

STRV-2 Payload Early Orbit Experience and Findings¹

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Abstract — The STRV-2 (Space Technology Research Vehicle) Experiment Module (EM), was launched June 7, 2000 on a Pegasus XL launcher out of Vandenberg Air Force Base. STRV-2 is the primary payload on this Tri-Service Experiment Mission 5 (TSX-5), which is the sixth mission for the Air Force Space Test Program (STP). The EM is an integrated collection of eleven active Experiments and one passive. The active Experiments are commanded and controlled by the STRV-2 System Control Module (SCM) over a 1553 bus. The SCM is also the data interface to the spacecraft's command, communications, and data handling processors. The active Experiments include high data rate optical communications, infrared imaging of aircraft and ships, vibration isolation and suppression, micrometeoroid impact detection, active pixel sensor imaging, micro-g accelerometers, contamination transport mechanisms, advanced solar photovoltaic systems, thermal control materials, and radiation monitors on a chip. The TSX-5 orbit is a 410-km by 1710-km elliptical orbit, which

takes STRV-2 into the Mid-Earth Orbit (MEO) region of space. STRV-2 is the first to study the micrometeoroid and debris population at these altitudes.

Nine Principal Investigators (PIs) are associated with the active Experiments. The Jet Propulsion Laboratory (JPL) is coordinating with the PIs to establish weekly operation timelines for all Experiments; each competing for limited spacecraft resources. This paper describes the processes for developing deconflicted operation schedules, for developing the operation files, which are loaded to the SCM to command and operate the individual Experiments, and for processing, distributing, and reporting Experiment operation results. Eight to ten space ground link sessions are required daily to upload and download STRV-2 command and data files. Experiment results will be described for the first seven months of mission operations, as will the plans for the last few months of this one-year mission.

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Introduction

The Space Technology Research Vehicle-2 (STRV-2) Experiment Module (EM) is a technology demonstration payload flown as part of the TSX-5 space vehicle (SV). The STRV-2 is integrated by JPL, California Institute of Technology under the sponsorship of the Ballistic Missile Defense Organization (BMDO).

BMDO initiated the STRV-2 Project as a technology demonstration project with the Defense Evaluation and Research Agency (DERA), Ministry of Defense (MOD) of the United Kingdom (UK) as a cooperative partner. STRV-2 is the second of three BMDO and DERA cooperative missions dedicated to technology advancement.

BMDO requested JPL to define and organize a technology demonstration payload that would benefit BMDO, NASA, industry, and DERA. JPL completed a systems study in June, 1994 which defined payload and orbit options for an integrated technology demonstrations payload. The payload options were selected to enhance or enable technology

needs for future Department of Defense (DOD) programs such as the Space Missile Tracking System (SMTS). Candidate Experimenters participated in the study. Experimenters provided technical information used to select the experiment/technology suite for the various payload options. Agreements between the BMDO and Experimenters, and their sponsors, included (1) BMDO Power, Materials and Structures (PM&S) Office would provide the payload integration, launch, and mission operations at no cost to the Experimenters, and (2) the Experimenters, if selected, agreed to develop their experiments at no cost to the BMDO PM&S Office and deliver the experiments to JPL for integration with the EM. Experiments were selected in October, 1994.

The EM was designed in advance of a spacecraft selection. The Project defined and developed Experiment interfaces (mechanical, electrical and command/data) prior to spacecraft selection. From the requirements and design phase, a Spacecraft Requirements Document was prepared in conjunction with Air Force Space Test Program (STP). STP utilized the Requirement Document in their Request for Proposal to industry to supply a spacecraft and launch vehicle.

Experiments

The payload option selected is a combination of synergistic, interdependent subsystems and twelve experiment systems. The twelve experiments were developed by twelve separate organizations and agencies under independent sponsorships. The STRV-2 EM Experiments and subsystem, the developers, and the sponsors are listed in Table 1.

Table 1: STRV-2 Developers and Sponsors

EXPERIMENTS & CONTROL SUBSYSTEM	DEVELOPER	SPONSOR
All Composite Experimental Spacecraft Structure	Boeing Defense & Space Group	Air Force Research Laboratory (AFRL)
Electronics Test Bed	NASA JPL	BMDO & NASA
Micrometeoroid and Debris Impact Monitor	NASA Langley Research Center (LaRC)	NASA
Micrometeoroid Impact Detection System	Innovative Dynamics, Inc	BMDO
Active Pixel Sensor	NASA JPL	NASA
Micro Electrical Mechanical Systems	AFRL, NASA JPL	AFRL, NASA
Lasercom	AstroTerra Corporation	BMDO
Mid Wavelength Infrared Imager	DERA	UK MOD
Space Active Modular Materials Experiments	Physical Sciences, Inc.	BMDO
Calorimeter Test Module		
Low Earth Orbit Test Module		
Solar Photovoltaic Test Module		
Temperature-controlled Quartz Crystal		
Microbalance Test Module		
Vibration Isolation and Suppression System	AFRL & Honeywell Space Systems Group	AFRL
System Control Module	Physical Sciences, Inc.	BMDO

The EM payload consists of the All Composite Experiment Spacecraft Structure (ACCESS), the Electronics Test Bed (ETB) with four sub-experiments, the Laser Communications (Lasercom) Experiment, the Medium Wavelength InfraRed (MWIR) Imager Experiment, a Space Effects and Environmental Monitoring Experiment which includes the four Space Active Modular Materials Experiment System (SAMMES) Test Modules, and the Vibration Isolation and Suppression System (VISS) Experiment. The ETB sub-experiments include the Micrometeoroid Impact Detection Monitor (MDIM) Experiment, Micrometeoroid Impact Detection System (MIDS), the Active Pixel Sensor (APS) Imager, and two microaccelerometer devices packaged in the Micro Electro Mechanical Systems (MEMS) Experiment.

The EM employs a System Control Module (SCM) which acts as the command and data handler for all the Experiments and a command and data interface to the spacecraft. The SCM provides some power control and distribution to the EM Experiments. The STRV-2 EM is shown in Figure 1. The STRV-2 EM dimensions are approximately 38 inches wide by 35 inches high, and weighs 220 pounds.

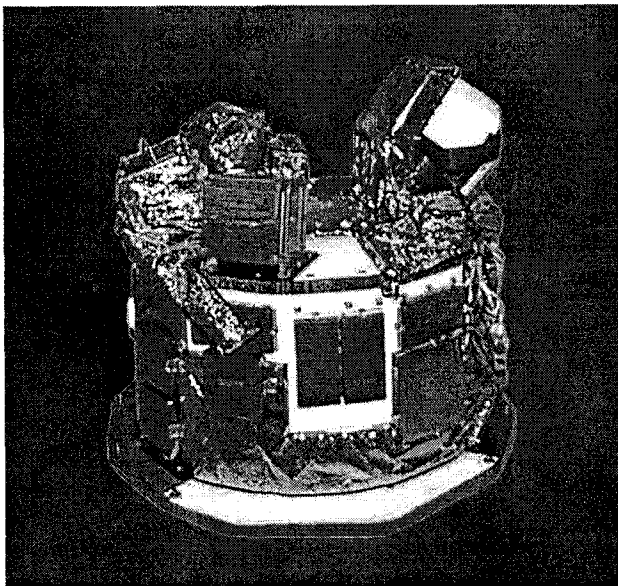


Figure 1. STRV-2 Experiment Module

Objectives

The overall objectives of the STRV-2 Mission are to:

- Obtain MWIR background, clutter data at high latitudes versus seasonal variations, using SMTS filters.
- Demonstrate use of adaptive structures for vibration isolation suppression.
- Measure hazardous space environment factors (radiation, debris/micrometeorites).
- Determine durability of critical materials and components in space environment.

- Demonstrate space-based airborne target detection.
- Demonstrate high bandwidth space ground laser communications.

The STRV-2 objectives are in support of Experiment objectives. The Experiment objectives follow.

ACCESS:

- Demonstrate a simple, low part count, light-weight all-composite spacecraft structure.

ETB:

- Assess the performance of advanced electronics MEO radiation environment.
- Measure micrometeoroid and debris in Low Earth Orbit (LEO) and MEO.
- Provide resources and command, control and communications for sub-experiments.

APS:

- Demonstrate radiation tolerance of APS technology.

MDIM:

- Measure man-made debris population in LEO a decade after the Long Duration Exposure Facility (LDEF).
- Measure the variation of particle population with altitude to 1800 km (MEO).

MIDS:

- Measure number and size of micrometeoroid impacts.

MEMS:

- Measure the degradation of micro-G accelerometers due to space radiation.

MWIR:

- Detect non-afterburner aircraft in flight in 4.3 to 6.0 micron-band.
- Collect image data of terrestrial backgrounds in 4.3 to 5.0 micron-band.
- Evaluate image-processing techniques.
- Image ships, ship wakes, and ship induced cloud wakes in 4.3 to 5.0 micron-band.

Lasercom:

- Demonstrate 155Mb/s space to ground laser communications for altitudes up to 1500 km.
- Demonstrate 1.2Gb/s ground-space-ground laser communications.
- Demonstrate S/N of >5 and 0.4W peak power

SAMMES:

- Measure space environment effects on selected materials.
- Measure long term performance of advanced solar cells.
- Collect contamination and radiation environment data.

VISS

- Demonstrate greater than 20db reduction of vibration transmission (isolation) to payload over 5 to 200Hz.
- Demonstrate greater than 20db suppression of fundamental and first harmonic frequencies on payload (cryocooler).
- Demonstrate ± 0.3 degree steering of payload.

Orbit

The orbit selected for the STRV-2 Mission is one that reaches into the radiation belt. The orbit is 410 km by 1710 km at 69 degree inclination as shown in Figure 2.

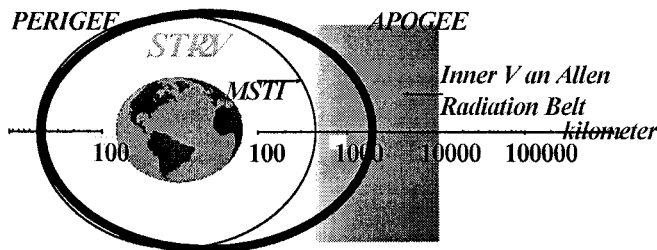


Figure 2. TSX-5 Orbit

Operations Process

STRV-2 operates continuously throughout its planned one year mission. ETB and SAMMES Experiments will be powered continuously to obtain space background information. The Lasercom, MWIR, and VISS Experiments will be operated at various times in the mission to demonstrate specific Experiment objectives. On the average one or more of these latter three Experiments operate every day. All activities are referenced in Universal Coordinated Time (UTC), also referred to as Greenwich Mean Time.

Organizational Interfaces

Overall operation of the TSX-5 mission is under the direction of the US Air Force Space and Missile Systems Center (SMC), Test and Evaluation Directorate, System Program Office (SPO) located at Kirtland Air Force Base KAFB, NM. Within SMC, the SMC/TEL branch, also referred to as STP, performs the mission management and the SMC/ Test and Evaluation Office (TEO) branch performs the daily mission operation.

BMDO provides the overall direction for the operation of the STRV-2 experiments, as shown in Figure 3.

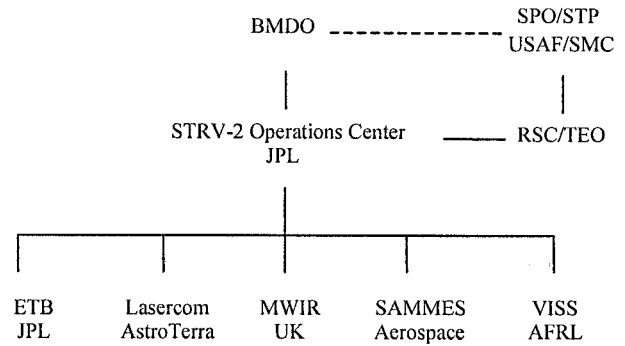


Figure 3. STRV-2 Organization Interfaces.

JPL—As the experiment integrator for BMDO, JPL is responsible for coordinating the STRV-2 Experiment activities with the TSX-5 mission. Specifically, it integrates all of the individual Experiment requests and commands and produces an integrated operating plan with associated command schedules and scripts. Included in the responsibility is assessment of the EM health and operation, removal of the ground added security transfer protocol, pre-processing of the state-of-health and ancillary data, STRV-2 file server administration, and data archival.

At the STRV-2 Ops Center, engineers develop the SCM command schedule (CS) and spacecraft Experiment Interface Processor (EIP) script (SCF) to sequence the Experiments according to defined EM States. There are approximately 25 States identified which integrate the Experiments into complete observation timelines. The individual Experiments are controlled through the use of Experimenter-provided Operational Configuration (OC) and Experiment Configuration (EC) command files. Parameters within the files provide internal Experiment configuration and timing.

Experimenters—The Experimenters prepare and provide individual Experiment requests, OCs and ECs, evaluate health and performance, and provide Experiment data analysis. Additionally, Lasercom coordinates the operation of its ground terminal, and MWIR coordinates associated DERA target activity. The Experimenters, operating from their home facility, communicate with STRV-2 Operations Center and exchange data files using the Internet. Standard phone and Fax communication are used as backup.

Experimenter Locations

- ETB – Jet Propulsion Laboratory, Pasadena, CA
- Lasercom – AstroTerra, San Diego, CA
- MWIR – DERA, UK
- SAMMES – The Aerospace Corporation, El Segundo, CA
- VISS – Air Force Research Laboratory, KAFB, NM

RSC—The STRV-2 Operations Center interfaces with the USAF Research, Development, Test and Evaluation Support Complex (RSC) located at KAFB, NM. The RSC refers to the facility housing the equipment, software and personnel used in operating the TSX-5 mission. The exchange of data with the RSC is through a RSC file server referred to as the Automated Data Distribution System (ADDS). The Internet is the primary method for communication (e-mail) and exchange of data products. Standard phone and Fax communication are used to supplement and backup the Internet.

The RSC uploads and downloads command files and data files to and from the spacecraft through the Air Force Spacecraft Communications Network (AFSCN) Remote Ground Facilities (RGFs). The facility also provides orbit planning, coordination of spacecraft activity with the Experiment Module, ground system scheduling, spacecraft health assessment and maintenance, spacecraft command file generation, spacecraft orbit determination (predict and final), coordination for Space Safety, weather information, integration of mission-unique equipment and mission unique software, and staging of received Experiment-Module data on the ADDS for STRV-2 access. Real-time Experiment state-of-health data is monitored for alarm conditions with contingency actions taken should an alarm violation occur.

In addition, the RSC provides the following:

- Program Action Plan lists the RSC requested supports submitted to the Range Scheduling. The actual scheduled supports are not be final until the day prior to the day in question. The information is used as a guide to satellite-to-ground contact passes which may be available for a particular Experiment activity.
- Pass Plan, also called a 24-hour board, shows the passes expected for next 24 hours (1600 to 1600 UTC). Included are objectives to be accomplished during the pass, the pass rise, fade and duration times, and the RGF to be used.
- Contact Reports compiled at the end of a day contain details regarding the accomplished tasks during each support pass, success/failure rate, and any problems encountered.
- Copies of RSC Operator screens displays containing anomalies observed are faxed to the STRV-2 Operations Center. Screens indicate green/yellow/red condition levels for temperature and current.

Data Interfaces

The ground system architecture is shown in figure 4.

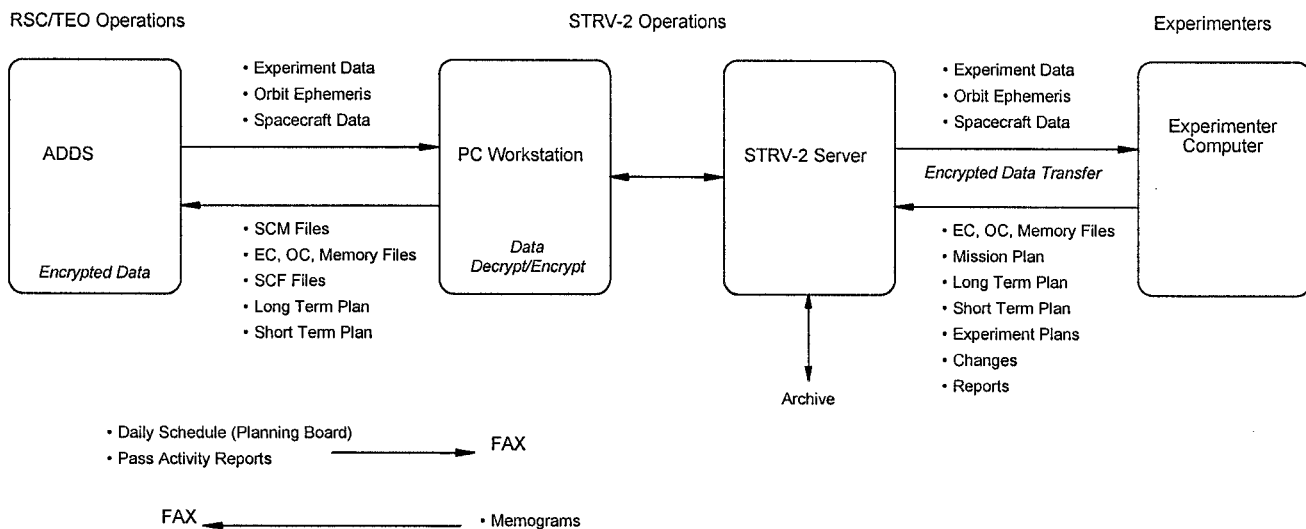


Figure 4. Ground System Architecture

The ADDS file server is used for transferring the command files, Experiment data files, orbit files, planning files, and spacecraft related data files between the RSC and STRV-2 Operations Center. A backup server provides basic upload/download capabilities should ADDS fail.

STRV-2 File Server—The primary Experimenter interface with STRV-2 Operations is through the STRV-2 Server. Through the server they receive planning, Experiment, orbit,

and related spacecraft data, and provide command files and reports. A Bulletin Board provides a shared space for status and other communication.

The STRV-2 server is organized into group files and Julian days. Group files include orbit and planning data, bulletin boards, and the Master Database containing current versions of State upload files. Julian days are further organized by Experimenter and Spacecraft data. Read and write

permissions control Experimenters access to specific subdirectories.

Data Security—In compliance with BMDO and USAF security policies, mission data products are considered STRV-2 Project Only:

- Data products coming from the RSC are exchanged using FTP with specified levels of security. Data files are encrypted using a Fortezza card system.
- The STRV-2 file server is a dedicated access-controlled system. Data files are exchanged using FTP with specified levels of security. Products are encrypted using Pretty Good Privacy (PGP) software.

Planning Cycle

The MWIR and Lasercom Experiments require accurate orbit predict knowledge of spacecraft location and pointing to accomplish their objectives. To achieve this, the RSC provides two orbit prediction files, Long Range Ephemeris Predict and Short Range Ephemeris Predict. These files are used by the Experimenter to accurately forecast their operation and subsequently develop the precise time related commands required by their Experiments.

The files are in Earth-Centered Earth-Fixed (ECEF) format with 1-minute increments. The Short Range file provides accuracy to ± 0.5 km (goal of 100 meters) in cross-track, and in-track. For post MWIR and/or Lasercom events a daily reconstructed orbit Ephemeris is provided. Full weekly reconstructed post-pass Ephemeris are provided each Thursday.

The Long Range Ephemeris Predict file covers a 30-day period and is used to schedule resources up to 18-days in advance. It also provides, although with somewhat less accuracy, the ability to forecast activities 4 weeks out. The Short Range Ephemeris Predict file covers the upcoming 72-hour period.

Deconfliction Process

To resolve conflicts in Experiment operations, the project uses planning calendars to alert Experimenters of each other's plans and potential spacecraft resource conflicts, e.g. power or ground resources. The calendar provides information on Experiment mode (State), time, type of activity, and level of importance to enable most conflicts to be resolved at the operations level. Those that cannot be resolved are taken to the program level for BMDO direction.

However, conflicts can also occur later in the planning process when the SMC/TEO finds out it may not have a specific ground station to support the activity. Generally these occur a few hours before the activity and therefore there is little that can be done to recover, and therefore, an Experiment opportunity is lost.

Monthly Calendar (MC)

The MC contains projected Experiment operations for the next 30 days and is updated weekly. The plan is provided for Experimenter use in adjusting or specifying Experiment operation times for the next week being planned. Experimenters use the MC and the Long Range Ephemeris to plan their week of activity. MCs are placed on the STRV-2 server on Fridays.

Long Term Plan (LTP)

The LTP is used to identify all Experiment operating times during a seven-day period. The seven-day period is defined to start on Monday at 0000 UTC and runs through Sunday 2359 UTC. The plan is developed and submitted to RSC operations each Wednesday, 12 days in advance of the active operating week, in order to obtain the necessary ground resources.

The plan contains the date and time in UTC for the State being run, estimated MWIR and Lasercom event time (if applicable), script duration time, and a comment field to relay notices on special types of Experiment activity.

Short Term Plan (STP)

The STP is used to identify all Experiment operating times during a UTC day (24 hours). The plan is developed by the JPL Operations Engineer and submitted to RSC operations by 2300 UTC for the day beginning 49 hours later. Script start times should not deviate from those in the Long Term Plan by more than ten minutes. There is an option to update the STP up to 6 hours before a scheduled MWIR or Lasercom event to further adjust timing.

For each State being run, the plan contains the date and time in UTC for the script start, MWIR and Lasercom event times, exact names of the command files to be uploaded to the spacecraft and Experiment data files produced by the state. Available command files called out should be submitted with the STP:

- Experiment Configuration Files (EC)
- Experiment Operational Configuration Files (OC)
- SCM Command Schedule (CS)
- EIP script file (SCF)

All files must be binary except the STP.

Operations Timeline

MWIR and Lasercom Experiments utilize absolute times embedded within their EC files to achieve absolute event times during the states in which they run. When the STP is submitted to the RSC 49 hours in advance of the start of that day, orbit predicts are not as precise as are needed to define Experiment absolute event times.

Increased accuracy of orbit data is required as a planned event approaches and necessitates a later submission of ECs with the absolute times embedded. These files are identified with asterisks on the STP as late submission files.

For an MWIR or Lasercom event, the EC files are placed on the STRV-2 Server no later than 12 hours before the State Script start time (T-12). Files to be uploaded to the STRV-2 must be provided to the RSC 9.5 hours from the scheduled event script start time (T-9.5). MWIR and Lasercom have

the option to provide the EC files or updates as late as seven hours before the State Script start. However, if the update option is exercised, 1) the names of the files must be provided at the 12 hour point, and 2) the update option is subject to RSC ground contacts being available for upload of the files. Available contacts are determined from the RSC 24-hour Pass Plan. All files for a state run must be to the RSC no later than six hours prior to the start of the State Script. See Figure 5.

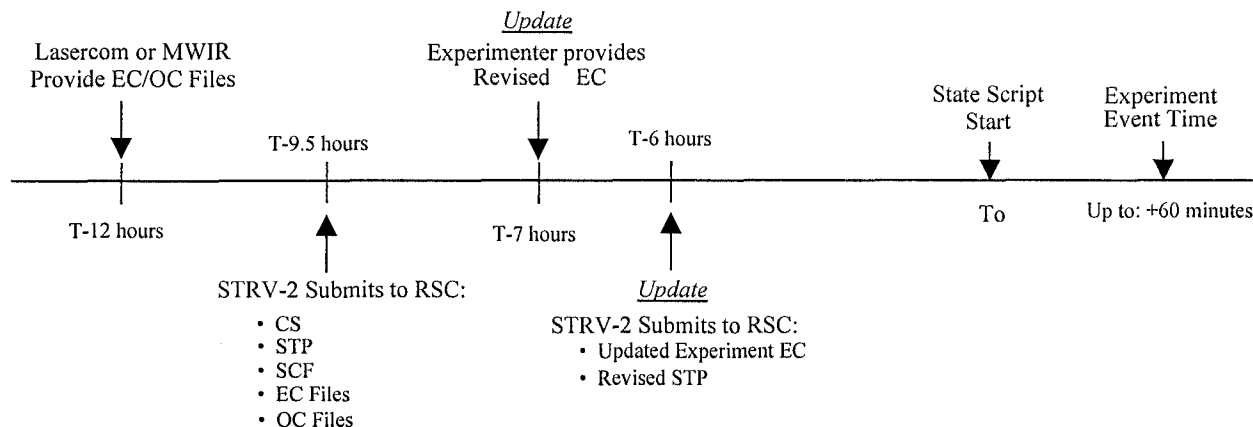


Figure 5. Lasercom & MWIR Command Planning

Mission Operations Activities

Weekly Activity

- Transfer Long Range Ephemeris Predict file and weekly reconstructed orbit files from ADDS to STRV-2 server.
- Receive Experimenter inputs to Long Term Plan, integrate requests, deconflict and provide final to RSC.
- Receive Experimenter inputs to draft Monthly Plan, integrate requests, deconflict, and place it on STRV-2 Server with the LTP. Notify Experimenters of plan availability.
- Archive previous week of data on STRV-2 server.

Daily Activity

- Transfer Short Range Ephemeris and daily reconstructed orbit files from ADDS to STRV-2 server.
- Receive any T-12 hour EC and OC files from Experimenters and process and approve change requests. Revise STP to note any event and script start time changes. Transfer updated files to ADDS and e-mail approved change request back to originator. Notify RSC of availability of updated files.
- Develop new STP at T-49 hours and verify times and name entries. On Fridays and holidays, additional STPs

and command files must be created to adjust for weekends/days off.

- Integrate command activities and develop SCM command schedule and EIP command script in text format, then convert to binary.
- Place copies of all available command files (STP, SCF, CS, OCs, and ECs) on both ADDS and STRV-2 servers. Notify RSC of availability of files.
- Retrieve data products from RSC. (state run data, products, orbit, spacecraft files). Verify that data products meet the criteria expected for the activity being performed. (i.e., file type, name, size). Record file size and any missing or zero byte files.
- Process SCM files to create MWIR and VISS State of Health (SOH) files for any states involving those Experiments.
- Encrypt Experiment SOH and data products and place into designated STRV-2 server directories. Place message on server flight data bulletin board announcing availability of files.
- Process tarred spacecraft files to extract MWIR data (current, thermal, engineering and spacecraft attitude data, converted to engineering units). Zip together separated MWIR data and original tarred files and place them on the STRV-2 server.
- Verify Experiment Module operation by running analysis programs on spacecraft SOH data files plotting temperatures and currents.
- Receive RSC pass summary.

Experiment Health Status Monitoring

The SMC/TEO provides an initial assessment of the overall payload by observing specific payload parameters. These parameters, currents and temperatures have red and yellow alarm limits assigned to them. There can be both upper and lower limits depending on the Experiment. Observed violation of these limits during a real time pass will cause the RSC controller to contact STRV-2 and follow a specific contingency procedure. The RSC also has a set of display screens showing Experiment health data, including the above parameters. These screens were used during launch, Experiment checkout and for special events.

STRV-2 Operations routinely scans the Experiment state of health data provided by the spacecraft to assess overall payload health and operation. Should a discrepancy occur, the Experimenter and/or SMC/TEO are advised.

Status Reporting

Experimenters and STRV-2 Operations provide weekly status reports to the project manager. Each report summarizes the past weeks' Experiment activity and identifies any observed anomaly or problem. Reports may include trending analysis to forewarn of possible problem, i.e., temperature rising or tabulation of recurring problems.

Configuration Management

The project uses Change Requests to maintain configuration control of all files.

Experiment OC and EC default files are on-board the satellite and are tracked by version number in the Master Database on the STRV-2 server. Each submittal of an updated OC or EC with a new version number requires an upload to the EIP for any state that uses that file. The Operations Engineer draws all command files from the Master Database to be used for a given operation. Should a different OC, EC, CS or script be required, a change request will be submitted to update the appropriate files.

Experimenter requests to change a previously submitted Experiment operating plan or individual EC or OC will require submission of a change request. Change requests are submitted on the STRV-2 Change Request Form along with the changed OC or EC files. These are uploaded to the STRV-2 Server in the Experimenter's folder under the Julian Day affected by the change. An e-mail should then be sent to notify the JPL Operation Engineers of a change request and new files.

Data Backup and Archive

STRV-2 Operations performs a precautionary Server backup every 24 hours and archives the data to CD-ROM every two weeks in a sliding window format. Requests for

archived files are submitted via e-mail to the Systems Administrator.

Anomaly and Contingency Process

Anomalies determined to be within STRV-2 are handled by the STRV-2 Operations Team with concurrence by BMDO. Anomalies involving the spacecraft or RSC actions will be handled by SMC/STP.

Contingency action plans and associated command files were developed and rehearsed with SMC/TEO prior to launch. Two levels of contingencies were developed:

- Level-1—SMC/TEO takes immediate action to safe (turn-off) an Experiment.
- Level-2—STRV-2 is contacted prior to SMC/TEO command action.

The contingency criteria is based on current levels and temperature limits.

Bypass Operation—Should an SCM failure occur the Experiments can be operated directly from the EIP. In this by-pass mode the CS and OC files are not used. During SCM Bypass operation, the EIP will perform most of the functions the SCM previously provided.

Future Operations

For the remainder of the mission, STRV-2 will continue to operate according to plan. Several Experiments have already met their primary objectives, which allow STRV-2 Operations to go to reduced staffing as planned for the remainder of the project while continuing to meet the remaining Experiment objectives.

Conclusions

The STRV-2 Operations Team has been successful in supporting the Experiment payload and meeting many of the primary objectives to date. The Internet has shown to be a reliable and expedient interface for daily file transfers of 50-75 MB. STRV-2 Operations has successfully handled numerous data products in a labor-intensive operation between Experimenters and RSC using minimal staffing and changes in file delivery times to meet the challenges encountered in providing support across several time zones. The basic operation plan was structured to be a 5-day per week operation, but was augmented to handle after hour and weekend activity support as necessary.

Biographies

Kerry D. Erickson is the STRV-2 Experiment Operations Manager. He is supervisor of Advanced Mission System Engineering in the Mission Systems Engineering Section at the NASA Jet Propulsion Laboratory, California Institute of Technology. He has over 30 years experience in the development and operations of flight operations at Jet Propulsion Laboratory. He has a BSEE from the University of Illinois.

Kathleen D. Kelleher is the Lead Operations Engineer and Systems Administrator for the STRV-2 Project. She is employed by User Technology Associates under contract to the Space Instruments Implementation Section at the NASA Jet Propulsion Laboratory, California Institute of Technology. She has a BA from the University of Minnesota-Twin Cities.

James T. Kenny is a Project Manager in the Space Instruments Implementation Section at the NASA Jet Propulsion Laboratory, California Institute of Technology. He has developed and led development of space hardware at Martin Marietta Corporation and Jet Propulsion Laboratory. He has a MS in Solid Mechanics from Colorado State University and a MS in Computer Information Systems from the University of Denver.

Lee D. Wiggleworth is the Software Engineer for the STRV-2 Project. He is a member of the technical staff in the Space Physics Research Element at the NASA Jet Propulsion Laboratory, California Institute of Technology. He has a BS in Computer Information Systems from California State Polytechnic University-Pomona.