The Integrator

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A Message from the Associate Director of Projects for Mission Services

Our organization continues to face and address many changes and challenges. Three of our GSFC contracts have been merged into the NASA-wide Consolidated Space Operations Contract (CSOC). Our Space Operations Management Office (SOMO) budget has been restructured, with a significant portion of it removed from our control and retained at JSC for direct funding of CSOC. The SOMO budget guidelines for future years contain dramatic reductions. In addition, we are continuing to shift our budget toward customer-oriented full cost accounting. I am pleased that, in addressing these changes, we have maintained a strong customer focus and that we continue to meet the Enterprise needs. Missions we have supported over the past year, include approximately 30 on-orbit NASA missions, 30 Expendable Launch Vehicles, 3 Shuttle missions, 2 Long Duration Balloon Program missions, and numerous sounding rocket/Wallops range operations. Time and again we have displayed our winning combination of customer focus, expertise, and dedication to achieve excellence.

I would like to highlight a few of the more noteworthy events that have taken place since our last publication. The launch of Landsat-7 on April 15, 1999 was magnificent. Many members of our staff, both at Greenbelt and Wallops, contributed to this accomplishment, setting a high standard for upcoming missions, such as Quick Scatterometer (QuikSCAT), TERRA (EOS AM-1), Tracking and Data Relay Satellite (TDRS) H, and Far Ultraviolet Spectroscopic Explorer (FUSE). We provided mission support to the initial steps in assembling the International Space Station, and provided hardware support [i.e., the Early Communications System (ECOMM)] from our organization. In addition to direct mission support, staff from our organization participated in a historic North Pole expedition. While there, the team demonstrated how NASA-developed technology and the Internet have made it possible for scientists working in very remote locations to send and receive data worldwide, conduct science observations, and contribute to the Agency's goal of educational outreach. Details about these events are described in articles within this newsletter.

We continue to successfully accomplish our mission of enabling a rich variety of customer missions. We also have made significant progress working through the challenges brought about by the CSOC transition and decreased budgets. I am confident that we will continue to remain a vital component of our Enterprise customers' missions, and that we will contribute to the successful development and implementation of NASA's strategy for entering the 21st century.

Phil Liebrecht

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Highlights in This Issue...

In This Issue ...

Network Elements

EBNet Ready to Support TERRA and QuikSCAT

The TERRA spacecraft (a.k.a. Earth Observing System AM-1) has been shipped from Valley Forge, Pennsylvania, to the Vandenberg Air Force Base (VAFB), in preparation for its launch. Launch from VAFB is currently scheduled for July 28, 1999. TERRA carries a payload of five sensors that will study the interactions among the Earth's atmosphere, lands, oceans, life, and radiant energy.

The EOSDIS Backbone Network (EBNet) will provide network support for TERRA using Timeplex multiplexers at the VAFB, Goddard Space Flight Center (GSFC), White Sands Ground Terminal (WSGT), the Second TDRSS Ground Terminal (STGT), the Svalbard Ground Station (SGS), the Wallops Ground Station (WGS), and the Alaska Ground Station (AGS) at Poker Flat, Alaska. Pre-launch testing is currently being conducted using EBNet circuits and equipment at each of these locations. For this mission, clock and data communications support is being provided between the ground stations and the Earth Observing System (EOS) Data and Operations System (EDOS) at GSFC.

Pre-launch testing was also being conducted for the Quick Scatterometer (QuikSCAT) mission, which launched on June 19 on a Titan 2 launch vehicle (see article on page 17). QuikSCAT carries the SeaWinds instrument, which is a specialized microwave radar that measures near-surface wind speed and direction—key factors in determining weather patterns—over the Earth's oceans.

The AGS, WGS, SGS, and McMurdo Ground Stations (MGS) in Antarctica will be used for QuikSCAT support. The ground stations are on the IP Transition Network while the Mission Operations Center (MOC) in Boulder, Colorado, and the Mission Monitoring Center (MMC) at the Jet Propulsion Laboratory (JPL) are on EBNet. Instrument operations will be conducted from the SeaWinds Processing and Analysis Center (SeaPAC) at JPL, which is also on EBNet. Internet Protocol (IP) is being used for communications between the MOC and the ground stations and SeaPAC.

An Asynchronous Transfer Mode (ATM) service was recently implemented in Boulder, Colorado for QuikSCAT support, completing an EBNet ATM implementation linking GSFC, JPL, the National Snow and Ice Data Center (NSIDC) in Boulder, as well as the EROS Data Center (EDC) in Sioux Falls, South Dakota and the Langley Research Center (LaRC) in Hampton, Virginia.

By James M. Cameron/GSFC Code 291

For additional information on EBNet, please contact the author at (301) 286-6287 or via email at james.m.cameron@gsfc.nasa.gov

EOS Polar Ground Stations Support Landsat-7

The EOS Polar Ground Stations (EPGS) Project reached a major milestone on April 15, 1999 when it provided launch and early orbit support to Landsat-7 (for more on Landsat-7, see the article page 14). The ground stations at Alaska and Norway performed flawlessly for Landsat-7, providing S-band telemetry, tracking and command (TT&C) services. The ground stations continue to support S-band TT&C services in addition to capturing science data on the X-band downlink. The X-band science data is recorded on magnetic tape and shipped to the Landsat Processing System in Sioux Falls, South Dakota for level zero data processing. Since the Landsat-7 launch, the ground stations have demonstrated stable operations.

In addition to supporting Landsat-7 on-orbit activities, the EPGS Project has routinely performed interleaved Quick Scatterometer (QuikSCAT), TERRA, and EO-1 testing and pre-launch support activities. This support includes a series of TERRA verification tests where command and telemetry data flow is verified between the ground stations and the EOS Data and Operations System (EDOS)/ EOS Operations Center (EOC). The EPGS project also successfully participated in a QuikSCAT ground data system Year 2000 (Y2K) test that demonstrated the integrated ability to receive, record, store, process, and forward real-time data, playback data, and tracking data in Consultative Committee for Space Data Systems (CCSDS) format during a Y2K test scenario. The ground stations have now entered a configuration freeze for the QuikSCAT launch.

Other project highlights include a mid-April visit to the Norway ground station by NASA Administrator, Dan Goldin, that resulted in high praise for joint NASA-Norway collaboration on the development of an outstanding facility. Also, under the Consolidated Space Operations Contract, a second EPGS ground terminal is being implemented in Alaska (collocated with the current EPGS station) to provide additional tracking and data acquisition necessary for the future EOS missions starting with PM-1. That station is scheduled to be operational by June 2000. Other missions supported by the EPGS include ICESat and CHEM-1.

Key EPGS Project Milestones:
- QuikSCAT Launch 6/18/99
- TERRA (AM-1) Launch 7/28/99
- EO-1 Launch 12/15/99

By Mark Burns/STel

For more information about EPGS, please contact Bob Stelmaszek at (301) 286-5263.

Ground Station Reengineering Effort Nearly Complete

During the STS 96 mission, the new equipment at Merritt Island (MILA) and Ponce De Leon was successfully used as prime for mission support. Most of the subsystems were under workstation control. The remaining task to be completed involves the transfer of range safety data to the Range Operations Control Center (ROCC). Once this transfer is finished, the MILA/Bermuda Reengineering (MBR) project will, for all intents and purposes, be completed after approximately five years of planning and implementation effort. Expectations are that the investment will be recovered within the next few years from reduced recurring and operational costs.

By Frank Stocklin/GSFC Code 451

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White Sands Complex Expanding Services

The services offered by NASA's White Sands Complex (WSC) just keep getting better and better! WSC is currently the scene of several new efforts which will expand the range of services provided to customers.

WSC's latest addition is the Guam Remote Ground Terminal (GRGT), which allows the Tracking Data Relay Satellite System (TDRSS) to support customer spacecraft from within the USA's territorial boundaries, 24 hours per day with global coverage. The GRGT site is located on the island of Guam, in the Mariana Island chain. GRGT is connected to the WSC via fiber optic cables, which currently flow roughly 2 Mbps of customer data. The link is scheduled for a gradual ramp-up of capacity and will eventually provide over 80 Mbps of customer data flow for the International Space Station. Recent problems with the MIR Space Station (for example, the crew reporting a fire aboard the Space Station, just as they orbited out of the field of view of their ground stations, entering a communications blackout) serve to emphasize the importance of GRGT to the International Space Station. More information about GRGT and a map of the site's location is available on the web at url *http://wscproj.gsfc.nasa.gov/wscserv.htm*.

The WSC Alternate Relay Terminal (WART, see article on page 27) will soon provide a seventh TDRS link. WART will be dedicated to supporting the National Science Foundation's South Pole Relay. WART is an economical use of spare equipment that will provide the limited TDRS support required for this project.

In addition, WSC's Multiple Access support services are being enhanced to allow for unscheduled, demand-driven

(continued on page 6)

The Guam Remote Ground Terminal Site

(continued from page 5)

customer support that will not impact normally scheduled supports (see article on page 23). WSC has also completed its TDRS H, I, J modifications and is ready to support the new spacecraft, the first of which is scheduled for launch later this year. The WSC engineering team is also modifying the customer support equipment to provide TDRS coverage for satellites that were designed for Ground Network support—a utilization of the TDRS which was thought impossible until recently.

Seismic Star is another potential modification to the WSC system. WSC may offer support to oil exploration vessels at sea, allowing the real-time transfer of seismic exploration data. This effort may reduce the costs of oil exploration and help lessen America's dependence on foreign oil. TDRS is the world's only communications system that offers real-time support/data link for earth orbiting satellites, rocket launches, aircraft in flight, and ships at sea.

By Douglas Perkins/ATSC/WSC Training

For more information, please see the WSC Project Office home page at http://wscproj.gsfc.nasa.gov, or contact Jim Gavura, Station Director, or Bryan Gioannini, Deputy Station Director, at (505) 527-7000.

TCP/IP Services Available at the White Sands Complex

The White Sands Complex TCP/IP Data Interface Service Capability (WDISC) is ready for operations! WDISC allows Space Network customers to receive telemetry and send commands using TCP/IP.

At the WDISC Operational Readiness Review (ORR) on February 22, 1999, the WDISC was unanimously deemed ready for operations, pending the resolution of open System Trouble Reports (STRs) and Review Item Dispositions (RIDs). Since the review, GSFC engineers diligently worked these problems, successfully solving all critical issues. In addition, CSOC engineers developed and documented plans for maintenance and sustaining system support, vendor support, and division of responsibilities. The WDISC system was officially delivered to Consolidated Space Operations Contract (CSOC) Operations on May 1, 1999.

The Far Ultraviolet Spectroscopy Explorer (FUSE), scheduled for launch no earlier than June 18, 1999, will be the first WDISC customer. Other future customers will include the New Millennium Program/Earth Orbiter-1 (NMP/EO-1), Gravity Probe B (GP-B), and the Microwave Anisotropy Probe (MAP).

For additional information on WDISC, please contact Cathy Barclay (ATSC) via email at Catherine.B.Barclay.1@gsfc.nasa.gov or via telephone at (301) 805-3221.

Network Control Center News

The Network Control Center (NCC) has several ongoing activities and significant accomplishments to report in this issue of *The Integrator*. As a result of the successful NCC 98 delivery, several systems are being removed from the NCC since they are no longer needed. Transportation personnel removed the Masscomp Intelligent Terminal equipment from the NCC on Thursday, May 20th. Removal of the Unisys 2200 and Restricted Access Processor (RAP) systems is now underway.

The NCC fail over to the Auxiliary Network Control Center (ANCC) has been delayed until further coordination takes place. This event will be the first time that a complete fail over to the ANCC cluster/servers will take place, and will occur after the STS-96 shuttle mission. To date, NCC operations have transitioned to the ANCC workstations on several occasions, but remained on the operational server cluster.

Since the successful transition to NCC 98 on February 12th, minor problems have been encountered. These difficulties have been corrected either procedurally or by quick fixes, or will be prioritized and corrected in the upcoming completion release. The NCC 98 Completion Release (99.1) will include Flexible Scheduling and will be delivered in mid June after STS-96 (see article, page 7).

Ground Network Scheduling System Replacement (GNSSR) testing and training is proceeding without any major problems. Documentation personnel are currently working on a preliminary user's guide. Report generation code is under development and will provide the type of information that has been requested over the years at the click of a button. The full system is online in the Operations Control Room (OCR) and will be used for shadow support during the STS-96 shuttle mission.

On May 5th, there was an unannounced audit of Communications Security (COMSEC) assets held on the

GSFC COMSEC account, including the NCC. The audit was performed by the COMSEC Auditor and the Central Office Of Record (COR) representatives from KSC. All NCC hardware, equipment, and key packages (down to the control records and individual key strips/segments) were scrutinized. The safeguarding of these assets is flawless. All associated record keeping and position logs were without discrepancy. The customer recognized the outstanding effort by the Security Watch Officer (SWO) to maintain perfect records for the NCC.

In addition to the activities described above, the NCC supported 13 Expendable Launch Vehicle (ELV) launches and one Space Shuttle mission since January 1st of 1999.

Upcoming activities at the NCC include the implementation of:

- NCC Software Release 99.1
- An equipment move from the Software Engineering and Research Facility (SERF) in Building 12 and Labs and also from the Greentech II Software Development Facility (SDF) into the NCC
- A full ANCC Operational failover after STS-96.

By Joe Snyder/ATSC

For further information, please contact Bill Webb/GSFC Code 451 at (301) 286-3264 or visit http://ncc.gsfc.nasa.gov on the World Wide Web.

Beyond NCC 98 – The Completion Release and Maintenance

NCC 98 has been operational since February 12, 1999. Preparations for transitioning the NCC 98 Completion Release into Operations are well underway. This transition is scheduled to occur after the completion of STS-96. The NCC 98 Completion Release puts the final touches on the Service Planning Segment Replacement (SPSR) system. This release implements the Flexible Scheduling capabilities, which are intended to optimize the usage of the Space Network resources and increase the likelihood that a customer can schedule an event when necessary.

Through rigorous testing, NCC 98 was verified to be Year 2000 (Y2K) compliant. In accordance with NASA guidelines, the System Test group performed a series of Y2K regression tests to ensure that the NCC 98 Completion Release remains Y2K compliant. As a further check for Y2K "problems," one of the test facilities was left in the year 2000 - 2001 for all of their regression testing—over a full month. There were no Y2K problems noted during the testing of the Completion Release.

As the NCC 98 Completion Release effort decreases, planning for the NCC 98 maintenance effort swings into full stride. The primary focus of this maintenance effort is to resolve existing problems/deficiencies impacting operational activities. The goal is to:

- Improve system/software stability
- Enhance system performance for operator functions
- Repair problems requiring labor-intensive workarounds by NCC operators
- Reduce manual intervention by the sustaining engineering team.

Problems identified for resolution will be prioritized/ constrained by cost effectiveness (i.e., "bang for the buck") and operational needs.

The maintenance activities are planned to run from July 1999 to September 2000. Currently, three Maintenance Releases are being planned. The first release will focus on high-priority Problem Reports (PRs) with short-term resolutions. This release is presently scheduled to transition to operations during or after January 2000. The major component of the maintenance effort is the second release. This release targets the problem resolutions requiring any redesign or database schema changes. Finally, the third release will complete the resolution of remaining or resulting PRs that are deemed operationally necessary.

By John (JR) Russell/CSC

For further information about NCC 98 and its completion and/or maintenance releases, contact Roger Clason at (301) 286-7431.

NCC 98 Is Going Strong!

The NCC 98 Initial Release was successfully transitioned to operations on 2/12/99. Since then, the NCC proficiency metrics have measured above 99.65!

Science Data Processing Facility Preparing to Support HST Call-up Servicing Mission

Science Data Processing Facility (SDPF) personnel are currently involved in preparations for the Hubble Space Telescope (HST) Call-up Servicing Mission (SM3a), scheduled for October 15, 1999. This mission became necessary when a third HST gyroscope failed, leaving only three of the six gyroscopes working properly. The gyroscopes allow the telescope to point at stars, planets and other targets. If fewer than three are operating, HST will be unable to continue its science mission and will automatically place itself in a protective "safe mode." Flight rules allow for a 'call-up mission' when no backup gyroscopes are available. Since preparations were already being made for a scheduled third servicing mission next year, it was decided that the planned mission would be divided into two flights in order to reduce the workload on each.

During SM3a, the first of the two flights, all six gyroscopes, a guidance sensor and the spacecraft computer will be replaced. The new computer will reduce the burden of flight software maintenance and significantly lower costs. A voltage/temperature kit will be installed to protect spacecraft batteries from overcharging and overheating when the spacecraft goes into safe mode. A new transmitter, the S-Band Single Access Transmitter (SSAT), will replace a failed spare currently aboard the spacecraft, and a spare solid-state recorder (SSR) will be installed to allow efficient handling of high-volume data. Insulation that has degraded will also be replaced. The insulation is necessary to control the internal temperature of the telescope.

The SDPF is currently involved in pre-mission testing and verification activities to help ensure the success of this vital mission. Through the use of special scripts developed by the SDPF staff, spacecraft times in the fill packets of the SSR data received by our Pacor II system can be identified. Knowing these times makes it possible for the Data Management System (DMS) group to determine if all of the expected data are present. Pacor II is also able to provide statistics for the data sent from the Simulation Operations Center (SOC) to test the SSAT. Baseline data has been received for use in bit comparisons with the data sent from the SOC to ensure that no data corruption is taking place. Also, the Generic Recording System (GRS), the archival system for HST data at the SDPF, is being used to record engineering data for pre-mission testing.

The primary role of the SDPF during the mission will be as a participant in the verification of the new SSAT and SSR. Previously, the SDPF participated in the first and second servicing missions, and our staff is looking forward to being a part of the team that addresses the challenges in this next phase in the life of HST.

By Carl Henning/ATSC (portions of this article were excerpted from NASA Press Release 98-38 dated 3/10/99)

For further information, please contact the author at (301) 286-8334 or via email at Clifford.O.Henning.1@gsfc.nasa.gov

User Planning System Release 12 Nearing Completion

In late February 1999, the User Planning System (UPS) began operational support for a new version of Release 11, known as Version 4. This version supports true TCP/IP connectivity to the Network Control Center (NCC), as well as the Initial Release of NCC 98. UPS Version 4 has been deployed operationally at the GSFC Multi-satellite Operations Control Center (MSOCC)—currently supporting ERBS, EUVE, CGRO, TRMM, UARS, and RXTE. UPS Version 4 is also used by HST and Landsat-7. The JSC operations team has installed Version 4, and expects it to be used to support the next Shuttle mission, as well as all International Space Station events.

Over the last few months, UPS development task personnel have been very busy finalizing UPS Release 12, which will support the new flexible scheduling features that will be available in the Completion Release of NCC 98. Some of the features the UPS will support are:

1. Flexible Scheduling, including:
   a) Flexible TDRS
   b) Customer-defined schedule request priority
   c) Service tolerances
   d) Service bounding and coupling
   e) Service minimum duration
   f) Alternate schedule add requests (SARs)
   g) Replace requests
   h) Wait list requests
2. Transmission of TDRS Scheduling Windows (TSWs) to NCC
3. TDRS Unscheduled Time
4. Customer-supplied TDRS contact data.

In addition, a new schedule request generator, Recurrent Scheduling (RS), will replace the Automatic SAR Generation

capability. The new RS will allow customers to generate a schedule of recurrent (e.g., weekly) flexible schedule requests. Similar to Autogen, RS compares customer-entered schedule request patterns and prototypes against a customer's TDRS contacts to create the flexible schedule requests. RS can use TDRS contact data generated from either the Flight Dynamics Facility or the new customer-supplied TDRS contact data, a feature in Release 12 known as TDRS Communication Window data.

One significant capability that UPS Release 12 does not provide is support for the new TDRS H, I, J services: S-band Multiple Access (SMA) and Ka-band Single Access (KaSA). Although a Release 13 task plan has been created including SMA and KaSA services, significantly enhanced graphical/tabular capabilities, and possibly the incorporation of real-time capabilities, there is currently no funding nor direction to implement these capabilities. Missions who are interested in supporting continued UPS development should contact the UPS Task Lead, Howard Michelsen.

As stated in previous *Integrator* articles, once all UPS customers have transitioned to Release 11, Version 4, support for the old UPS Nascom Gateway will be terminated. In any case, all support for the old gateway will be terminated no later than Fall 1999.

By Howard Michelsen /CSC

Further information regarding the UPS Project can be found on the WWW at http://isolde.gsfc.nasa.gov/ups/ or contact the author via email at hmichels@cscmail.csc.com

Wallops Test Range Supports X-33 Program

From April 15, 1999 through June 30, 1999, ten Wallops operations personnel will be at NASA's Dryden Flight Research Center in Edwards, CA to support X-33 testing (for more about the X-33, see the article on page 23). In addition to sending personnel to NASA Dryden, Wallops is also providing mobile range systems, including a radar system, flight termination command system, and generator system.

Scheduled activities include the full integration and testing of all range systems supporting the initial X-33 flights. The range systems set up at Dryden will have the opportunity to flow static data to and from the NASA Dryden X-33 Integration and Test Facility, and also to track an X-33 avionics subsystem integrated into a NASA F-18. The next task will be to move these systems from NASA Dryden to the Dugway Proving Grounds (DPG) in Utah.

Wallops personnel have just completed the installation of a 9-meter antenna system at DPG. The mobile systems will move from NASA/Dryden to DPG in July 1999, and will then begin the final phase of integration and testing prior to the first launch of X-33, which is scheduled for July 2000.

By Steve Kremer/WFF Code 452

For additional information, please contact the author via email at steven.e.kremer.1@gsfc.nasa.gov

Network Customers

The Compton Gamma Ray Observatory Points at Pulsars

Launched in April 1991 by the space shuttle Atlantis, the Compton Gamma Ray Observatory (CGRO) is now well into its ninth year in orbit, and continues its successful operations. The spacecraft and its various subsystems are, for the most part, continuing to function nominally. There exist several minor subsystem anomalies—one of the gyroscope motor currents increased and exhibited mild fluctuations, and there were some concerns over the depths of some battery discharge levels—but none of these problems have escalated to a serious level. Automation of a number of flight operations activities has been successfully implemented, leading to a reduction in the operations staffing levels necessitated by budgetary constraints. In addition, extensive preparation for the forthcoming millennium change, and its potential impact on spacecraft and data operations software, have been made.

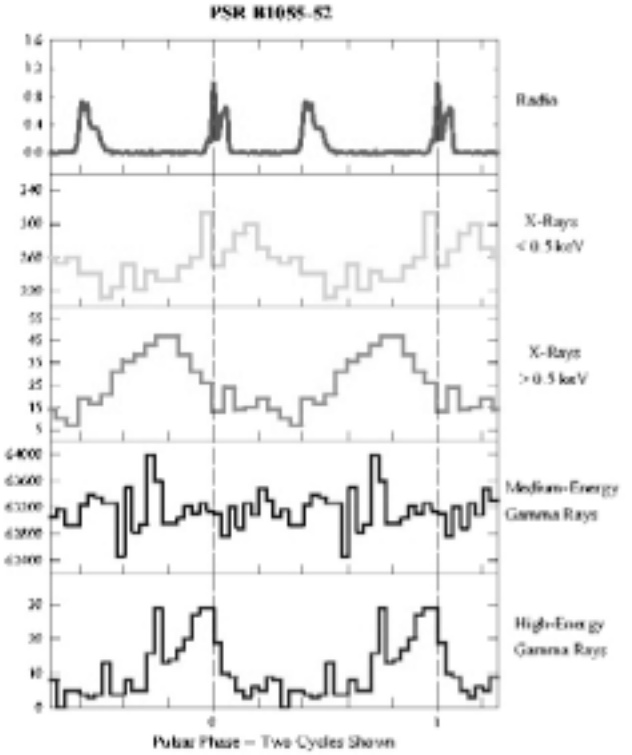
CGRO's scientific instruments also remain in good health overall, with only a few problems occurring. One component of the Energetic Gamma Ray Experiment Telescope

(continued on page 10)

(continued from page 9)

(EGRET) spark chamber failed during the fall of 1997, causing event recognition efficiency to fall to a level only about 25% that at launch. However, turning off the failed component has reduced spurious sparking, and thus will reduce gas consumption and extend the life of the instrument. The instrument can be activated on short notice, in the event of significant celestial events. Even in its reduced mode of operation, EGRET has enabled discovery of yet another gamma ray quasar!

The Oriented Scintillation Spectrometer Experiment (OSSE) and the COMPton TELescope (COMPTEL) continue to operate nominally. Each of the Burst and Transient Source Experiment (BATSE) detectors are operating properly. Some small gain changes have been made, but voltages are still well below limits. It is anticipated that the useful lifetime of three of the four instrument packages is another 5-10 years. CGRO is currently budgeted to continue operating through FY02, and a proposal to continue operations through FY04 will be reviewed by NASA during the summer of 2000. Most importantly, CGRO continues to produce new and exciting science!



Multiwavelength light curves for PSR B1055-52. The bottom panels were obtained with COMPTEL and EGRET. The brightness of the pulsar varies as the neutron star rotates, with the two rotations shown here lasting about four-tenths of a second. If the pulsar were a simple "lighthouse," the bright peaks would all occur at the same time.

CGRO has recently made significant new contributions to the study of pulsars. A pulsar is a rapidly rotating neutron star—the tightly packed remains of an exploded, massive star. Each pulsar is approximately 10 km diameter, and rotates about its axis with a period ranging from seconds to milliseconds. The pulsar's ambient environment is characterized by superstrong magnetic fields—presumably generated by a dynamo mechanism derived from the "liquid core"—and associated electrical high voltages. Like a spinning top, a pulsar gradually loses energy as it "spins down," the main energy loss in this case involving the magnetic-dipole field. This energy loss can be detected by astronomers as radio waves, visible light, and X-rays. Seven pulsars are known to produce gamma rays, the most energetic form of radiation. Prior to the advent of CGRO, only two gamma ray-producing pulsars were known.

In the simplest pulsar model, the pulsar emits radiation in a manner similar to a lighthouse—that is, with a single beam of light sweeping through space. However, a team of astrophysicists led by David Thompson, an astrophysicist at NASA GSFC, found that the oldest of these gamma-ray pulsars, PSR B1055-52, produces flashes of light that arrive at different times and with different appearances, depending on the wavelength of the measurement. It was discovered that, while all the pulses from PSR B1055-52 repeat every two-tenths of a second, the different types of radiation arrive at slightly different times. The gamma-rays, measured with EGRET and weakly detected with COMPTEL, clearly precede the radio pulses and have a broader profile. This diversity indicates that the pulsar has a more complex geometry than the simplest models predict, with radio, X-rays and gamma rays probably produced at different places in the pulsar's whirling environment. It appears that the simple lighthouse model needs to be reconsidered.

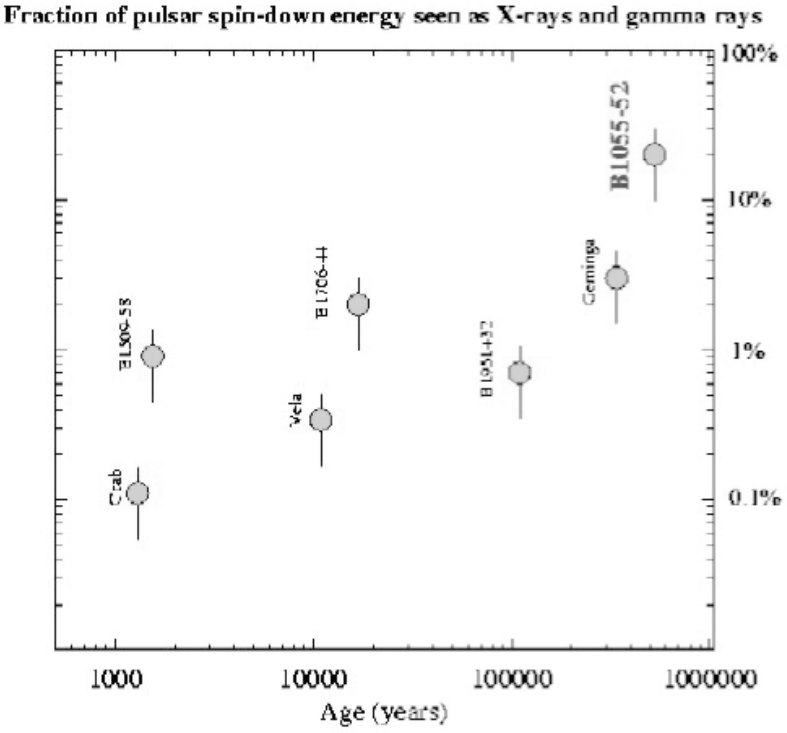
Another curious feature of PSR B1055-52 is that it produces gamma rays more efficiently than younger, faster pulsars, although the details of this gamma ray production are not well understood. For most pulsars, the gamma ray pulses are weak in the sense that they comprise only a small fraction of the total spin energy. Yet the 500,000-year-old PSR B1055-52 can convert 20 percent of its spin-down energy into gamma rays. In comparison, the well-known Crab pulsar—which resulted from a supernova event in the Taurus region observed by the Chinese about 1000 years ago—is the archetypal "lighthouse" pulsar. It has an energy output nearly 10,000 times that of PSR B1055-52, but only a tenth of a percent of that energy appears in the form of gamma rays.

Clearly, there are many unanswered questions about the nature of pulsars and the mechanism through which they emit radiation. The best way to gain a more complete

understanding of these complex phenomena is through these types of "multiwavelength" studies. The Compton Gamma-Ray Observatory has opened up a new window—that of gamma rays—contributing substantially to our understanding.

By Dr. Chris Shrader/CGRO Science Support Center/GSFC Code 661

For more information on CGRO refer to http://cossc.gsfc.nasa.gov on the world wide web.



This chart shows the efficiency with which seven pulsars convert their spin energy into gamma rays. Pulsars seem to become more efficient at generating gamma rays as they age (pulsar ages are estimated by their rate of rotation and the rate at which it decreases).

N&MSP Support of Expendable Launch Vehicle Support Grows

The Space Network (SN) has continued to add more members to the family of Expendable Launch Vehicles (ELV) it supports, with the recent successful support of the first Sea Launch mission on March 27, 1999 at approximately 5:30 p.m. (PST). During this first mission, Sea Launch successfully placed an instrumented demonstration payload, DemoSat, into geosynchronous transfer orbit, completing the first commercial launch from a floating platform at sea.

The Sea Launch program is a multinational partnership that uses a Russian-developed launch system aboard a converted oil rig to launch high-mass satellites from a location on the equator near Christmas Island in the Pacific. Launching at sea from the equator provides several performance advantages for payload capacity and launch inclinations, as well as reductions in the need for a traditional range. The Sea Launch uses a command ship for launch head activities, and relies on TDRS for support of the two transmitters located on the vehicle. The second Sea Launch mission is scheduled to launch a commercial satellite, Direct-TV, on August 15, 1999.

SN Atlas support continues to grow with the recent successful launches of two commercial Atlas IIAS rockets from the Eastern Range. The AC-152 JCSat-6 was supported on February 15, and the AC-154 Eutelsat-W3 spacecraft on April 12. The SN supported the upper-stage Centaurs as both were placed into geosynchronous transfer orbits. Continuing the increased use of the SN, the new Atlas III vehicle will be supported in its first launch this July. Also, the SN will provide support to the Atlas launch of the TERRA spacecraft (formerly EOS AM-1) from Vandenburg Air Force Base later this summer, and to the launch of TDRS H this fall from the Eastern Range.

The U.S. Air Force (USAF) Titan IV Program is going through trying times. The latest mishap was the third consecutive mission failure for Air Force Titan IV rockets, which provide the U.S. Government with its primary means of launching heavy national security satellites. The SN supported the Inertial Upper Stage (IUS) on the Titan IV launched on April 9. For this support, three Software Programmable

(continued on page 12)

(continued from page 11)

Advanced Receivers (SPAR) from the Network and Mission Services (N&MS) advanced technology development program were used to provide exceptional support to a signal that was not compatible with existing receivers at WSC. Support was nominal during the SN support period, but an IUS anomaly that occurred later in the flight left the payload in a less than desirable orbit. The latest failure occurred during an April 30 mission when a Titan IV/Centaur rocket failed to place a payload in the correct orbit. The SN provided support during periods of poor performance of the Centaur vehicle and was able to gather additional telemetry.

In both of these Titan cases, use of the SN enabled the USAF to gather more data for real-time and postflight analysis than they typically would have been able to obtain.

By Ted Sobchak

For further information contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

EUVE and 1999: New Science and Spacecraft Safings

So far 1999 has been another busy and interesting year for NASA's Extreme UltraViolet Explorer (EUVE) Project at the University of California at Berkeley (UCB). On the science front there have been a couple new EUVE discoveries worthy of special note. Dr. Brian Flynn (UCB) announced the first unambiguous detection of variability in the local interstellar wind. After analyzing EUVE survey-mode data sets taken in 1993 and 1998, Dr. Flynn discovered an increase in the angular width of the gravitational enhancement, or "focusing," of the helium density downwind from the sun. This is an important discovery that will lead to a better understanding of the physics of the interstellar medium and its interactions with local stars.

In addition, in March of 1998 EUVE observed the yellow-giant star mu Velorum for Dr. Tom Ayres (University of Colorado, Boulder). Upon analysis of the resulting data, Dr. Ayres has reported an unexpectedly large outburst, remarkable both for its long duration (~2 days) and for its total energy release approximately 1000 times that of a large solar flare. Because these types of giant stars are not typically thought of as flare stars, this result suggests a possible stellar equivalent of a solar coronal mass ejection. This discovery has major implications for stellar evolutionary theory, and opens up the possibility that more evolved red-giant stars can become "rejuvenated" by swallowing nearby objects like brown dwarfs or "hot Jupiters." For more details on these and other EUVE science highlights please see the Project's World-Wide Web (WWW) site at *http://www.cea.berkeley.edu/~science/html/Resources_high.html*.

In terms of new science observations as with previous years, 1999 has so far been a busy one for EUVE and UCB. Both the EUVE spacecraft and science payload continue to perform extremely well. In February EUVE began its seventh cycle of guest observer observations, during which it has so far conducted over 115 separate pointings of some 25 individual celestial targets. Some of the more interesting recent observations were of the Moon, Mars, two targets of opportunity (TOOs), the flare star AD Leo, and three science calibrations; the satellite also entered into safing modes on two occasions. Overall, the science data return rate remained very high at over 98%.

There have also been a number of interesting recent anomalous events in mission operations. First, on 8 February the EUVE spacecraft transitioned to Safe-Pointing Mode (SPM) as a result of a math error in the slew software. This error occurred while the spacecraft was executing a slew in a series of Moon observation. The vehicle remained healthy throughout the SPM event, although the high-gain antenna gimbal temperatures briefly exceeded their upper red limits. After verifying overall system health, the FOT quickly recovered the spacecraft and payload systems within the subsequent 12 hours. There were no negative effects to the vehicle from this SPM event, and the final series of the Moon observation was rescheduled and successfully completed on 9 March. The current theory for the most probable cause of the math error is related to small imperfections in the ground software's slew profile model. This error had not been seen before because, until this Moon observation, the FOT had never pushed the vehicle's slew capabilities to such a limit.

Second, on Monday, 3 May, the EUVE spacecraft entered Safe-Hold Mode (SHM) as a result of two factors: "orbit setback mode" coupled with anomalous behavior by one of the on-board batteries. As a direct result of UCB's "lights out" operations, the spacecraft entered orbit setback mode—a mission "first"—when the on-board ephemeris tables expired their 72-hour active life. On the previous Saturday operator error resulted in the loading of a day-old ephemeris table, and because UCB is no longer staffed on Sundays, this ephemeris expired early on Monday morning and triggered the transition to orbit setback mode.

At the same time, one of the on-board batteries was exhibiting high differential voltage levels, which tripped an on-board telemetry monitor that then triggered a desired auto-switch in battery charge mode [from the normal Voltage/Temperature (V/T) charging to constant-current charging] to avoid battery overcharging. The reverse switch back to V/T charging is usually triggered later in the orbit by an on-board processor. Unfortunately, due to the orbit setback condition, this processor had been automatically disabled so that the batteries never returned to V/T charging mode. Therefore, the batteries continued to discharge until they reached a low enough level to begin shedding loads (which triggered pages to FOT personnel) and, ultimately, to transition to SHM. At no time was the spacecraft in any danger and the FOT recovered the on-board systems in about 12 hours. UCB is currently working on a patch to its "eworks" telemetry monitoring system so that, in the future, it specifically detects orbit setback mode.

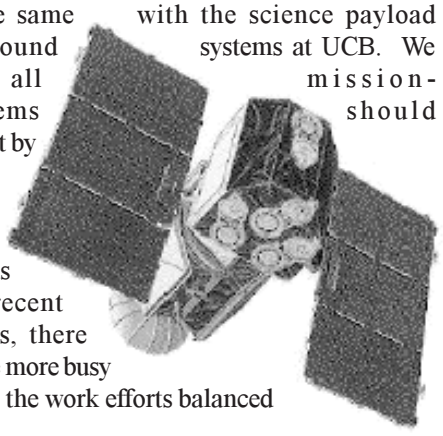
On 11 April UCB experienced a different type of anomaly when an unknown hacker gained illegal access to all of the EUVE Project's Solaris-based computers on the data analysis network. The intruder replaced key system software utilities with so-called "Trojan horses" geared to sniff out and collect user logins and passwords. EUVE systems administrators quickly isolated the problems and restored the network—or so it was thought. Unfortunately, a week later the hacker returned via a "back-door" entrance that UCB had not discovered earlier. In order to ensure the network's integrity, EUVE system administrators had to rebuild the operating systems for the affected machines from scratch. This hacking disrupted all EUVE employees to varying degrees. Similar hacking events were widespread at the time, affecting many sites on the UCB campus and others. It is important, however, to note that the secure EUVE operations network was NOT affected by these hackings.

In addition, after last year's Senior Review, Dr. Guenter Riegler at NASA Headquarters tasked the EUVE Project with developing a "lessons-learned" document for the mission. In response, on 13 April EUVE management submitted a 26-page "Summary of EUVE Lessons Learned" to Dr. Riegler. This document was based on direct and indirect inputs from numerous current and previous EUVE personnel, both at UCB and at GSFC, and included lessons learned on every major functional area of the EUVE Project. UCB then posted this document on the Project's WWW site at *http://www.cea.berkeley.edu/~pubinfo/html/CEA_lessonslearned.html* and announced the posting via the GSFC "lights-out" mail exploder. Within its first few weeks on line, the document received "hits" from over 100 unique clients, indicating a high degree of external interest in, and applicability for, this type of material.

Although much has been accomplished this year, the EUVE Project has much additional work to complete during the next year. As a result of the successful EUVE outsourcing effort, UCB's Space Sciences Laboratory (SSL) requested that the EUVE Project at UCB provide support for two major upcoming SSL-based satellite missions: Fast Auroral Snapshot Explorer (FAST) and the High-Energy Solar Spectrosopic Imager (HESSI). The EUVE Project has agreed to provide technical management assistance to support the outsourcing of FAST spacecraft operations from GSFC to UCB's SSL. Second, EUVE will supply engineering personnel to support the HESSI mission's Integration and Test (I&T) and Launch and Early Orbit (L&EO) activities at SSL and other support locations.

On the technology test-bed front, UCB personnel continue to work hard on the Remote Expert Tools for Engineers (RETOOLE) project. This tool will be a "multi-mission" tool providing access to real-time and playback telemetry via the Internet. RETOOLE is a client-server system based on the use of the WWW and the Java programming language. Phase 1 of the RETOOLE effort, which focuses only on the delivery of real-time telemetry data, is nearing completion. FOT engineers have successfully validated the system's prototype by using it, from their homes, to monitor in real-time EUVE spacecraft performance! UCB recently submitted a proposal to NASA requesting additional funding for the Phase 2 efforts, which will focus on delivering playback telemetry.

Last, but certainly not least, the Year 2000 (Y2K) effort will remain the EUVE Project's main focus throughout 1999; work on the mission-critical systems is currently ~30% complete. In late February the EUVE Project Manager (Brett Stroozas) visited GSFC to officially kick off the Y2K work on all of the GSFC-supported areas, mainly those related to spacecraft command and control. In addition, the FOT and GSFC flight software (FSW) personnel have already successfully validated the spacecraft FSW as Y2K compliant; the FOT did the same with the science payload flight and ground systems at UCB. We expect that all mission-critical systems should be Y2K compliant by 1 October.



So, although the EUVE Project has enjoyed many recent accomplishments, there will continue to be more busy times ahead, with the work efforts balanced

(continued on page 14)

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between ongoing science and mission operations, technology testbed efforts, technical support for other missions, and working to squash out EUVE's Y2K millennium bugs. There is never a dull moment with EUVE at UCB, which keeps our work lives interesting, challenging, and fun!

Article by Brett Stroozas/EUVE Project/Mission Manager

For more information, visit the UCB/EUVE WWW site at http://www.cea.berkeley.edu or contact the author at (510) 643-7312 or via email at bretts@cea.berkeley.edu

Landsat-7 Launch: An Overwhelming Success!

Landsat-7 (L-7) was successfully launched on April 15, 1999. It was a beautiful day and the Delta launch vehicle performed beyond belief. The initial L-7 orbit was within a half kilometer of prediction in both apogee and perigee and the inclination was right on target! Observatory performance has been outstanding.

Initial orbital operations from launch through July 15 are being performed per the On-Orbit Initiation and Verification Plan (OIVP). First images were acquired a few days after launch and released on April 22. The new 15-meter panchromatic band has made it possible to sharpen images to a higher resolution than those from earlier Landsats. As a consequence, these first images are very impressive. All images acquired during OIVP are classified as "engineering" and are not available for purchase.

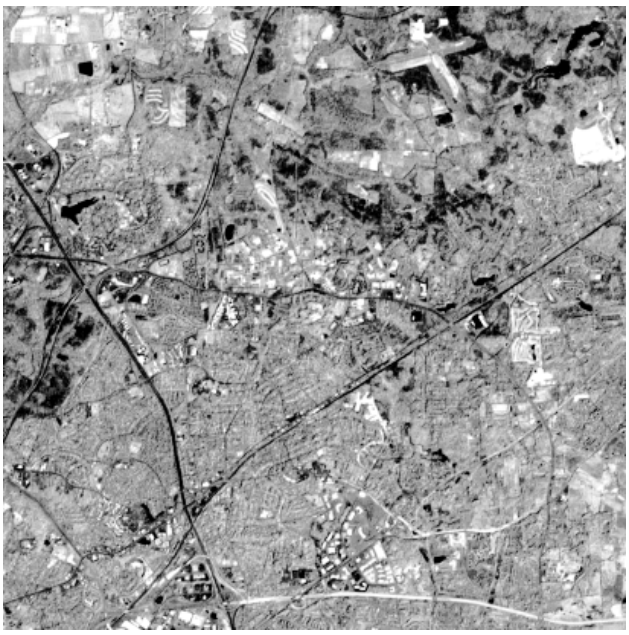
Here is a thumbnail sketch of the events during OIVP. Shortly after launch, the Enhanced Thematic Mapper Plus (ETM+) instrument was activated and put into "outgas" mode for 15 days. During this period the instrument was on for short periods and engineering images were acquired in the prime focal plane bands. These images were used to produce a few full resolution images for release to the public. After the 15-day outgas period, the instrument's cooler door was opened and the cold focal plane cooled to its operating temperature of 91 Kelvin. Images from the cold focal plane bands are also excellent. Images acquired are being used to check out the ground system elements and to develop calibration parameters.

Also during this period, L-7's orbit was adjusted using thrusters, so it would underfly Landsat-5 (L-5). Through a working agreement with Space Imaging, L-7 and L-5 acquired images coincidentally during a three-day period (June 1-3) to cross-calibrate their instruments. After the underfly, L-7 is scheduled to drift toward a position on the Landsat World Wide Reference System (WRS), 8 days out of phase with L-5. As it approaches this location, thrusters will be used to raise the orbit to 705 kilometers and put it on the WRS. L-7 is scheduled to acquire the WRS about June 27. When on the WRS, Landsat repeats the same ground track every 16 days (233 orbits).

A dedicated team of scientists, engineers, and operators has been flying L-7 and analyzing its performance. This team is made up of the Flight Operations Team and Flight Support Team at Goddard, the Data Handling Team and Distributed Active Archive Center (DAAC) Team at the EROS Data Center (EDC), the Landsat Science Office, and engineers at contractor's facilities. These teams are made up of personnel from Goddard, EDC, Lockheed Martin Missiles & Space, Raytheon Santa Barbara Remote Sensing, AlliedSignal Technical Services, Computer Science Corporation, Raytheon STX, and other Goddard support contractors. The engineering teams evaluating observatory performance will complete their duties after the spacecraft has been on the WRS for one 16-day cycle, about July 15. U. S. Geological Survey (USGS) and NASA operations and support personnel are working together to identify, prioritize, and correct problems in preparation for the hand-over of management responsibilities from NASA to USGS.

The Mission Operations Center (MOC) was well prepared for launch through training, hands-on spacecraft operations, and simulations. As a result, mission planning and flight dynamics functions have proceeded smoothly. Critical events, like thruster burns, have caused no problems, and image scheduling and computer loads have become routine.

The Science Data Processing systems have performed very well since launch, processing over 3500 scenes during the first 50 days of on-orbit verification and initialization. The Landsat Processing System (LPS) has captured and processed 99% of the data down-linked. The ECS DAAC has



Landsat-7 Image of the GSFC Area

successfully ingested and archived nearly all science data recorded by the LPS, and continues to support product ordering and distribution. The Image Assessment System (IAS) is performing as designed, averaging 10 scenes per day as it processes level 0R data to level 1G format to establish the nominal spacecraft calibration parameters.

Here is a list of upcoming L-7 events:

- Landsat Technical Working Group meeting at Sioux Falls – June 29 through July 1
- Landsat Coordinating Group meeting at GSFC – July 15
- Landsat-7 data available for purchase from EDC – On or about July 15
- Landsat-7 Operational Ribbon Cutting at EDC – Early August.

By Ken Dolan/GSFC Code 430

For further information about Landsat-7, please visit the Landsat-7 home page at http://geo.arc.nasa.gov/sge/landsat/landsat.html, or contact the author at (301) 286-7962 or via email at Stephen.K.Dolan.1@gsfc.nasa.gov

Tropical Rainfall Measuring Mission: Mid-Year Status

The Tropical Rainfall Measuring Mission (TRMM) spacecraft is well into its second year of on-orbit science data collection operations. Data collection remains at over 99.9% of available science data received. The TRMM Flight Operations Team (FOT) expects the satellite to surpass orbit 9000 late in June 1999. Nominally, the FOT conducts spacecraft health and safety operations by means of 17 real-time TDRSS contacts per day.

As mentioned in an earlier issue of *The Integrator*, the Clouds and Earth's Radiant Energy System (CERES) science instrument experienced performance degradation caused by a faulty +15V converter. The instrument has not returned to a nominal operational mode, and remains off except for selected, short-duration data collection opportunities. In January 1999, CERES was powered on for 53 hours to support data collection in conjunction with the French-built SCARAB instrument flying on board the Russian RESURS-01 spacecraft. CERES was on three times in March, again supporting SCARAB and the Indian Ocean Experiment (INDOEX), the purpose of which is to investigate "large scale effects of emissions from Asia in order to help answer questions of how pollutants are impacting global warming." Lastly, on 17 May CERES supported an Atmospheric Radiation Measurement Unmanned Aerospace Vehicle (ARM-UAV) experiment over Kauai in the Hawaiian islands.

The four healthy instruments, the Precipitation Radar (PR), TRMM Microwave Imager (TMI), Visible and Infrared Scanner (VIRS), and Lightning Imaging Sensor (LIS), are all functioning properly and obtaining good science data.

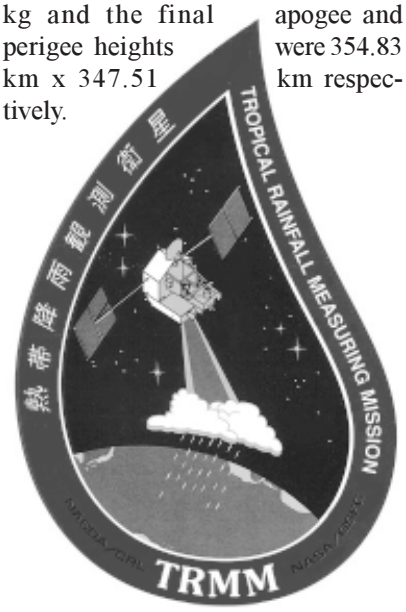
The Power subsystem has performed well, although two new anomalies have been generated. On May 17 and 18, two onboard Telemetry and Statistics Monitors (TSM) were tripped after detecting that the End-of-Day State-of-Charge (EOD SOC) counters for both batteries were in low limits. These counters had been low for some time, due to an extended period when the spacecraft was orbiting through low Beta angles. This is a nominal condition during certain times of mission lifetime, and so the tripping of these monitors was not a total surprise. A Charge/Discharge (C/D) ratio change was successfully commanded (to 1.02 from 1.03) on May 18th. Both batteries gradually reached 100% SOC by 22 May 99.

(continued on page 16)

(continued from page 15)

Unrelated to the above condition, the Power System Interface Box (PSIB), an orbit status mnemonic, has been fixed in Day mode since 17 May. Supporting Flight Software personnel and the Code 700 Engineering staff performed a problem analysis which indicated that an onboard subroutine that resets orbit status, and increments time in day and time in charge, was not being called. This subroutine should be called once per second when the PSIB clock (tick counter) is "greater than or equal to" orbit status time. Should any word accessed by this subroutine not meet the "greater than or equal to" condition, a stop occurs. We await confirmation for corrective action, which will probably require resetting the tick counter to zero. In the interim, TRMM spacecraft operations continue without mishap.

In an effort to reduce the load on the power subsystem, the FOT modified the duration of the Catalyst Bed Heaters turn on for Delta-V maneuvers. The turn-on time, nominally 91 minutes prior to the first burn, was reduced to 45 minutes. This tactic was employed for the first time during Delta-V maneuver #99 on 21 May and went well. The amount of hydrazine fuel remaining (after #99) was 728.699 kg and the final apogee and perigee heights were 354.83 km x 347.51 km respectively.



Based on solar flux predictions, fuel consumption performance to date, and fuel required for ocean disposal, analysis indicates that the fuel level should allow operations to continue for 6.6 years from the TRMM Thanksgiving Day launch in November 1997.

By Lou Kurzmiller/TRMM FOT

For additional information, please visit the TRMM web site at http://trmm.gsfc.nasa.gov, or contact John Grassel/ATSC at (301) 805-3167 or via email at john.grassel.1@gsfc.nasa.gov

Upper Atmosphere Research Satellite Mission Status Update

Eight of the ten Upper Atmosphere Research Satellite (UARS) instruments continue to operate, utilizing time-shared operations to maximize science with available resources. Data is routinely processed and reprocessed using a central facility, and is distributed electronically to the scientific community.

Among the most important UARS accomplishments are:

- Seasonal mapping of chlorine radicals and reservoirs in the lower stratosphere
- Containment of polar vortex chemistry within the vortex region
- Descent in the center of the polar vortex
- Infrared mapping of aerosols and Polar Stratospheric Clouds (PSCs)
- First direct measurement of winds from space
- First global maps of chlorofluorocarbons and their products from space
- Examination of tropical transport in the stratosphere
- Measurement of the UV and visible component of solar variability
- Study of the role of energetic particles in stratospheric chemistry
- Investigation of upper tropospheric water vapor in the presence of clouds.

By Rick Hudson / CSOC UARS FOT

Comments or questions may be directed to Edward J. Macie, UARS Project Manager, Code 453. For further information on UARS you may visit the FOT web site at http://uarsfot08.gsfc.nasa.gov/

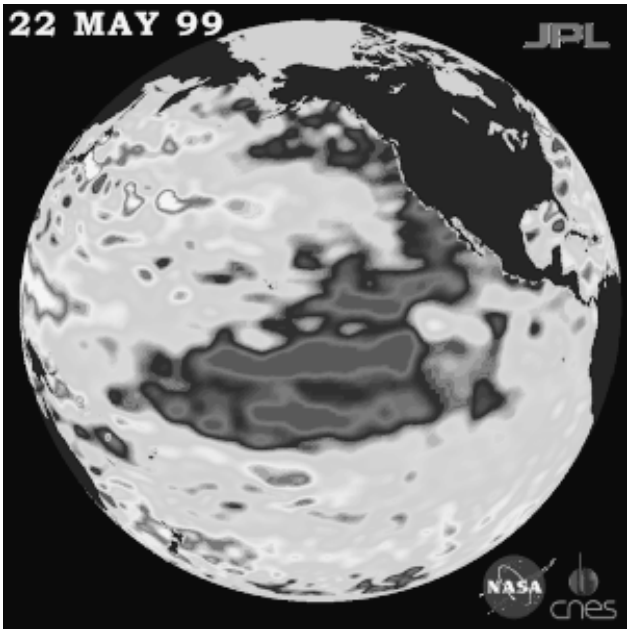
TOPEX/Poseidon Observing Unusual Pacific Behavior

Recent sea surface height measurements from the TOPEX/Poseidon satellite show that a large area of abnormally cool Pacific Ocean water has formed along the west coast of North America. Scientists say that this event will likely influence regional weather patterns, and may cause increased smog over the Los Angeles basin due to a continuing inversion layer over Southern California

throughout the summer months. According to JPL oceanographer, Dr. William Patzert, "our data certainly show that the unusual oceanic climatic conditions that gave rise to El Niño and La Niña are not returning to a normal state. Our planet's warm and cold, high and low sea levels are slow-developing and long lasting, and will certainly influence global climate and weather for the coming summer and into next fall."

TOPEX/Poseidon continues to provide detailed views of the ocean sea surface height with unprecedented precision. Since our last report, a switch to the redundant radar altimeter was successfully performed. Otherwise, the satellite remains in excellent health, with all sensors continuing to be fully operational. As we approach completion of our seventh year of operations in August 1999, the team is now focusing on the launch of Jason-1 in May 2000.

Jason-1 will serve as the follow-on mission to TOPEX/ Poseidon, and is also a joint partnership between NASA and the French space agency, CNES. TOPEX/ Poseidon data will be used to calibrate and validate Jason-1 performance



Indicates warm water

Indicates cold water

This image of the Pacific Ocean was produced using sea-surface height measurements taken by the U.S.-French TOPEX/Poseidon satellite. These observations show sea surface height relative to normal ocean conditions on May 22, 1999. Sea surface height is an indicator of the heat content of the ocean. This image also exhibits the unusual large-scale cooling in the eastern Pacific that is currently being studied.

for approximately six months after launch. Given the overall outstanding performance of the TOPEX/Poseidon satellite over the life of the mission, the team fully expects to be able to provide this critical data to Jason-1 scientists during the latter half of next year.

By Mark Fujishin/Mission Manager, TOPEX/Poseidon Project

More information about the TOPEX/Poseidon spacecraft is available on the WWW at http://topex-www.jpl.nasa.gov, or contact the author via email at Mark.Fujishin@jpl.nasa.gov

QuikSCAT Is Back on Schedule

NASA's Quick Scatterometer (QuikSCAT) was successfully launched from Vandenberg AFB, California aboard the Titan II launch vehicle on June 19. The 870 kg (1,914 lb) QuikSCAT spacecraft was placed in an 803 km Sun-synchronous orbit with a 98.6 degree inclination. Originally, QuikSCAT was scheduled for a November 24, 1998 launch. The Titan series, however, was grounded following a Titan IV accident in August 1998, in which a DOD satellite was destroyed. The launch of QuikSCAT was postponed awaiting the outcome of a Titan series investigation. On May 22, 1999, a B-12 satellite was launched on a Titan series rocket from Vandenberg AFB. That successful launch cleared QuikSCAT for launch on June 18 with final launch rehearsal scheduled for June 8.

QuikSCAT specializes in microwave radar that measures wind speed and direction under all weather and cloud conditions over the Earth's oceans. QuikSCAT replaces the "Sea Winds" instrument, which was lost in a June 1997 malfunction of Japan's Advanced Earth Observing Satellite (ADEOS). QuikSCAT uses the EOS Polar Ground Network (EPGN) for tracking and ground system services. The EPGN includes ground stations in Poker Flats, Alaska; Svalbard, Norway; Wallops Island, Virginia; and McMurdo, Antartica.

Mission operations support will occur at the Colorado University-Laboratory for Atmosphere and Space Physic (CU-LASP). Backup mission support will be provided by the Mission Monitoring Center (MMC) located at the Jet Propulsion Laboratory (JPL). The ground network will be supported through the EOS Data and Information System Backbone Network (EBNet) and the IP Operational Network (IONET). The life of the mission is intended to be two years

(continued on page 18)

(continued from page 17)

and the spacecraft is carrying consumables to support an additional year of orbit operations.

The QuikSCAT mission is a joint venture between the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL). The QuikSCAT spacecraft was developed under the Rapid Spacecraft Development Office's (RSDO) Rapid I program. Rapid I allowed the customers to conduct a mini-competition between vendors who had established Indefinite Delivery Indefinite Quality (IDIQ) contracts with the government. Development of the QuikSCAT spacecraft was contracted to Ball Aerospace, and in only 11 months the spacecraft was ready for shipment to the launch site—on schedule for the original launch date.

The QuikSCAT Spacecraft

Following launch, QuikSCAT separated from the launch vehicle, and the RF Transmitter was activated over the tracking station in Malindi, Kenya. The spacecraft was then tracked by the station in Svalbard, Norway, confirming the RF Transmitter capability. The first command uplink originated from CU-LASP through the Poker Flats, Alaska ground station. An orbital maneuver is planned to raise the spacecraft's altitude from 260 km to 803 km. The instrument will then be turned on and systems verified and calibrated. Finally, the spacecraft will be ready to collect science data that will be sent to the National Oceanic and Atmospheric Administration (NOAA) for distribution.

By Vinny Patel/BA&H

For additional information, please visit the Internet site at the following URL: http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html or contact Raymond Pages/GSFC Code 581.2 at (301) 286-6012.

Additional Activities of Note

Early Communications System Support Continues on Orbit

The International Space Station (ISS) Early Communications System (ECOMM) was placed into orbit aboard STS-88 on December 3, 1998. As scheduled, on December 10-11, 1998, the ECOMM was installed by astronauts Jerry Ross and Jim Newman, and then activated. The services provided were flawless, and the system supported the first two-way video conference from the new ISS. A distant cheer was heard at GSFC because a key ingredient to that system, the ECOMM transceiver, was developed and acceptance tested here at GSFC. The GSFC ISS Test Team witnessed the events from the Network Control Center (NCC) with high energy and team spirit.

For approximately four months the ECOMM provided primary U.S. communications to the ISS. A minor anomaly with an antenna that was bumped during installation developed during that period, but the system continued to provide more than enough contact with the new ISS. Satisfaction was high for a system built on an extremely fast track using a modified Commercial Off-the-Shelf (COTS) box—the ECOMM Transceiver—at its heart.

Then, during typical operations on April 22, 1999, the ECOMM system failed to provide return link services. With assistance from the Russian communications system aboard the Zarya, NASA JSC was able to confirm that the forward link into the ECOMM system was present and operational. The reason for the failure of the return link was uncertain. Indications from the telemetry via Zarya implied that either the RF switch within the RF Power Distribution Unit (RFPDU) was in an open state or the transceiver transmitter had encountered an unrecoverable condition.

JSC operations and engineering personnel made several attempts to exercise the RF switch to analyze the state of operation, but, the RFPDU

continued to report it was in a failed mode. As time proceeded, it became evident that more drastic measures needed to be taken to correct the problem. Additional analysis of the components of the ECOMM system indicated that the transceiver had been placed through an unexpectedly high number of temperature cycles. Information on the preflight ISS thermal model was different than the actual flight information.

The decision was made by ISS management to perform corrective action. The STS-96 crew received an additional assignment during their 10-day mission. Recommendations for In-Flight Maintenance procedures were made to address both the potential areas of concern and the need to troubleshoot and fault isolate the exact problem. The management team decided to replace the ECOMM RFPDU and the ECOMM Transceiver with the spare flight components. This decision was based on the knowledge that the RF switch had failed to an open state and the transceiver had been exposed to more thermal cycles (5000-8000) than expected. Installation of a "fresh" system was expected to be the quickest, most manageable method to correct the problems and provide a communication system with a higher probability of survival until the next docking with ISS in December.

On May 30, astronauts (Jernigan/Tokarev) made the ingress into Unity Node 1 and replaced the ECOMM RFPDU and the ECOMM Transceiver. Shortly afterwards the system was reactivated and successfully checked out. At the time of this writing the ECOMM system was again providing the main means of U.S. communications with the ISS.

As for the components that were replaced, they will be returned to Earth and subjected to various tests (including destructive analysis conducted on various parts) to determine the exact cause of trouble, and the impacts of thermal stress. Time will tell why the system ceased certain functions. The ECOMM system remains key to ISS communication success. Plans are already underway to take the soon-to-be-returned FM#1 ECOMM Transceiver back to the ISS in December as an on-orbit spare.

By John Smith/LMCO and Ted Sobchak/ GSFC Code 451

For further information, check out the Human Spaceflight Web site at http://tip.gsfc.nasa.gov/hpshuttl/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

N&MSP Participates in International Space Station Multi-Element Integrated Test

GSFC's role in the International Space Station (ISS) Multi-Element Integrated Test (MEIT) has been instrumental to test success. During MEIT, launch packages are integrated and checked out for cargo integration testing. MEIT involves communications equipment for ISS Flight 3A (launch 6/99), Flight 4A (launch 8/99), Flight 5A (launch 10/99), and Flight 6A (launch 12/99) at Kennedy Space Center's (KSC) Space Station Processing Facility (SSPF). The Communications and Tracking (C&T) portions of the testing are key to the success of MEIT. In previous editions of *The Integrator*, it was noted that GSFC provided equipment (the TDRSS User RF Test Set, or TURFTS) to KSC for Test Configuration (TC)#1 to assist in converting between RF and baseband signals. MEIT TC#1 was successfully completed in January 1999.

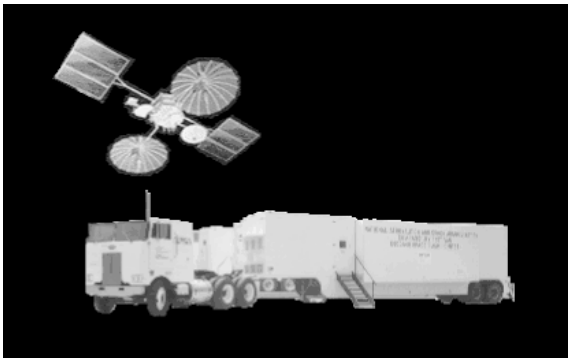
The MEIT has now progressed into the next configuration of testing, and again GSFC is providing key equipment to conduct the Ku-Band testing. The GSFC Compatibility Test Van (CTV) will assist with the RF testing for Ku-Band 50/75 Mbps (and possibly 150 Mbps) testing activities .

The CTV will be positioned outside the SSPF and will provide an interface between the Flight components to the TDRSS. During TC#2 activities, the CTV will function in a manner similar to the Seattle testing conducted in the February/March 1998 timeframe.

As MEIT proceeds, GSFC will continue to be a valuable asset to successful ISS testing.

By John Smith/LMCO

For further information, check out the Human Spaceflight Web site at http://tip.gsfc.nasa.gov/hpshuttl/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov



Networks and Mission Services Projects Prepared for Year 2000

The Space Network has completed all required Year 2000 (Y2K) certifications and testing! The final test was the Human Spaceflight End-to-End test, specifically test case 2, which is very similar to the verification/validation tests performed prior to each Shuttle mission. The Network Control Center will participate in at least one more Y2K test to support customers.

The Ground Network (GN) stations are completing their Y2K testing, and are preparing to support the Human Spaceflight End-to-End test case 4, planned for August. This test case is similar to the launch countdown testing performed prior to each Shuttle mission, and involves all the networks used to support Shuttle launches. Other ground network systems continue with their end-to-end testing with the help of their customers. GN Y2K testing is scheduled to complete in late July.

The Mission and Data Services projects have completed all their certifications. They are completing end-to-end testing for spaceflight missions, testing from spacecraft simulators, through Nascom, through the Mission Operations Centers (MOCs) and science data processing facilities, to the principal investigators. Rossi X-ray Timing Explorer (RXTE) testing is completed and the Tropical Rainfall Measuring Mission (TRMM) is close behind.

The Networks and Mission Services Projects are looking good for Y2K!

By Lynn Myers/GSFC Code 451.5

For further information regarding the Y2K effort, please contact the author at (301) 286-6343 or via email at Lynn.Myers@gsfc.nasa.gov

Code 450 Products and Personnel Visit the North Pole

Recently, the North Pole was the unique site for a technology demonstration showing how NASA-developed technology and the Internet have made it possible for scientists working in very remote locations to send and receive data worldwide. GSFC engineers, scientists, and outreach personnel traveled to Resolute Bay, and Eureka, Canada before heading north to the "top of the world" where they broadcast the very first live webcast via the Internet, from the North Pole. What was most unique about this feat was that students worldwide were actively involved (via their personal computers) in scientific activities in this most remote location. The students were able to communicate with the scientists using their computer keyboards, while watching live video of the scientists performing research activities.

Three separate communications packages were demonstrated during the thirteen-day expedition; TILT (TDRSS Internet Link Terminal), ECOMM (Early Communications), and PORTCOMM (Portable Communications). The TILT, which was developed at GSFC by code 450, provided full duplex Internet Protocol data links at 1.024 Mbps. ECOMM provided full duplex Internet Protocol data links at 128 Kbps in a very portable package, and PORTCOMM provided transmit-only file transfer links at 4.8 Kbps and was used while moving at speeds up to 40 mph. ECOMM and PORTCOMM were built by Stanford Telecom and were integrated and tested for the expedition by GSFC. The high latitude TDRSS link was provided by TDRS-1. Launched in 1983, TDRS-1 is currently in a geosynchronous orbit that is inclined sufficiently to make it visible to the polar regions of the globe four hours each day, with a maximum elevation of 1.6 degrees.

In addition to communications activities, the team conducted science observations and measurements as an integral component of the expedition. They collected ozone measurements, Global Positioning System (GPS) measurements, and measured sea ice thickness. The ozone measurements will be compared with satellite observations made by the Total Ozone Mapping Spectrometer (TOMS). The GPS measurements will be used to examine glacial rebound and to quantify the polar flattening of the Earth. The sea ice thickness measurements are being compared with other Arctic ice thickness measurements to study climate change.

ECOMM Hardware for the TDRSS Ground Terminal

The expedition team departed GSFC on April 19 for Resolute Bay, Canada (75N, 95W). While in Resolute Bay, the team worked with local educators and students before departing on April 26 for Ellesmere Island and the airport at Eureka, Canada (80N, 86W), a necessary refueling station. The next day, five members of the expedition team headed for the North Pole, finally touching down on the ice floes of the Arctic Ocean at 89° 59'N, 69° 41'W—almost at the exact North Pole. There the team conducted the first live webcast video from the North Pole using ECOMM. Students worldwide observed the scientists collecting data, and were able to communicate directly with those at the North Pole.

Twelve hours after the live webcast, the TDRS-1 satellite was over the opposite end of the earth. There it provides Internet connectivity daily for scientific experiments via the South Pole TDRSS Relay (SPTR). On that day it also provided the means of making a voice phone call at the South Pole. Using an Iridium Satellite telephone at the North Pole and the SPTR, the team completed a call from their tent at the North Pole to the Amundsen-Scott Research Station at the exact South Pole in Antarctica. This historic first also included the EOS PM Project Manager, George Morrow, who sponsored the expedition. At the South Pole representatives from both NOAA and the National Science Foundation participated.

Schools participating in these adventures were selected through the EOS PM Project's "You Be the Scientist" program, and interacted with the North Pole team via special webchats during all 10 of the live webcasts conducted during the mission. The webcasts were available to anyone with internet access, but the chat sessions were restricted to the pre-selected participating schools.

The GSFC North Pole 1999 expedition team included Team Leader, Mike Comberiate/EOS PM Project/Code 422; Chief Scientist, Dr. Claire Parkinson/Oceans and Ice Branch/Code 971; Communications Engineer, Andre Fortin/Space Network/Code 451; Webmaster and Producer, David Beverley/EOS PM Project/Code 422; Logistics Chief, Chris Morris/EOS PM Project/Code 422; and Education Liaison and Announcer, Steve Graham/EOS Project Science Office/Code 900/Raytheon ITSS. In addition to the GSFC personnel, a videographer, consulting engineer, two educators and two students rounded out the expedition team.

An archived collection of all the webcasts and digital pictures is available on the expedition's website at: *http://coolspace.gsfc.nasa.gov/northpole*.

By Steven M. Graham/EOS Project Science Office/Raytheon Information Technology and Scientific Services

For additional information, please contact the author at (301) 441-4169 and visit http://earthobservatory.nasa.gov/Study/NorthPole/

TDRSS Internet Link Terminal (TILT) Update

The next stop for the TILT will be the Black Sea, where it will be used to webcast the total solar eclipse on August 11, 1999. More information about the TILT can be found at *http://rodent.gsfc.nasa.gov/tilt*.

Five historic milestones were accomplished in this expedition:

1. The first internet link to the North Pole, (1930 - 2015 GMT) April 27, 1999.

2. The first live webcast video from the North Pole, (1945 - 2015 GMT)April 27, 1999.

3. The first virtual participation by students in NASA Arctic field work via the Internet, including live interactive chats and videos between students worldwide and NASA scientists at 75 N, 80 N, and 90 N.

4. The first North-Pole-to-South-Pole phone conversation (1030-1115 GMT, April 28, 1999). The conference call was coordinated by MSFC, and included the NASA North Pole Team, NSF and NOAA representatives wintering over at the South Pole, and representatives from NASA GSFC, Global Learning and Observations to Benefit the Environment (GLOBE) Headquarters, and a GLOBE school in Pennsylvania.

5. The first placement of a piece of the exact South Pole into the exact North Pole, in commemoration of Earth Week.

TDRSS Support for Range Safety Receiving More Attention

Is there real potential for TDRSS to support Range Safety telemetry and command destruct? Many organizations are interested in finding out. Previous *Integrator* articles have described the growth of this activity; however, a new force has taken this endeavor a step closer to Proof of Concept.

In Congressional Hearings as recent as February and March 1999, the topic of U.S. Launch Range Upgrades was addressed. Personnel from NASA's Kennedy Space Center (KSC) and the U.S. Air Force (USAF), along with Industry top officials, presented their opinions on the current status of the U.S. Launch Ranges. The group has been concerned about the ineffectiveness of the USAF Range Standardization and Augmentation (RSA) program. As a result of these discussions, NASA was requested to review the RSA program and provide suggestions as to how the U.S. Launch Ranges could be upgraded with new technologies. Within NASA, KSC was identified as the Center for Advance Technologies for launch ranges, specifically the KSC Advanced Development and Shuttle Upgrades Office. They were tasked to investigate new technologies within NASA that could be considered for assisting in a new way of conducting U.S. Launch Range Services.

The KSC Advanced Development and Shuttle Upgrades Office prepared material in four areas of advanced technology: Launch Range Capacity, Launch Modeling and Simulation, Weather Prediction, and Space-Based Range Services. With respect to the Space-Based Range Service, KSC was impressed with the development of the Space Network support for Range Safety concept and the amount of work and coordination that has been accomplished with the Range Commanders community.

At this time, the GSFC Networks and Mission Services Project team is diligently working towards Proof of Concept activities. The proposed Proof of Concept plan not only includes the use of TDRSS services, but also the development of vehicle communications components. The KSC/GSFC team will investigate the flight success of the test components on vehicles from the X-Program within the next twelve to eighteen months, if all goes well. One of the technologies that is instrumental to the GSFC concept is a multi-channel TDRSS compatible receiver that can also process Global Positioning System signals.

From its beginnings in June 1996 at the Second TDRSS Workshop, development of the concept of using TDRSS for Range Safety services has been a tremendous experience for everyone involved. Provision of these services through a space-based platform of any type is still in the infancy stage and the outcome is unknown. What can be said is that the GSFC team will continue to play a part in determining the role of a space-based platform in U.S. Launch Range upgrades.

By John Smith/LMCO and Ted Sobchak/451

For further information, contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

TDRSS On-line Information Center

Have questions about TDRSS or the Space Network (SN)? Check out the *TDRSS Online Information Center*. Discover new information about Demand Access, SN services using TCP/IP, and SN services for Range Safety Support. We've updated the Universal Spacecraft Correlation Clock System (USCCS) manual. Our link budget and USCCS calculators have been improved, and are available for your use. Use the Javascript search engine to help you locate specific information. You can also email questions to us using our feedback form. We'll direct your questions to the appropriate expert, and return an answer directly to you, via email. The *TDRSS On-line Information Center* is updated twice monthly to ensure information is current and accurate.

The web site can be found at *http://nmsp.gsfc.nasa.gov/tdrss/*

Detailed information is currently available on:

- The Tracking and Data Relay Satellites (including TDRS H, I, J)
- The White Sands Complex (WSC) including the WSC TCP/IP Data Interface Service Capability (WDISC)
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay System (MTRS)
- TDRSS Telecommunication Services
- Customer Communication Systems and Products (including Transponders)
- Plus much more…

Coming Attractions

Demand Access Return Link in Development

The Demand Access System (DAS) began life as a Space Network technology demonstration project in 1994. The project explored different methods of implementing Multiple Access (MA) forward and return link service "on-demand" concepts. The studies, analyses, and simulations resulted in two concepts that could allow cost-efficient expansion and simplification of MA services for customers. The first concept, involving a Web-based interface to the Network Control Center is presented in an article by Roger Clason on this page. The second concept, involving hardware and software implementation for enabling MA demand access, is presented here.

Recently, the MA demand access concept (the hardware and software implementation of DAS) was reviewed by the Code 450 Systems Engineering Team (SET), and a formal set of system requirements is now in development. The SET determined that the performance gains with respect to forward services do not warrant further work. The return-link capabilities however, appear to be advantageous, and a draft Project Commitment Document (PCD) is in development.

This new DAS capability will provide dedicated or shared return link equipment at the White Sands Complex (WSC) for customers and will require little or no scheduling.

Current system operation will not be affected with the implementation of DAS. One significant limitation, however, is that the DAS can only use legacy TDRS spacecraft; TDRS H,I,J spacecraft form return link beams onboard the satellite and do not downlink the individual element signals as the original spacecraft do.

A core component of the new system will be the Third Generation Beamforming System (TGBFS). The TGBFS consists of Element Multiplexer Correlators (EMCs) and Independent Beamforming Unit Groups (IBUGs). EMCs will be installed in all of the MA-capable Space-to-Ground-Link Terminals (SGLTs) and will feed signals to the IBUGs for processing. Demodulators hooked to the IBUGs will recover baseband data. The implementation of the TGBFS is well underway, with acceptance testing of the EMCs and a pre-production IBUG scheduled for completion in July 1999. Stanford Telecommunications (STel) is the implementation contractor.

DAS services are ideally suited for customers concerned with service cost and availability. With dedicated TGBF equipment, support can easily be provided 24/7 (i.e., 24 hours per day, 7 days per week). Fleets of spacecraft flying in formation or other "grouped" transmitters, are just the type of customer that could benefit from this new service.

System availability is currently targeted for late 2000. More schedule details will be known and reported in subsequent issues of *The Integrator* after the requirement generation process and PCD are finalized.

By Tom Gitlin/GSFC Code 451

For more information on this project, contact the author at (301) 286-9257 or via email at tom.gitlin@ gsfc.nasa.gov

Web-based Network Control Center Interface Is on the Way!

In May, the Space Network (SN) Project kicked off an effort to develop a hypertext transfer protocol (http) interface to the Network Control Center Data System (NCCDS), with the objective of allowing customer missions to request, reconfigure, and monitor data services using a standard web browser. This effort is based on prototype work done as part of the Demand Access activity.

Targeted for missions with relatively simple scheduling, reconfiguring, and/or monitoring requirements, this new http interface will complement the existing formatted message interface to the NCCDS. The User Planning System (UPS) will remain the tool of choice for missions with more demanding scheduling needs, such as TDRS view-period computation and recurrent schedule generation.

This effort is still in the formulation phase. A delivery schedule will be established once final authorization has been granted. Watch The Integrator for future news.

By Roger Clason/GSFC Code 451

For more information about this new product, please contact the author at (301) 286-7431.

X-33 Using State-of-the-Art Technology

The X-33 is a half-scale, suborbital technology demonstrator of a reusable space plane which Lockheed Martin calls the "VentureStar." Managed by NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama, the goal of the $1.2 billion program is to demonstrate advanced technologies that will dramatically increase reliability and lower the cost of putting a pound of payload into space from $10,000 to $1,000. The X-33 is scheduled to conduct flight tests beginning in mid 2000. It eventually will fly at speeds faster than Mach 13 and at an altitude of 60 miles to prove its technologies and systems.

Although the X-33 has had some minor setbacks, significant milestones have been reached. One example is the implementation of the Innovative Metallic Thermal Shield. Development of a low-cost space plane took a step forward in February of this year when one of the technologies essential to its success was declared "ready for flight." The rugged, metallic thermal-protection system panels designed for X-33 passed an intensive test series that included sessions in high-speed, high-temperature wind tunnels. The panels also were strapped to the bottom of a NASA F-15 aircraft and flight-tested at nearly 1.5 times the speed of sound. Additional laboratory tests duplicated the environment the X-33's outer skin will encounter while flying roughly 60 miles high at more than 13 times the speed of sound.

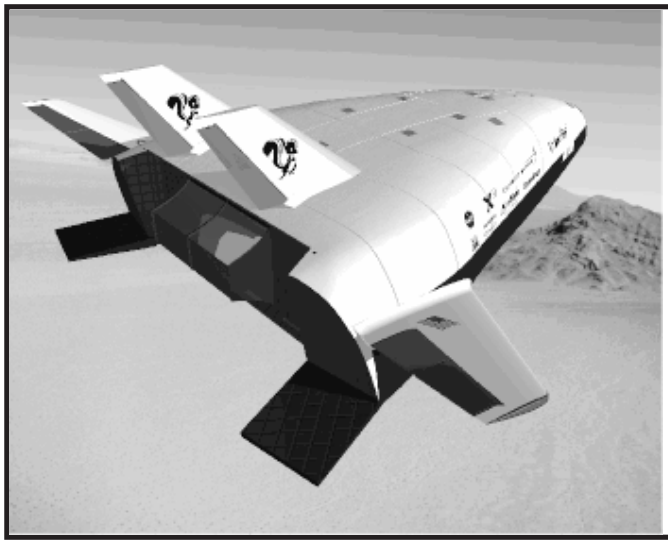
NASA expects the metallic thermal protection panels—developed and built by team member BFGoodrich Aerospace/Aerostructures Group in Chula Vista, California—to dramatically cut maintenance time and costs associated with more fragile thermal tile systems. Since the metallic panels on the lower surfaces of the X-33 make up the vehicle's windward aerodynamic structural shell, the system also will result in significant weight savings over traditional thermal systems, and will be much more durable and waterproof.

Another milestone was delivery of the very important cryogenic fuel tanks, which arrived at MSFC in April. They are constructed of a lightweight, yet strong, composite. The tanks will provide fuel for the X-33's two aerospike engines. The fuel tanks form the flanks of the X-33, and with the liquid oxygen tank at the nose, compose a significant portion of the airframe of the vehicle.

Work on the structure is proceeding as program personnel continue intense testing and qualification of the X-33. The X-33 is scheduled to make as many as 15 test flights from Edwards Air Force Base in California, to Dugway Proving Ground in Utah and Malmstrom Air Force Base in Montana, beginning in 2000.

By Al Muscella/ATSC

For further information contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov



X-33 Specifications

Length: 69 ft
Width: 77 ft
Takeoff weight: 285,000 lbs
Fuel: Liquid hydrogen with liquid oxygen
Fuel weight: 210,000 lbs
Main Propulsion: 2 J-2S Linear Aerospike Engine
Takeoff thrust: 410,000 lbs
Maximum speed: Mach 13+

X-34 to Test New Technology

The X-34, a single-engine rocket plane, will fly itself using onboard computers. The X-34 will launch from an L-1011 airliner and will reach altitudes of up to 250,000 feet, traveling up to eight times faster than the speed of sound.

Flights of the X-34 will test many new technologies: composite material structures; composite tanks; and new, integrated avionics. The vehicle also will demonstrate its ability to fly through inclement weather, land horizontally at a designated landing site, and safely abort during flight. The planned 27 flights within a year will demonstrate the program's ability to fly within 24 hours of its last mission, using a small ground crew.

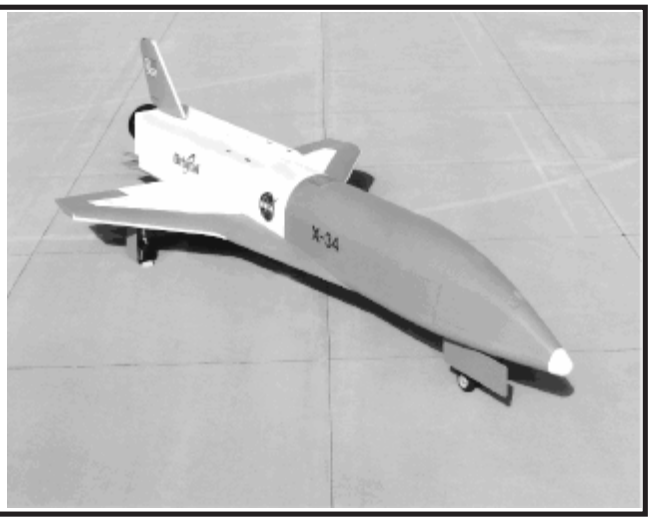
The X-34 has completed ground vibration tests, ensuring there will be no potentially hazardous vibrations during flight. The L-1011 and the X-34 prototype were tested separately and together at NASA Dryden in Edwards, California. After the rollout, the X-34 will be mounted underneath the L-1011 and flown on "captive-carry" flights to allow the Federal Aviation Administration to approve modifications to the L-1011. When powered flights begin for X-34, the demonstrator will be carried aloft and will separate from the L-1011 before igniting its rocket engine. Following the powered portion of flight, the unpiloted X-34 will land horizontally, initially on a dry lake bed and eventually on a runway.

By Al Muscella/ATSC

For further information contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

X-34 Specifications

Length: 58 ft
Width: from wing tip to wing tip, 28 ft
Height: from bottom to tip of tail, 11 ft
Altitudes: up to 250,00 feet
Speed: Mach 8+



X-38 Prepares for Next Free Flight

On May 27, 1999, with the launch of Space Shuttle Discovery on Mission STS-96, NASA resumed the work of building the International Space Station. In June, NASA Dryden continues the flight test of the X-38 technology demonstrator for the Crew Return Vehicle that will be used with the International Space Station.

In preparation for the second free flight of Vehicle 132, or Ship 2, tests on a new drogue parachute were conducted at the U.S. Army Proving Grounds in Yuma, Arizona. Also, a parafoil cutaway system was added. The system will be used to cut the parafoil risers after landing, giving controllers more options for landing in high ground wind conditions. For this second free flight, testers plan to release the vehicle from a higher altitude (30,000 ft) and fly the vehicle longer (31 seconds).

In August, the project team plans to release the vehicle from about 35,000 feet and fly for 44 seconds. Also, they plan to replace the current flight control system with a system designed by Honeywell Controls called MACH. According

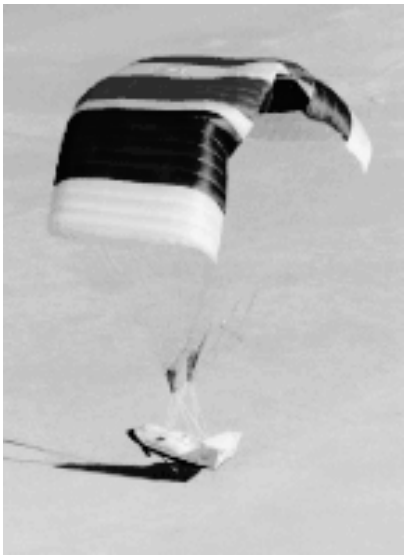
(continued on page 26)

(continued from page 25)

to Tim Cox, Dryden X-38 controls engineer, MACH uses a dynamic inversion process to improve the vehicle's bare-airframe dynamics, allowing the control system designer to tune the vehicle's flight performance to whatever is desired.

The atmospheric tests of the X-38 began in July 1997. To date there have been three free flights of two vehicles. Vehicle 131, or Ship 1, made its first flight on March 12, 1998 and its final flight on Feb. 6, 1999. Vehicle 132, or Ship 2, completed its first on March 5, 1999. In the first test, the vehicle was released from the B-52 at 23, 000 feet. The primary objective of that test was to find out how well the vehicle's parafoil would work. Atmospheric drop tests of the X-38 will continue at Dryden for the next three years using increasingly complex test vehicles. The free flights will increase in altitude to a height of 45,000 feet and include longer flight times for the test craft before deployment of the parafoil.

The Crew Return Vehicle is targeted to begin operations aboard the International Space Station after the Station is completed. When operational, the Crew Return Vehicle will be the first new human spacecraft built in the past two decades. The new spacecraft will primarily be used as an International Space Station "lifeboat" or "ambulance." However, the project team also is looking at a design that could be easily modified for other uses, such as a joint U.S. and international human spacecraft to be launched on expendable rockets as well as the Space Shuttle. The European Space Agency is cooperating with NASA in the current development work, supplying several components for the planned space test vehicle.



The X-38 with Parachute Deployed

In 2001, an unpiloted space test vehicle will be deployed from the Space Shuttle and descend to a landing. The X-38 team continues developing and testing of communication systems for this vehicle. An X38/TDRSS Engineering and Demo Test was recently completed using an engineering model of the 4th Generation TDRSS/GN transponder. These tests experimented with a test RF system and prototype command and data-handling equipment. Various command and telemetry data rates were tested.

By Al Muscella/ATSC and Danh Nguyen/LMCO

For additional information, check out the Human Spaceflight web site at http://tip.gsfc.nasa.gov/hpshuttl/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

EOSDIS Is Ready for TERRA Launch

The EOS Data and Information System (EOSDIS) continues to recover from earlier problems with the Science Data Processing and Flight Operations Segments (SDPS and FOS, respectively) of the EOSDIS Core System. Final testing of the latest SDPS release (4PY) is on schedule, and end-to-end tests have been successful. As described in a previous issue of *The Integrator*, the FOS has been reconstituted as the EOS Mission Operations System (EMOS), with software from the original FOS used with other contractor-developed software to provide critical functionality. TERRA (EOS AM-1) Connectivity and End-to-End Tests were successful, with minor problems identified. EMOS Build 2.5, currently used in this testing, will be the operational build for launch and post-launch support. Enhancements in Build 3 should be available in September.

The EOS Data and Operations System and EOS Polar Ground Stations have also encountered problems which are being fixed in preparation for launch. All EOSDIS systems have been tested to a level indicating launch readiness for a launch defined as "no earlier than July 30, 1999."

This uncertainty in the launch date is a result of failures this year of Titan 4, Athena, and Delta III launch vehicles. The Delta failure creates uncertainty about the TERRA (EOS AM-1) launch because of the failure of the Delta's RL-10B engine. That engine has similar components to the RL-10A4 engine used in the Atlas IIAS launch vehicle that will take TERRA to orbit. Meanwhile, a Titan 4 on the pad at Vandenberg AFB (VAFB) must be launched before either QuickSCAT or

TERRA can use another VAFB pad. A failure review board is expected to complete its report and a definitive launch schedule should be developed by mid June.

EOSDIS participation in development of the EOS PM-1 systems is on schedule for support of a December 2000 launch. EOSDIS participated in the EOS PM-1 Mission Status Review (MSR) June 2-4, 1999, and will hold the PM-1 EMOS System Design Review (SDR) on June 17. This SDR follows a System Requirements Review held on 4/22 and requirements baselining that occurred on May 18.

Early design/development effort has also begun on ICESat and EOS CHEM missions.

By Gene Smith/Code 423/581

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WSC Alternative Resource Terminal to Control TDRS-1

The White Sands Complex (WSC) Alternative Resource Terminal, also known as WART, will soon provide a limited capability to control the oldest TDRS spacecraft, F1, thereby enabling continued support of science operations at the South Pole. Currently, this support is being accomplished through the South Pole TDRS Relay (SPTR), which utilizes F1 and one of the prime Space to Ground Link Terminals (SGLTs) at WSC. With the upcoming launch of TDRS H and activation of F6, all of the available WSC SGLTs will be utilized. The options for F1 were either to terminate it, or provide additional resources to control it. Termination, however, was undesirable, since use of TDRS is the only viable way to accomplish the valuable science occurring at the South Pole. At a joint meeting in February 1999, representatives from NASA and the National Science Foundation produced an agreement to develop WART to serve as the new resource to control TDRS-F1.

To implement WART, engineers will reuse some of the retired GRO Remote Terminal System (GRTS) hardware, merging it with some existing tracking, telemetry, and control hardware at WSC, and some additional new hardware and software. Currently, engineers are procuring WART hardware and developing some initial software as well. The planned operational date for WART is late October 1999. We expect the operational transition from SPTR to WART to be transparent to the science efforts at the South Pole. By the next issue of *The Integrator*, WART should be well on its way to completion (assuming, of course, that F1 remains healthy).

By Frank Stocklin/GSFC Code 451

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Updated Networks and Mission Services Projects Charts Provided

We have updated both the **Ground Network Project Milestones** chart and the **Networks and Mission Services Projects Schedule** and included them in the center of this issue of *The Integrator*.

Edited by: Lena Braatz (Booz·Allen & Hamilton)
Layout & Illustration by: Sherri Tearman (Booz·Allen & Hamilton)

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