The Science Operations and Data Analysis Systems (SODAS) section at Southwest Research Institute (SwRI) has extensive experience with mission and science operations, as well as end-to-end data management and data analysis solutions for supporting scientists and engineers in all mission phases. We provide scalable solutions ranging from full mission science operations and planning, to custom data analysis software for focused science studies.

We support the entire mission lifecycle and have developed many successful systems, including currently operating experiments on the Juno, New Horizons, Cassini, Rosetta, Mars Express, Lunar Reconnaissance Orbiter (LRO), and Magnetospheric Multi-Scale (MMS) missions. We have built systems for mission planning, instrument development, calibration, science planning, uplink sequencing, downlink management and state-of-health analysis. Additionally, these systems provide data processing pipelines and interfaces necessary for end-to-end data management from science planning to data distribution, visualization, analysis, archiving and storage.

Science Operations Centers

SwRI has developed and operated several Science Operations Centers (SOCs) with many staff members dedicated to science operations. Our responsibilities include coordinating science campaign observations and spacecraft data volume and power management, monitoring of sensor housekeeping, developing autonomous and command mode switching protocols, managing instrument throughput,keydown considerations, fault protection, instrument software simulation, etc. Commanding products for in-flight are tested on a software simulator and/or the engineering qualification model (EQM). The policy is to "test what you fly" and "fly what you test." Tools and processes developed to perform operational planning and data processing tasks are used and adapted to support the operational requirements of any investigation.

The basic SOC infrastructure (e.g., user authentication framework, application and web interface framework, data system management) is the foundation for many science data systems produced at SwRI, with the software developed using reusable modules that are easily modified to meet the specific needs of any mission. In addition, the science operations and the data management functions are easily customized to meet the unique requirements of each science investigation.

Science Data Systems

SwRI has a long history of data processing and visualization for science analyses and data archiving, using secure, web-based ground systems. Data processing captures the raw data and converts it to engineering units and physical parameters. SwRI has a strong reputation when it comes to analyzing, verifying, and validating data sets for delivery to the public archive, such as the Planetary Data System (PDS), and for publishing science results.

The data management infrastructure is proven and the majority of the software is reusable, thus reducing time and cost in developing applications for new missions. In many cases, architects of these systems are available to tailor systems for any science investigation.

Data Management and Analysis

Data management includes all stages of ingesting, processing, formatting, distributing, archiving, retrieving, and mining data in automated and interactive fashion. Data analysis includes numerical computation, data fusion techniques, and visualization in a variety of 2D and 3D views.

The staff relies on more than 25 years of systems design and development experience to produce quality solutions using applicable software technologies across the span of computer science and engineering. Applications for clients are developed by applying design methodologies, rapid prototyping, and knowledge of a broad spectrum of standards.

We have extensive experience with many data formats, such as HDF, FITS, ASCII, IDL, Save Sets, and with various archival standards, such as the Planetary Data System (PDS) and the Space Physics Archive Search and Extract (SPASE) standards. A computer laboratory provides an adaptable development and testing environment for almost any software need. The developers use cross-platform (UNIX, Linux, Windows, Macintosh) development techniques, multiple programming and scripting languages (C/C++, FORTRAN, IDL, Python, Perl, PHP, Java, Lua, Python), open-source tools (VTK/Visualization Toolkit, Qt, SciPy, PostgreSQL, SPICE), and proprietary tools (IDL, MATLAB, Mathematica®, SIMION®) to develop analysis, visualization (2D/3D), data fusion and mining applications both on and off the web.

Conclusion

The SODAS section at SwRI has the experience, processes, and the infrastructure to design and develop cost-efficient science operations and data management systems for new missions and science investigations using appropriate technologies.