



Comprehensive Large Array data Stewardship System (CLASS)

Project Highlights

Key Accomplishments:

- Performed all lifecycle phases, through requirements, design, implementation, test, deployment, operations, and maintenance
- Maintained 99.9% system availability
- Managed ingest of up to 15 TB per day, distribution of up to 20 TB per day, and a total data volume of more than 15 PB
- Served more than 1,000 unique users and millions of data access orders
- Managed a multicompany team using standardized processes and procedures across multiple CLASS locations
- Successfully achieved CMMI Level 3 certification and maintained certification throughout the life of the contract
- Developed successful Submission Agreement format that was then used across NCEI organization
- Developed an engineering assessment process to receive new archive requests and requirements and evaluate the system impacts and cost
- Implemented Infrastructure as a Service so system administrators at NOAA data centers could use CLASS-managed tape robotics
- Completed almost 700 procurements and managed millions of dollars of equipment and licenses

GST Support for NOAA CLASS

For over 15 years, GST was a prime contractor for NOAA CLASS, NOAA's primary science data archive, providing largescale development and operational support for this complex system. We also earned substantive experience managing geographically distributed teams and contractor teammates with a CMMI Level 3-compliant development environment.

System Design and Evolution: GST was an architect of the CLASS design and oversaw the expansion of CLASS's archive capacity to meet the demands of ever-increasing information holdings while maintaining high system availability. GST collaborated with NOAA and NASA to support new mission requirements of JPSS and GOES-R. Our team continuously evolved the system to incorporate new data types and associated augmentations to the metadata repository necessary for data retrieval, as data volumes increased by 6 times reaching a total volume of 120 Pb. As technologies matured, GST met evolving objectives driven by new satellite data inputs, including GOES-R and JPSS. GST's system sustainment services covered three complete system lifecycle evolutions. These included optimized systems architecture updates, incorporating highly reliable data storage with higher capacity and speed. The evolutions provided greater data processing power to maintain near real-time (NRT) data processing requirements. They improved and expanded a three-node database system to maintain integrity of the NOAA environmental information metadata. Additionally, state-of-the-art network technology was used to disseminate data to NOAA and NASA NRT operational customers, as well as the scientific community. The system also replicated data to other NOAA national facilities via the emerging NOAA N-Wave, addressing the needs of rapidly advancing technology that produces remotely sensed environmental information.

GST engineering staff ensured that the system was 3-5 years ahead of expectations in terms of data types, the number of near real-time files processed, and the volume and frequency of data to be received, archived, retrieved, and delivered.

Systems Engineering: GST developed and implemented a systems engineering plan that defined processes and procedures for the full System Development Life Cycle, including concept of operations development, requirements management, document management, engineering changes, and more. GST established a Systems Engineering Board that performed full engineering analyses of all requested changes and issued recommendations to the Configuration Control Board, and a System Evolution Management Plan that defined how the system would evolve over a five-year period to meet customer goals.

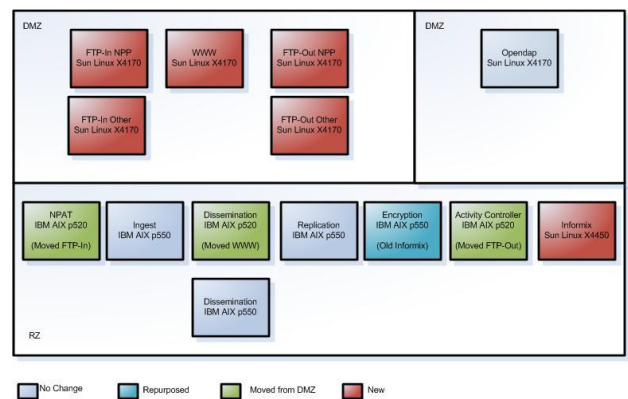
Project and Quality Management: The CLASS PMO executed day-to-day project management responsibilities smoothly, provided high-quality deliverables, and adhered to contract requirements and cost and schedule targets throughout the contract. This included using an ANSI/EIA748B-compliant earned value management system (EVMS) to track actual cost, performance, and schedule against the baselined cost and schedule; collection, analysis, and reporting of quality, productivity, and other performance measures; and risk management. GST had an established, independent quality management program to ensure that contractual objectives were effectively and efficiently achieved, resulting in the delivery of high-quality products and services. This program included measures to detect and prevent deficiencies, including peer reviews, test readiness reviews, operational readiness reviews, spot-check walk-throughs of operations activities, and process and work product audits.

GST's mature and effective project management maintained the project on schedule, within costs, and oversaw exceptional technical performance.

Software Development: GST developed the CLASS software following CMMI-DEV maturity Level 2 processes: CM - Configuration Management, MA - Measurement and Analysis, PMC - Project Monitoring and Control, PP - Project Planning, PPQA - Process and Product Quality Assurance, REQM - Requirements Management, and SAM - Supplier Agreement Management. GST staff achieved CMMI-DEV maturity Level 3 by implementing DAR - Decision Analysis and Resolution, IPM - Integrated Project Management, OPD - Organizational Process Definition, OPF - Organizational Process Focus, OT - Organizational Training, PI - Product Integration, RD - Requirements Development, RSKM - Risk Management, TS - Technical Solution, VAL - Validation, and VER - Verification.

The CLASS software development environment provided an area for code and unit testing, and it was promoted to the integration environment where operational scenarios were used to fully test the software prior to its deployment to three different environments. Our Development teams were formed based on functional elements of the system: controller, ingest, archive, replication and dissemination. Each team would provide a release plan to identify when additional capabilities and features would be incorporated into an upcoming software release. GST maintained a full set of system documentation including a version description document, the software description document, network diagrams, and test plans. We developed and implemented test plans that standardized how we performed testing in multiple environments beginning with unit testing, followed by integration testing, operational testing, and performance testing. Over time, we evolved to an agile-like process to more quickly respond to changing requirements.

Strategic Planning: GST financial analysts provided structured cost planning, estimation, tracking, and reporting at the program and project levels. GST developed NOAA's GAO-compliant lifecycle cost estimate, which identified and projected detailed costs for the entirety of the CLASS lifecycle. For CLASS system-related cost estimation, team members used the Forio Simulate™ modeling software to maintain the CLASS System Estimation Tool (CSET), which estimated future costs of the system and of implementing new data streams. GST used this tool to perform engineering assessments to analyze requested changes.



Cloud Computing: GST conducted a study to investigate the potential uses of public, private, and hybrid cloud services, especially as a viable solution for data dissemination using a common access service. Following the study, CLASS initiated a pilot project to procure public cloud services to assess performance and build a local small-scale cloud computing system using Amazon Web Services (AWS) S3 to test the feasibility and security issues for both private and hybrid cloud services architectures.

Acquisition Management: GST was responsible for all procurements and subsequent acquisitions of hardware, software, and networking equipment for the duration of the CLASS contract. Our team completed almost 700 procurements over the contract period, and managed millions of dollars of equipment and licenses. GST tracked and managed assets and coordinated commissioning and decommissioning activities with the government. GST conducted rigorous asset audits, and NOAA deemed our CLASS asset management to be 'best in class.'

Operations and Maintenance: GST provided 10x5 onsite support and 24x7 on-call operational support for CLASS. Our operators, system administrators, archive managers, and IT security personnel managed daily data ingest, performed preventative maintenance, implemented hardware and firmware upgrades, and performed security patching. GST provided support for all aspects of CLASS, including desktops and laptops, server farms, storage area networks, network-attached storage, enterprise tape robotic libraries, and all associated networking for Linux, Windows, and Apple operating systems. Team members managed a variety of CLASS databases, including Informix, MongoDB, MySQL, and Oracle. GST used the Remedy Incident Reporting tool to document and track issues that occurred in the operational system. GST also used its performance monitoring to identify potential performance problems before they became a threat, and to proactively investigate methods to increase system performance and balance the load across system components and CLASS nodes. GST implemented, managed, and maintained a dual-site archive in Asheville, NC, and Boulder, CO, that provided backup and failover capabilities for the ingest, data storage, and dissemination of large volumes of data. In order to ensure that data backups were reliable, we implemented and performed automated data replication from one node to the other. GST designed, built, and operated receipt nodes with built-in redundancy to provide disaster recovery from any unplanned downtime.

Metadata Management: GST followed NOAA's guidelines for data management including the principles of NOAA Global Earth Observation - Integrated Data Environment (GEO-IDE) along with NAO 212-15 and its relevant procedural directives. Working closely with NOAA's data managers, GST implemented Submission Agreements that standardized how data was received, documented, ingested, archived, and made available for search and discovery. The implementation of these Submission Agreements that define the relationship between a data provider and the data archive was so successful that the rest of NCEI adopted their usage.

Security Engineering and Management: GST staff developed and maintained the CLASS system security plan and its associated documents. It defined the security boundary and included IT resources across three NOAA facilities and CLASS staff offices. GST also managed and executed CLASS security operations and collaborated with the Office of the NOAA CIO. The GST security team created Interface Control Documents (ICD) for secure enterprise connections with multiple NOAA/NESDIS systems, including the NASA Science Data Segment. CLASS was categorized as FISMA 800-53 Moderate impact system, which included over 200 controls, over 100 enhancements, and spanned more than 500 IT inventory items. GST Staff maintained the CLASS Plan of Action and Milestone (POA&M) records within the NOAA enterprise system to identify non-compliance items and track their resolution. GST implemented a security monitoring system that used the following Security Event and Incident Management tools: SecureVue and ArcSight. GST developed and followed the Business Continuity Plan whose goal was to minimize the impact of infrastructure outages and security incidents on operational functions. The plan was used annually during NESDIS Continuity of Operations (COOP) exercises in coordination with other participating NESDIS systems.