal resolution and to increase the number of ensemble members. These improvements are designed to provide our customers with improved weather forecast products (including enhanced precipitation and Air Quality forecasts) on a daily basis.

4.1 Number and Types of Users

NCEP manages access to operational supercomputing environments. Currently, about 125 users have access to the primary machine to manage and monitor the daily operational suite of products that are made available for weather forecasting. About 360 users have access to the backup supercomputing environment that aside from being used as the failover environment for the primary supercomputer, is used by NCEP community of modeling developers and its collaboration extended community as a testbed for products destined to become operational.

4.2 Other

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 accommodate more users and incorporate evolving technology, will force the program to find efficiencies and to do more with the same amount of resources.

Project to Address Challenge: **Keeping pace with EMP modeling requirements**.

The NCEP Production Suite systems will be oriented toward generation of a full suite of ensemble-based, probabilistic products. In addition, NPS systems will be run at higher resolution to provide increased accuracy. The most stringent computing requirements are a factor of 30 for the GDAS and GFS analysis and model, a factor of 27 to accommodate enhanced regional Air Quality (RAQ) forecasts, and factors of 26-30 to provide for improved severe weather and aviation forecasts with high-resolution (nested) and ensemble (SREF) runs. The GDAS increase provides resources for assimilating the advanced sensors aboard the NPOESS Preparatory Program (NPP) and METOP suites as well as improved data assimilation techniques such as use of Situation-Dependent

Background Errors (SDBEs), for both global and regional applications. The RAQ requirements are a result of higher resolution for increased local accuracy. The following new capabilities will also be added to the NPS: a global (offline) air quality (GAQ) system, the monthly forecast system, a reforecast system, global and national land surface data assimilation systems, space weather models, hydrological assimilation and forecast systems, marine transportation system and ecosystem models. Together, these systems will require 33.5% greater computational capability and hence a request for three times increase over the current level of funding.