The Integrator

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A Message from the Associate Director / Program Manager for Mission Services

I would like to acknowledge the hard work and dedicated performance of Mission Services Program (MSP) staff. Like so many organizations Agency-wide, we have experienced organizational and staffing changes over the last few years. In the coming months we will experience further changes designed to align our organization with the evolving needs of our customers. Changes will bring challenges. With a winning combination of experience and innovation, the MSP personnel will overcome these challenges and maintain a strong customer focus.

Congratulations to the entire Tracking and Data Relay Satellite (TDRS) Project team for successfully launching TDRS-H from Cape Canaveral aboard an Atlas IIA rocket last month! TDRS-H is the first in a trio of the next generation of communication satellites used to link astronauts and orbiting satellites with the earth. TDRS-H will more than double the capacity of data transmissions with its new Ka band service and upgraded multiple access capability. TDRS-I and TDRS-J, the remaining two satellites, are scheduled to launch in 2002 and 2003, respectively.

In the past few months MSP staff been very busy preparing for many mission events, including the historic Compton Gamma Ray Observatory reentry, which was supported in an excellent manner by the Space Network and Mission and Data Services Projects. Ground Network Preparations for the upcoming EO-1 and Aqua missions are going well, and GSFC SOMO Technology Program initiatives were prominently highlighted at the Space Ops 2000 symposium in Toulouse, France. This newsletter includes articles describing Advanced Range Technology Initiatives and exciting commercialization activities for the Ground Network.

In closing, I would like to reiterate my commitment to providing an exceptional level of service to our diverse customer community. As our role in the space community evolves, we in the MSP look forward to working to identify efficient and effective ways to provide mission-enabling services for our customers.

Phil Liebrecht

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Highlights in This Issue...

In This Issue ...

Mission Services Program Elements

TDRS H Launch Successful!

On June 30, Tracking and Data Relay Satellite H (TDRS H) successfully launched from Cape Canaveral Air Force Station, FL aboard a Lockheed Martin Atlas IIA rocket. TDRS H is the first in a series of three "replenishment" satellites which will enhance the aging TDRS constellation already in existence. This new communications satellite incorporates many additional capabilities, including Ka-band Single Access services, which will enable an increase in data throughput. TDRS H was built by Hughes Space and Communications of El Segundo, CA, under a fixed-price contract. The remaining satellites in the replenishment series, TDRS I and J, are scheduled to launch in 2002 and 2003 respectively.

For more information about the new spacecraft and its mission, visit http://tdrs.gsfc.nasa.gov/Tdrsproject/ on the World Wide Web.

Network Control Center News

The Network Control Center (NCC) has several transition activities and significant operational accomplishments to report for this issue of *The Integrator.*

NCC personnel continue to participate in the transition of NCC functions to the White Sands Complex (WSC) for the Data Services Management Center (DSMC). The DSMC is a Consolidated Space Operations Contract (CSOC) initiative to move all of the NCC functions to the White Sands Complex by spring 2002. Since our past report, NCC Operations personnel worked extensively on several aspects of the DSMC project. The transition will occur in phases, some of which are currently being implemented.

The NCC recently supported the Customer Services Representative (CSR) and CSR/Customers DSMC communications meetings on June 6 and also met with WSC personnel on June 7 to continue refining the details of the Technical Manager (TM) and Performance Analyst (PA) transition. Some of the TM/PA functions will transition to the WSC by the end of June.

The majority of the NCC Ground Network (GN) Scheduling responsibilities have already moved to the Wallops Flight Facility. This move will initially consolidate GN Scheduling at Wallops, prior to an eventual move to the WSC. Santiago (AGO) scheduling transitioned to Wallops on April 17 as a pilot program. The Transition Readiness Review was held on June 8 and Wallops also assumed responsibility for Merritt Island, Ponce DeLeon, and Bermuda scheduling on June 12. MIR VHF and International Space Station (ISS) scheduling will also move to Wallops along with TDRS-H scheduling in the near future.

NCC personnel also contributed to the DSMC Operations Concept document and the Transition Plan, and are coordinating with DSMC Hardware Engineering personnel to plan for implementation of upgraded Communications and Control Segment (CCS) systems and the eventual transition of all NCC systems to the WSC.

In addition to all of the DSMC activity NCC Operations continues to provide daily valuable customer support. NCC Operations personnel successfully supported the Compton Gamma Ray Observatory (CGRO) Reentry (see article on page 12). Burns occurred on the evenings of May 30 and 31, with the final burns and actual reentry occurring early on June 4. The PA worked in coordination with the Flight Dynamics Facility (FDF) to provide the reentry vectors. The NCC issued Interim Support Instruction 92s (ISI 92s), terminating the network hardware and software freeze and terminating the

mission. The NCC also hosted the reentry party later that morning in the NCC break area.

Maintenance Release 1 (M00.1) to the NCCDS was delivered to operations successfully on February 28. (For more information on the NCCDS maintenance releases, see the adjacent article.)

In addition to the activities described above and daily routine support, the NCC supported eight Expendable Launch Vehicle (ELV) launches and two Space Shuttle missions since February 1 of this year.

Upcoming activities at the NCC include:

- Continuation of DSMC activities
- Exercise of a full Auxiliary Network Control Center (ANCC) Operational fail-over
- Resolution of Hardware/Software issues that will allow a full NCC operations fail-over to the ANCC in the near future.

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.

NCCDS Maintenance Status and Future Plans

The first Maintenance Release of NCC Data System (NCCDS) 98, dubbed Release M00.1, was successfully transitioned into Operations in February. M00.1 included the resolution of 107 problem reports and an NCC Change Request (NCR). With these changes, the NCCDS became more stable, reducing the number of workarounds and the amount of human intervention required by the sustaining engineering team.

Engineers have completed system testing for the second Maintenance Release, M00.2, and will complete Operations Evaluation Testing (OET) by the end of June. This release is the major component of the maintenance effort. The contents of this release, which can be reviewed at *http://ncc98.gsfc.nasa.gov/bld-cont/m002.stm,* include solutions to 150 problem reports and 24 NCRs. Release M00.2 includes major redesigns of wait list processing, TDRS mapping changes, and processing of requests off of the autoqueue. This release also includes performance improvements for many of the operator windows, which will allow the operators to do their jobs more efficiently. M00.2 also contains the NCCDS changes for the final phase of the Space Network Interoperable PN Code Libraries implementation. This release is targeted for transition into Operations in early July 2000. The transition will be scheduled so that any major changes will be avoided close to the TDRS H launch.

Development of the Third Maintenance Release, M00.3, is underway. This release will "cleanup" some problems introduced in M00.2, along with additional requests from Operations. Defining the contents for M00.3 will probably be a more iterative process than for the two previous releases, because Release M00.3 must be planned around other NCCDS activities. This release will include software changes to implement NCCDS support of Ka-band "Wide Band" services. These services are part of a demonstration of the capabilities of Ka-band services for both the Space Network and the Ground Network. The M00.3 changes will allow Ka "Wide Band" services to be scheduled and transmitted to the ground terminals. The real-time monitoring and control of "Wide Band" services will be implemented in a follow-on release.

Additionally, NCCDS personnel are now making intensive preparations to move the NCC to the White Sands Complex (WSC), where it will be the major component of the Data Services Management Center (DSMC). As part of this preparation, the Communications and Control Segment (CCS) and the NCC Test System (NTS) are being re-hosted on more compatible hardware. As this activity proceeds, the influence of the DSMC will limit the scope and duration of future endeavors for the NCCDS.

During the CCS re-hosting effort, the current VAX 8550 platform will be replaced with a VAX 6610. The target platform will work better in the DSMC, because it is more compatible with the existing WSC VAX equipment. This re-hosting effort will follow the development of M00.3 and is currently scheduled for completion in spring 2001.

The NTS porting effort is similar in purpose to the CCS Re-host; that is, to migrate to a platform that will be more effective for the DSMC. In this case, however, the effectiveness does not result from the target platform as much as from the elimination of the existing platform. This activity will also bring the NTS more in line with NISN protocols and away from the current proprietary protocol. The elimination of the older systems and the proprietary protocols will make the NTS easier to sustain in the future.

By JR Russell/CSC

For more information about the NCC maintenance releases, please contact Roger Clason at (301) 286-7431.

NASA Makes Significant Progress Toward Ground Network Commercialization

With the first half of 2000 behind us, several noteworthy events have taken place in preparation for the commercialization of NASA's Ground Network (GN). First, the EPGS (EOS Polar Ground Stations) have successfully transitioned to a fully operational status, paving the way for the continuation of the evolution of the EPGS from a NASA owned, managed, and contractor operated system to a fully commercialized capability. Another year 2000 milestone was the integration of the EPGS into the NASA Ground Network. The significance of this change is the recognition of the assets as part of a system capable of supporting multiple missions, rather than as a dedicated network. The third, and very significant action was the procurement of commercial services on a cost per pass basis by the Consolidated Space Operations Contract (CSOC), which NASA put in place to accomplish the transition to commercial services.

The first CSOC commercial services contract took place in November 1999 with Honeywell Technology Solutions Incorporated. Their DataLynx 11-meter antenna system is now being installed at NASA's Poker Flat Research Range near Fairbanks, Alaska. The new system, scheduled to be operational this November, is required to support the full range of S-band, X-band, and tracking requirements for the EOS mission set. Their first endeavor will be to support the EOS Aqua launch and on-orbit requirements beginning in late December of this year.

Installing the feed assembly on the DataLynx antenna at Poker Flat, Alaska

An additional step to add much needed GN capacity came in mid April, when CSOC contracted with Kongsberg-Lockheed Martin Space Data Services (KLM SDS) to obtain backup and contingency support services from their existing 11-meter antenna system located in Svalbard, Norway. Testing and modification of the KLM SDS system to ensure NASA mission compatibility is progressing as planned to meet a September operational date.

To add even more GN capacity, CSOC has released a draft Request For Offer (RFO) for the purpose of obtaining a number of potential service providers via an Indefinite Delivery, Indefinite Quantity (IDIQ) contract. The goal is to complete these contractual arrangements by early fall.

KLM SDS antenna (right) collocated with NASA's SGS antenna in Norway

With the initiation of these activities, it is clear that NASA and CSOC are making significant progress towards the goal of commercializing routine NASA Ground Network operations.

By Steven Kremer/GSFC/WFF Code 452

User Planning System Nearing Completion of TDRS H, I, J Capability

Having completed system testing of Release 12, which supports flexible scheduling, the User Planning System (UPS) task team is putting the finishing touches on a release supporting the new services available on

TDRS H, I, J. The UPS 2000 release will support all three H, I, J services (SMA, KaSA, and KaSA "WideBand"), and will be ready to support Level 6 testing with the White Sands Complex in mid August.

Although Release 12 is now available to customers, the UPS 2000 release is approaching very close on its heels. Therefore, it was decided to transition directly from Release 11 to the UPS 2000 release. Upon successful Level 6 test completion, the UPS in MultiSAT will transition directly from Release 11 (supporting only baseline scheduling) to the UPS 2000 release. By combining the two transitions into a single activity, system downtime will be reduced, stability enhanced, and the total transition time will be condensed from four weeks to two weeks, thus increasing UPS staff productivity.

The Hubble Space Telescope project plans to deploy UPS Release 12, and JSC will transition from Release 11 to UPS 2000 in October.

Plans are also underway to support the Long Duration Balloon Program (LDBP) in Palestine, Texas via a "loaner" X-terminal. LDBP will remotely connect to the MultiSAT UPS in a manner similar to the way the Extreme Ultraviolet Explorer (EUVE) mission, in Berkely, California, schedules its TDRS contacts using a remotely connected X-terminal.

Finally, although we recently bid farewell to an old friend, the Compton Gamma Ray Observatory (CGRO) mission (see article on page 12), we on the UPS team are proud to have assisted CGRO with its TDRS contacts over the years, which were all flawlessly scheduled using the UPS at MultiSAT.

By Howard Michelsen / CSC / CSOC

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.

STS Mission Support

For the first time in over 20 years, a new person sat at the Network Director's console for a Shuttle launch. What is the reason for this momentous occasion? The former Network Director, Gary A. Morse, accepted a position with the Space Operations Management Office (SOMO) as the Space Operations Manager, and has moved to Houston to assume his new responsibilities. In the 20 years that Mr. Morse served as the Network Director, communications using the TDRS ran effortlessly and uninterrupted. Now, Ted C. Sobchak has assumed the role of maintaining the integrity and reputation of excellence that the integrated networks provide the Shuttle. How will Mr. Sobchak tackle this challenge? Well, if the STS-101 mission is any indication, Mr. Sobchak will have no problem continuing the legacy of success.

White Sands Complex News

White Sands Complex (WSC) personnel are exceptionally busy supporting numerous new projects which will enhance the value of the Space Network (SN) to NASA. WSC personnel have been:

- Preparing for the launch of the new Tracking Data Relay Spacecraft (TDRS) H
- Modifying existing spacecraft modems to support the communication modes used by the Ground Network (GN)
- Supporting the Data Services Management Center (DSMC) project
- Installing the Third Generation Beam Forming System (TGBFS) at WSC and the Guam Remote Ground Terminal (GRGT)
- Completing the Consolidated Space Operations Contract (CSOC) ISO 9000 Certification effort.

WSC personnel contributed extensively to the preparations for TDRS H, providing operational support and developing and testing software. Development of operational procedures and software debugging were required prior to launch approval. WSC personnel will also play a critical role in the successful deployment and support of the new satellite.

WSC engineers have implemented, modified, tested, and accepted changes to Space To Ground Link Terminals (SGLT) 4 and 5, which now can provide the satellite communications modes which formerly were exclusively provided by NASA's GN. The Far Ultraviolet Spectroscopy Explorer (FUSE) satellite was used to test the new GN support capability, with 100% success. With the advent of this capability, NASA will realize a significant increase in the

(continued on page 8)

(continued from page 7)

communications support offered to satellites that were restricted to use of the GN. The TDRS System can support between 80% (worst case) and 100% coverage of a satellite's orbit, whereas the GN system seldom exceeded 20% support coverage. The increased TDRSS coverage may also allow a more immediate response to any spacecraft emergency. All of the WSC SGLTs are scheduled to receive the GN modification soon, and the Guam SGLT will be modified shortly thereafter.

The Data Services Management Center (DSMC) Operations Concept and Transition Plan have been completed. Establishment of the DSMC includes moving the functions of GSFC's Network Control Center to the WSC, NASA's primary satellite communications resource. NASA will therefore gain the advantage of having control and scheduling functions collocated with primary satellite communications resources. WSC hosted the DSMC's Sub-System Design Review (SSDR) on June 27.

The TGBFS has been installed, tested, and accepted on all of the SGLTs which offer Multiple Access (MA) support. The TGBFS acts as an extender to the existing MA Beam Forming Equipment (MABE) and allows the addition of numerous spacecraft receivers (demodulators). The TGBF sends the MA signals to an Independent Beamforming Units Group (IBUG), which provides up to five beam-formers. Customers will provide receiver systems (demodulators and bit syncs) to complete the system. The first IBUG will be installed at GRGT in early July and will provide support to the DAT1 Project. The TGBFS is essential to the completion of the Demand Access System (DAS).

The CSOC ISO 9000 Certification went very smoothly at WSC. WSC was "hit" with eight minor Non-Conformance items, which will be corrected immediately and will not interfere with the certification effort. WSC personnel's commitment to excellence continues to enable us to provide NASA with the world's premiere satellite communications system.

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.

Second TDRSS Ground Terminal (STGT) antenna field, circa 1992

FDF Community Involvement Makes Headlines

The Flight Dynamics Facility (FDF) recently made television and newspaper headlines by hosting local sixth-grade students during the launch of STS-101. The students had an experiment flying on the Shuttle as a part of NASA's Space Experiment Module program.

The project began more than two years ago, when twelve students from Benfield Elementary School (in Anne Arundel County, MD) proposed an experiment that would test the effects of space exposure on yeast, photographic film, and seeds. Their proposal was one of only ten selected from thousands of applications.

Eleven of the students traveled to Kennedy Space Center to view the April 24 launch attempt. One student, Greg Zingler, was unable to make the trip. FDF Group Manager, Scott Wallace, invited Greg to watch the launch attempt from the FDF Operations Room located at GSFC Building 28.

As Greg sat with the FDF Shuttle Launch Team, he listened to the astronauts and Houston Mission Control officers talk through the FDF's communications loops, and learned about the FDF's role in supporting Shuttle launches. Although bad weather eventually postponed the launch, the media coverage was overwhelmingly positive. The FDF was featured on television by ABC affiliate, WMAR, and in *The Capital* newspaper.

After three weather-related launch delays, the students who had traveled to Florida returned home without seeing their experiment fly. When the FDF heard of their disappointment, they contacted the NASA Education Office and invited all twelve students to the FDF for the next launch attempt.

At 5:00 A.M. on May 19, almost 50 students, educators, family members, and friends arrived at the FDF. Bleary-eyed but smiling, the students were escorted to the FDF Operations Room, where the FDF team answered questions about careers in space and technology. The media responded enthusiastically, with outstanding coverage by Baltimore's television station *WJZ* and four local newspapers: *The Capital*, *Bowie Blade*, *Capital Gazette*, and *Laurel Ledger*.

As the Shuttle main engines ignited, the excitement amongst the students was electric. The students cheered and clapped, while the FDF Launch Team quietly provided picture-perfect launch support. It was a rewarding experience for all involved, and the FDF was proud to provide positive role models for students just embarking on scientific careers. The FDF welcomes the opportunity to participate in future community and education-oriented events.

By Holly Offerman/CSOC/GSFC Code 453.2

Please contact FDF Mission Coordinator Holly Offerman at (301) 286-2197 for more information.

The Flight Dynamics Facility hosts local students and news crews during the May 19 launch of STS-101.

RSDO Awards Delivery Orders for IP Based Spacecraft Study

In the next ten to fifteen years, NASA expects to continue to increase the complexity and frequency of its missions, with some missions even consisting of formations or constellations of satellites. This rapid growth is anticipated to tax NASA's projected communications resources. As a result, the National Space Policy directs NASA to begin a transition to commercially provided communications services.

To achieve this goal, NASA intends to fly an increasing number of commercially obtained satellites that can interface with global IP networks. Eventually, plans are to implement a Space Internet, where each element of the spacecraft system is an easily addressable node. In this scenario, a Principal Investigator in the lab would be able to communicate with his instruments in space as easily as he can communicate with his instruments on the ground today.

New technologies and protocols in fields such as Mobile IP will evolve rapidly in the commercial markets. One goal is to reduce the overhead code for addressing and packet accountability. These capabilities may be adopted in a Space Internet. The backbone space to ground communications transport layers could utilize existing NASA Space and Ground based tracking systems as well as commercial, academic, or foreign cooperative based tracking capabilities.

Last April, the Rapid Spacecraft Development Office (RSDO) and the Glenn Research Center released a Request For Offer (RFO) for a study to evaluate the ability of current commercial satellite communications technologies to support Internet Protocol (IP) based satellite communication. The goal of the study is to identify critical gaps where additional research or "proof of concept" development is needed to ensure the success of IP based spacecraft buses and payloads.

In May, an evaluation team met to assess the offers received. Four companies (Orbital Sciences Corp.; Spectrum Astro, Inc.; Surrey Satellite Technology, LTD; and TRW, Inc.) were selected to receive funds to conduct such a study. The results of the studies, which are scheduled for completion in August of this year, should be very interesting, and may enable some exciting research opportunities .

To download the IP Satellite Study RFO or Decision Document, please visit http://rsdo.gsfc.nasa.gov/rapidii/misinfo.cfm on the World Wide Web.

To learn more about RSDO activities, please visit the RSDO web site at http://rsdo.gsfc.nasa.gov/ or contact Bill Watson at (301) 286-1289.

Mission Services Program Customers

Network Support of Expendable Launch Vehicles

Space Network support of Expendable Launch Vehicles (ELV) continues to grow and it is becoming harder and harder to keep track of the activity without a scorecard. Current and future customer requirements have kept the Network very busy in the past few months, and the trend is towards more work for TDRSS. NASDA has joined Delta IV as a new TDRSS launch support customer, with hopes of assigning several H-2A launch missions to the Space Network schedule. Everything for the ELV program was not "all roses" though, as the latest Sea Launch mission failed shortly after launch. The Sea Launch Project has addressed this failure and is moving towards resumption of launches this summer. Titan IV-B has returned to service with the successful launch of a Defense Support Program (DSP) satellite, and Atlas 3 finally made its long awaited maiden flight placing the European Telecommunications Satellite (Eutelsat) W4 satellite in orbit. Details about these and other ELV endeavors are summarized below.

Sea Launch

The Sea Launch Program suffered a major setback on March 12 when its Zenit rocket went out of control, destroying the first ICO mobile communications satellite. Launch appeared to be normal, occurring at 1449 GMT on March 12, but shortly after the Zenit's second stage ignited, the communications through TDRS became intermittent. Communications with the vehicle continued for another 5 or 6 minutes. This data proved valuable in determining the cause of the anomaly, which was traced to a valve on stage two that software failed to command to close. Sea Launch has since completed a review of the anomaly and has tentatively scheduled the launch of a PanAmSat payload on July 15.

Titan IV-B

The Titan IV-B program is back on track after experiencing three failures between August 1998 and April 1999. Titan IV-B29 carrying a DSP satellite was successfully launched from Cape Canaveral Air Force Station on May 8. TDRSS support was augmented by three Software Programmable Advanced Receiver (SPAR) units provided by ITT. These units were shipped to the White Sands Complex in order to support unique telemetry requirements for this mission. ITT personnel traveled to White Sands to operate the receivers and support the mission.

The next Titan IV-B launch is scheduled later this summer from Vandenberg, and another launch is planned this fall from the Cape.

Atlas 3

The maiden voyage of Atlas 3 was finally achieved on May 24, with a successful launch from pad 36B at Cape Canaveral Air Force Station. Originally scheduled to launch Telstar-3 in the summer of 1999, the inaugural flight was postponed when the original customer backed out due to concerns with the vehicle upper stage engine. Launch of Atlas 3 and its European Telecommunications Satellite (Eutelsat W4) was not without difficulties. Launch was stalled for 10 days by various problems and range conflicts, including a scheduled Shuttle launch. Launch attempts on Saturday, May 20 were delayed by a fishing tournament involving 70 boats in the launch safety zone. Problems with the Bermuda station's radar also contributed to a postponement. The Network had to place a transportable radar at Bermuda to support special range requirements for the first Atlas 3 mission. Once off the pad, the vehicle performed

Inaugural flight of the Atlas 3, shown here lifting off from Pad 36b at Cape Canaveral Air Force Station on May 24, 2000.

flawlessly and provided breathtaking video from a vantage point down the side of the vehicle.

The mission provided a historic footnote with the first launch of an American vehicle using a Russian-built engine. The Atlas 3 uses a Russian-made RD-180 engine that produces over 900,000 pounds of thrust. The RD-180 burns liquid oxygen and kerosene, giving it the ability to throttle during ascent, providing additional capabilities not available with solid rocket engines.

The Atlas 3 Centaur upper stage took about 12 minutes to ascend, and within 30 minutes of liftoff had placed the Eutelsat W4 in orbit over the Central Atlantic off the West Coast of Africa.

Atlas 2

Atlas 2 continues to be the workhorse of the Atlas family, with a successful launch of Hispasat-C on February 3. AC-158 was launched from pad 36B at the Cape Canaveral Air Force Station. The next Atlas 2 launch will be of great interest to the Space Network, as the TDRS H, the first of the next generation of TDRS satellites, is launched. TDRS H is scheduled to fly atop Atlas 2A on AC-139 from launch pad 36A at the Cape Canaveral Air Force Station on June 30, 2000.

Delta 2

On March 25, a Delta 2, with the Image spacecraft aboard, was launched from Vandenberg Air Force Base, California. TDRSS support was provided through a P-3 aircraft, which was on station downrange from Vandenberg. Delta 2 is also due to launch a Global Positioning System (GPS) vehicle, but the mission has been delayed due to problems fitting together two stages of the vehicle at the pad.

Delta IV

The Delta IV Program achieved an important milestone this May with the completion of compatibility testing at the Goddard Space Flight Center. Data was relayed through TDRSS for the first time. Boeing will use a Cincinnati Electronics transmitter on their Delta IV launch vehicle. Testing was successfully conducted during the week of May 16 and was attended by representatives from Boeing, Cincinnati Electronics, B. F. Goodrich, and Aerospace Company.

The Delta IV Program will continue later this year, with Pathfinder testing at the Cape. The first launch is currently planned for April 2001. The Delta IV Program is intended to launch both military and commercial satellites for many years, and already a substantial list of commercial and military customers have signed up.

H-2A (NASDA)

Representatives of NASDA were at Goddard on June 15 to attend the first Technical Interchange Meeting between NASDA and TDRSS for the H-2A/Selene mission. NASDA is planning to use TDRSS to support the H-2A launch of Selene to the moon in 2003. Selene will be launched from the Tanegashima Space Center in Japan.

By Joe St. John/CSOC/ GSFC Code 451

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

CSOC at JSC Ready for the 2000 Hurricane Season

The first tropical depression of the hurricane season (June through November) developed in the southern Gulf of Mexico in early June. CSOC Production Operations personnel at the Johnson Space Center were up to speed, with their preparedness plans well in place.

CSOC personnel are educated to understand the effects of nature's wrath of wind and rain, and have received information regarding JSC's preparation levels and readiness actions. In emergencies such as hurricanes, however, the need to maintain operational effectiveness is a critical requirement. To that end, CSOC Production Operations has staffed "Rideout Teams" for real-time coverage of all pertinent buildings. JSC buildings are designed to withstand hurricane force winds. During storms, "Rideout Teams" will occupy operationally vital positions to ensure continuous operation of critical functions. Rideout duration depends on the size of the hurricane. There is not much one can do but wait out the storm—I recommend Cribbage or Texas No-Draw poker with all that change you have been saving!

By Dennis T. Postel/Cimarron

For additional information on JSC activities, please contact John Snyder at john.snyder@csoconline.com or 281-853-2350.

Hubble Space Telescope Update

With the recent success of the Hubble Space Telescope (HST) Servicing Mission 3A (SM3A), HST personnel are gearing up for the next big on-orbit rendezvous—Servicing Mission 3B (SM3B). During SM3B, the following activities are planned:

- Replacement of the Faint Object Camera with the Advanced Camera for Surveys (ACS), which should increase the survey capability of the HST tenfold
- Installation of new Solar Arrays (SA-III) which are rigid, more robust, smaller, and more efficient than current arrays
- Installation of a new cooling system for the Near Infrared Camera and MultiObject Spectrometer (NICMOS) instrument
- Continued installation of the Multi-Layer Insulation (MLI) Blanket, begun on SM3A
- Use of the Shuttle's jets to reboost HST to the proper orbit (HST has no on-board propulsion systems)

To accomplish these tasks, four Extra Vehicular Activities (EVAs) are scheduled during SM3B, which is slated to occur in 2001.

For additional information on HST, please visit http://hstsci.gsfc.nasa.gov/ on the World Wide Web.

The Compton Gamma Ray Observatory Mission Comes to an End

After nearly a decade in orbit and numerous scientific discoveries, the Compton Gamma Ray Observatory (CGRO) mission came to an end in the early morning hours on June 4, 2000. Engineers at the Goddard Space Flight Center began planning for the Observatory's reentry in April 1999, when one of its gyroscopes first began experiencing problems. A number of deorbit scenarios were conceived prior to any actual failure. None of these, however, were simple or foolproof, and given the mass of the observatory and the density of a number of its constituent components, safety was a key consideration. Thus, although the observatory was still functioning properly and still scientifically productive, a decision was made to follow the path of least risk, which was to perform a controlled reentry maneuver at the earliest plausible time.

As noted in the previous issue of *The Integrator*, one of CGRO's three gyroscopes, which provide attitude reference position and rate information, failed in December 1999. Goddard engineers inferred from the telemetry data that its ball bearings gyro seized, causing its spin-motor to stall. Although out of 45 similar gyroscopes, with hundreds of years of flight time, only two other failures have occurred. The loss of any additional gyroscopes would lead to a more complex reentry plan incurring a greater risk of failure. Thus, a review by NASA Headquarters in late March 2000 resulted in the decision to terminate the mission and de-orbit the spacecraft as soon as possible.

A strategy of lowering CGRO's orbit using four deorbit burns was devised. Windows of opportunity, driven by a combination of the required vector orientation at apogee and optimal illumination of the solar arrays, were calculated to occur about every 45 days. The first plausible window, taking into account the necessary time for preparation and staff training, was near the end of May 2000.

On May 28, a test burn was performed, and the four science instruments were powered down. Following this action, a series of four burns of about 30-minutes duration each was initialized via a sequence of commands sent to the spacecraft by controllers on the ground. The corresponding decrease in the orbit perigee is illustrated in Figure 1.

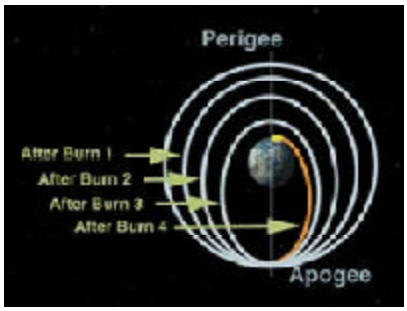

Figure 1. Schematic illustration of the decreases in the CGRO perigee resulting from each of the 4 deorbit burns.

The final two descent burns occurred on June 4, 2000. As the spacecraft reentered the Earth's atmosphere, it began to tumble and heat up as about 60-70% of the mass disintegrated (Figure 2). More than six tons of metal debris was expected to survive the reentry process and reach the surface of the Earth. The surviving debris fragments were traveling at very high speeds. The size of debris fragments was expected to range from small (the

Figure 2. Schematic illustration of the expected reentry path, and the "breakup" altitude at which the telemetry was lost and the spacecraft began to disintegrate.

size of a small stone) to several hundred pounds. The debris was predicted to be spread over a long and narrow corridor (Figure 3). Thus, to ensure safety to human life, the optimal reentry target area was determined to be the south Pacific ocean, southeast of Hawaii. As planned, pieces of the observatory that survived the reentry landed in the Pacific Ocean approximately 2,400 miles (3,862 km) southeast of Hawaii.

Figure 3. The approximate "footprint" of the debris field following breakup and final descent.

Thus ended one of NASA's most successful scientific missions. The CGRO spacecraft and its flight control team performed admirably right up to the end. Nonetheless, it was a bittersweet moment for the many scientists who participated in the mission and had hoped for further discoveries. As "Murphy's Laws" would dictate, approximately one week subsequent to CGRO's reentry, a major solar flare occurred. The study of the gamma-ray emission associated with these energetic events, which usually occur only near the maximum of the 11-year solar cycle, was the primary unfulfilled scientific task for CGRO.

By Chris R. Shrader, CGRO Science Support Center, NASA/GSFC

For more information on the CGRO mission, refer to http://cossc.gsfc.nasa.gov on the World Wide Web.

WIRE Testbed Demonstrates Star Tracker Flight Software Modification

Personnel from the Wide-Field Infrared Explorer (WIRE) Testbed Project and the Geostationary Operational Environmental Satellite (GOES) Project worked together to flight test a modification to the Ball CT-601 star tracker flight software. On orbit experiences gathered from all GSFC missions currently operating a CT-601 star tracker identified that all such trackers experience brief outage periods on a regular basis during South Atlantic Anomaly (SAA) or polar region crossings. These outages are due to radiation-induced upsets that prevent the tracker from maintaining track on the selected guide stars. A modified version of the CT-601, the CT-602, has been selected by the GOES Project for the follow-on GOES spacecraft. Due to concern about the performance of the star tracker during radiation events, the GOES Project contacted the WIRE testbed personnel for assistance.

WIRE provided high rate raw pixel data to Ball Aerospace engineers, who were then able to quickly determine the root deficiency in their software, and develop a patch to correct the problem. The GOES Project sponsored a flight test of the star tracker software patch on the WIRE satellite. Prior to the upload of the patch, WIRE typically experienced several radiation-induced events per week, in which background level counts became elevated to several hundred counts above the nominal 4 to 5 counts. During some events, the background counts increased to the point that the tracker lost the ability to maintain lock on the guide stars, resulting in a tracking outage. Following the activation of the software patch, the counts have not exceeded 40, and there have been no loss-of-track events. Raw pixel data examined by the WIRE flight operations team and Ball Aerospace indicate that the patch performed as expected to mitigate the impact of the radiation events.

The Wide-Field Infrared Explorer (WIRE) Testbed Project is actively accepting, working, and executing test proposals to utilize the on-orbit satellite to perform engineering and scientific experiments. The objective of the Project is to

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provide an affordable and accessible on-orbit spacecraft to the space community to enable science observations, measure engineering performance, accelerate technology readiness and infusion, verify operations concepts, and perform educational outreach. This resource derives its funding solely from the individual experimenters. Experimenters must fund not only their own needs, but also provide the funds to operate the spacecraft, on a prorated basis, for the duration of the investigation. To date, the Testbed Project has completed or partially completed five tests and is currently working the details of eight more. In addition, the project is actively negotiating the support for and evaluating the feasibility of seven additional tests.

By Patrick Crouse/GSFC Code 581

For additional information, please visit the Testbed website http:// wiretestbed.nascom.nasa.gov/ or contact one of the following:

Patrick Crouse, WIRE Mission Director
Systems Integration & Engineering Branch
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(301) 286-9613

Robert Buchanan, Explorers Program Testbed Manager
Mission Integration & Planning Division
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(301) 286-0491

TOPEX/Poseidon Helps Scientists to Solve Ocean Tides Mystery

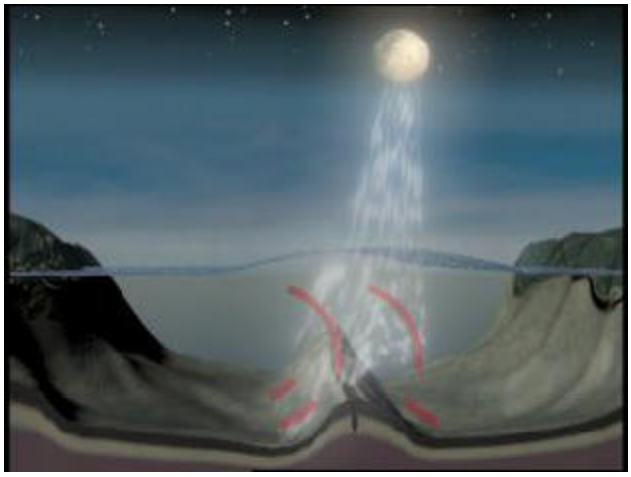
The U.S.-French TOPEX/Poseidon satellite continues to provide scientists with exciting and unique measurements of sea surface conditions worldwide. The satellite bus and instruments remain in good health, as the mission completes its eighth anniversary this August. Although TOPEX/Poseidon has become well known for providing El Niño and La Niña images of the Pacific, new and unique studies continue to be enabled by the satellite altimetry data.

Richard Ray at NASA's Goddard Space Flight Center and Gary Egbert at Oregon State University (Corvalis) have studied six years of data from TOPEX/Poseidon. These observations have greatly contributed to the understanding of the relationship between the Earth's moon and its effect on ocean tides. "By measuring sea level with the TOPEX/ Poseidon satellite altimeter, our knowledge of the tides in the global ocean has been remarkably improved," said Ray, a geophysicist at Goddard.

Their research appears in the June 15 issue of *Nature* magazine, and focuses on the main sources of energy required to maintain the ocean's large scale circulation patterns. It is estimated that two terawatts are required to fuel this process, with wind action supplying about half of this total. It has been hypothesized for many years that large amounts of energy from the moon's gravitational pull likely contribute much of the remaining terawatt.

According to Ray and Egbert's report, TOPEX/Poseidon data was used to empirically map tidal energy dissipation. This dissipation amounted to about one terawatt, and was found to cause localized turbulence and mixing in the deep ocean. This finding has provided supportive evidence that the moon's gravity is indeed a key factor in the ocean's "conveyor-belt" circulation pattern, which mixes upper ocean heat down through the cooler ocean depths. "It is possible that properly accounting for tidally induced ocean mixing may have important implications for long-term climate modeling," said Egbert.

Project personnel are excited that observations such as those by Ray and Egbert continue to be made possible from TOPEX/Poseidon data. It is evident that over the coming years, TOPEX/Poseidon and Jason-1 (the TOPEX/Poseidon follow-on altimeter



This image depicts the direct relationship between the moon's gravitational pull on the Earth and its effect on tides and deep ocean circulation patterns.

mission) will remain critical to the development and validation of long-term oceanographic studies. Along with monitoring of events such as El Niño and La Niña, potentially significant relationships between the Earth's oceans and ecology will continue to be discovered.

By Mark Fujishin/Manager, JPL Earth Science Mission Operations

For additional information on this topic, please visit the TOPEX/Poseidon homepage at http://topex-www.jpl.nasa.gov or contact the author via email at mark.fujishin@jpl.nasa.gov.

Additional Activities

MSPO Conducts Advanced Mission Planning

"Everyone" knows that every satellite launched must be supported by an infrastructure of data receiving, data distribution, mission operations, and data processing facilities if it is to succeed in its mission. Sometimes, we have seen missions which were successful, but only because the mission operations staff were able to solve a myriad of problems which surfaced after the satellite was launched. In some cases, these heroic measures were required because there were unusual and unexpected satellite subsystem failures in orbit. Such cases have often brought out the finest in the operations staff.

There are other cases, however, where operations problems could have been foreseen or completely avoided if operations had been adequately addressed early in the mission design and development phase. The Mission Services Program Office (MSPO) at GSFC is addressing this situation in several ways. This article examines activities the Office is undertaking very early in the mission planning phase, even before the "official" start of the implementation phase. This investment of time and energy early in a program reaps great benefits after launch. In fact, the money spent on many programs after launch equals or exceeds the program development cost. This early mission planning work can produce benefits encompassing the complete triad of "faster, better, cheaper."

The best time to start considering operations aspects of a mission is about the time the first idea for the mission is born. In our Advanced Mission Planning Function, we look for the earliest indications of a new mission, often starting before specific planning for that mission has coalesced into an early mission concept. One way we accomplish this is to track NASA Announcements of Opportunity (AOs). In the last few years, each AO has even included a reference to the mission support which can be provided by the Space Operations Management Office (SOMO). The AO identifies the SOMO Customer Commitment Officer (CCO) as the point of contact for further information about SOMO support. The MSPO provides a Center Customer Commitment Officer (CCCO) who functions as a working-level interface, providing any pertinent information about SOMO support to organizations responding to the AO. As an aid in keeping track of expected AOs, we develop a schedule, an example of which can be viewed on line at *http://nmsp.gsfc.nasa.gov/integrator.*

Not every mission begins as a response to an AO. Other new missions obtain early planning assistance from the Integrated Mission Design Center (IMDC). Since the IMDC began operations about three years ago, it has performed more than 80 mission studies. More information about this facility is available at *http:/imdc.nasa.gov*. The MSPO provides the Team Leader and some of the discipline engineers who staff the IMDC. By design, the IMDC is staffed by a rotating cadre of discipline engineers. Each discipline engineer is part of a home organization and supports the IMDC part time, thus providing a two-way exchange of expertise. Information from the discipline engineer's home organization enters the IMDC, and information about different types of new missions from the IMDC flows back into the discipline engineer's home organization.

Another MSPO mission planning activity used during several phases of mission support (including the Advanced Mission Planning Function) is the development and maintenance of the NASA Mission Set. This list of missions includes missions in all phases, from early planning to orbital operation. The NASA Mission Set holds the distinction of being the first, and so far only, integrated list to include all space missions supported by each NASA center. Currently, the NASA Mission Set includes 264 missions. For each mission, the Mission Set includes information about key milestone dates, such as implementation start, nominal

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launch date (actual for those in orbit), and expected support stop date. The Mission Set also includes information about points of contact for the Project Service Level Agreement (PSLA), the CSOC Customer Service Representative, the MSPO Mission Manager, and points of contact at other NASA Centers. To view a sample subset of the data contained in the mission set, please visit *http://nmsp.gsfc.nasa.gov/integrator.*

By John Martin/GSFC Code 453

For more information on this endeavor, please contact the author at (301) 286-8892, or via email at john.b.martin@gsfc.nasa.gov.

Technology Initiative Focuses on Reducing Launch Costs and Risk

Quick! What are the most expensive and riskiest 20 minutes in the life of every satellite?

The answer: The time that begins seconds prior to lift-off and ends 20 or so minutes later at orbital insertion is easily the period of most concentrated cost and risk. Costs for even medium sized launch vehicles can run well past half a million dollars when all tracking and command/control costs are included. Larger launch vehicles cost many times that to insert a payload into orbit and the risks include the potential for catastrophic failures that make national news. With new mission concepts depending on tens or even hundreds of satellites at a time, and with the International Space Station (ISS) one crisis away from needing a quick-turnaround resupply, the cost, reliability, and flexibility of Launch Range support is a high priority.

The Advanced Range Technology Initiative (ARTI) is designed to combat the high costs and risks of the launch phase. Its objective is to "enhance access to space by reducing launch costs and increasing range mission capacity, safety, and reliability by advancing the state of the art in Launch Range Technologies, their testing, and deployment." ARTI focuses on five main technology thrust areas:

- Flight Modem and applications
- Mission Management Knowledge Capture, Engineering, and Modeling
- Virtual Control Center Development
- Mobile/Configurable Launch Support Technologies
- Range Surveillance Technologies.

Working as a part of the Space Operations Management Office (SOMO) Technology Program and in cooperation with Kennedy Space Center, ARTI leverages the Wallops Test Range as a test bed for new technologies. Technology concepts and systems developed can then be infused into other U.S. ranges.

By Jay Pittman/ARTI Project Lead/ WFF Code 584W

For more information on ARTI, contact the author at 757 824 1506 or visit the ARTI Website at http://www.wff.nasa.gov/~arti/.

Symbolizing an eagerness to identify and explore new ideas, Arti is the symbol of the ARTI project.

DuVal Students Try for Second Ride Aboard Shuttle

The Independent Studies Aviation (ISA) class at DuVal High School, Goddard's neighboring high school, is making a second attempt at getting into space, after a first highly successful venture in 1998. The students in the class have been going through "Phase-A" planning and development efforts to devise a shuttle-borne Science Experiment Module (SEM) payload. The experiment, conceived early in the spring term, will measure the effect of microgravity on the hatching of brine shrimp eggs.

The DuVal students devised a relay mechanism to depress the plungers of two hypodermic syringes containing dried brine shrimp eggs. The needles of the syringes are prepositioned in vials of saline solution. Upon activation of the relays, the syringe plungers will depress, causing the eggs to be deposited in the saline solution, where hatching is expected to occur within 48 hours. The progress of the hatching will be taped with a miniature CCD video camera and tape unit. After the end of the shuttle mission, the experiment will be repackaged and shipped back to DuVal for the students to eventually replay the videotape of the anticipated successful hatching of the shrimp eggs.

As of this writing, the relay/plunger/ syringe assembly is going through re-development, due to stability issues. Shock/vibration testing in Building 5 is anticipated soon. The purchase requisitions are being prepared for two candidate video cameras and a miniature tape assembly. The timer/ controller mechanism and the on-board heating elements have been specified and are awaiting procurement. Now that the spring term is completed, most

activity will cease until the new class of students arrives in late August.

This particular experiment, if successful, will be the first attempt of a self-contained experiment in a shuttle cargo bay involving the hatching of brine shrimp eggs. DuVal's first shuttle payload, G-238, flew on board STS-95 in October 1998. The Get Away Special (GAS) canister experiment, known as DuVal's Roach MOTEL (Microgravity Opportunity To Enhance Learning), was devised around a similar concept of videotaping a life science experiment. That experiment involved investigating the effects of microgravity on the survival and subsequent development of a collection of American cockroaches. The results of that successful experiment were subsequently published in the proceedings of the 1999 Shuttle Small Payloads Symposium (NASA/CP-1999-209476).

Problems are often encountered during the development of such science experiments. The percentage of student turnover in the class from term to term can be large, with students opting to sign up for other classes instead. Since most students who first sign up for the class are juniors, even those who stay in the class for four terms (two years) will not be around to see "their" baby fly on board a Shuttle. A number of former students who had been involved over the years with G-238 and were in college or in the work force contacted the Aerospace Instructional Coordinator, Mrs. Carolyn Harden, in the fall of 1998 after seeing some of the television coverage or reading some of the newspaper articles about DuVal's experiment.

The students are guided in their efforts by Mrs. Harden, and by volunteer mentors from GSFC and neighboring aerospace companies. The class is usually composed of 15-20 students, all with an interest in contributing to the success of a science/technology experiment. The ISA class at DuVal is the original class in what has grown to be a 4-year sequence of science and aerospace technology applications courses for students in the Aerospace and Aviation Career Academy. The ISA class, however, is the only aerospace course that is open to all students at DuVal. The DuVal Aerospace Advisory Board (DAAB), a joint school administrator/teacher/NASA-industry group, was formed as an education and business partnership over 10 years ago and is dedicated to the academic success of the students at DuVal, with a focus on improving the science and technology skills of the students.

DuVal High School and the DAAB are always in need of enthusiastic tutors and mentors. If you wish to contribute your time, please contact the school at 301/918-8600 or send email to *dhsaero@pgcps.org*.

By Dale D. Shama/CSOC GSFC Code 567

New ELV Transmitter in the Works

After years of success supporting Expendable Launch Vehicles (ELVs) via TDRSS, the Space Network (SN) Project Office is proposing to enhance the services provided by introducing new vehicle technology. The SN Project Office is currently working with Consolidated Space Operations Contract (CSOC) contractors to develop the next generation of ELV transmitters. The technical aim of the project is to engineer a small, lightweight, and power-efficient transmitter by adapting the packaging and low-power design of the existing ITT Industries Low Power Transceiver (LPT).

After several meetings with the contractor team concerning the requirements and tentative project deadlines, a proposed budget and schedule for the completion of a prototype was submitted. ITT has completed a draft specification and is working toward building a prototype that will undergo RF and environmental testing. Some of the remaining details of the specification—such as packaging, interfaces, and test points—require close cooperation with ITT and the customer. Several in-depth discussions were held with ITT on these matters, but many details are yet to be resolved, the most difficult of which is the degree to which a Power Amplifier (PA) vendor will have to conform to the current design. The transmitter will use a 30W PA. The design and development of the amplifier will be outsourced. Central to the selection of the vendor will be a preliminary design of the PA. The ELV transmitter design, in short, is currently at a crossroads; in order to tap into the expertise of the best industry PA designers and to offer a finished product superior to existing ELV products, additional design changes may be required.

Soon to follow will be a comprehensive specification for the entire transmitter. Test plans for verifying compliance will be an immediate outgrowth of both specifications. In addition, arrangements for testing—which ranges from lab testing to random vibration and thermal vacuum testing—are yet to be determined.

As requirements, design, and fabrication come together, the project will gain headway and should move quickly, so keep watch!

By Jeff Jaso/CSOC/ GSFC Code 451 and Greg Worden/ CSOC/GSFC Code 451

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

ISS Multi-Element Integrated Test I Complete

Just to recapture the concept of the International Space Station (ISS) Multi-Element Integrated Test (MEIT)……MEIT involves flight model communications equipment cargo integration testing for ISS Flights 3A, 4A, 5A, and 6A at Kennedy Space Center's (KSC) Space Station Processing Facility (SSPF). In our last report in the July 1999 edition of *The Integrator*, the ISS MEIT I test team had completed the following, with support from GSFC:

- Test Configuration #1 - GSFC provided equipment (the TDRSS User RF Test Set, or TURFTS) to KSC to assist in converting between RF and baseband signals. MEIT TC#1 was successfully completed in January 1999.
- Test Configuration #2 – GSFC provided the GSFC Compatibility Test Van (CTV) to assist with the RF testing for Ku-Band 50/75 Mbps (and possibly 150 Mbps) testing activities. The CTV was positioned outside the SSPF and provided the RF interface between the Ku-Band Flight components and TDRSS.

Now, there are final MEIT I test events to report. Test Configuration #2R and Test Configuration #4 were completed in the January/February 2000 timeframe. This testing consisted of regression testing of specific issues encountered in previous S/Ku-Band testing (Test Configuration #2R) and ISS S/Ku-Band End-to-End Testing between the Mission Control Center-Houston (MCC-H) and the flight components (Test Configuration #4). GSFC support was instrumental in the successful completion of MEIT activities.

From a GSFC Networks perspective, all testing was completed successfully without issue. GSFC Network resources were used for the external interfaces between the KSC SSPF and JSC MCC-H. Network resources used during the testing included the TURFTS for land-line interfaces and the MILA Relay/TDRS interface for RF testing. GSFC was responsible for planning and accurately configuring the Network (data and voice) during the test events. No problems were attributed to Network support resources.

Although ISS component configuration problems implied TURFTS anomalies, GSFC TURFTS engineers quickly discounted these matters. What is significant to report is the GSFC Network team's outstanding efforts scheduling and rescheduling 116 hours of continuous TDRSS time, and the valuable personnel resources who provided support for the final MEIT I activities. Congratulation to the Networks Team that included personnel from GSFC, WSC, and MILA. Due to your dedication, hard work, and pride in a doing your job with excellence, this series was a success. Thanks again to everyone!

MEIT II and MEIT III follow-on testing are already in the planning stages. MEIT II will encompass testing to provide data to support the verification of a critical analytical model and significantly reduce documented program risk. Element availability, schedule, and cost may affect the test configuration and the involved elements. MEIT III will test system functionality and interface compatibility between International Space Station elements.

Stay tuned, as these test plans unfold, and events are defined!

By John Smith/CSOC/ GSFC Code 451

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

Space Network Web Services Interface Gears Up Development Effort

An experienced and uniquely skilled development team has been established to implement the Space Network (SN) Web Services Interface (SWSI). The SWSI system, currently in the design phase, will provide for a secure remote interface to Network Control Center (NCC) services. The goal of SWSI is to provide a standards-based customer interface to the NCCDS to perform TDRSS customer scheduling, real-time service monitoring and control, and state vector storage. SN customers will be able to perform all these functions for only the cost of a desktop computer or workstation. A web browser and a Java virtual machine, both of which are freely available, will also be required. The SWSI is designed to be accessed from both the NASA Integrated Services Network (NISN) IP Operational Network (IONET) and the Internet.

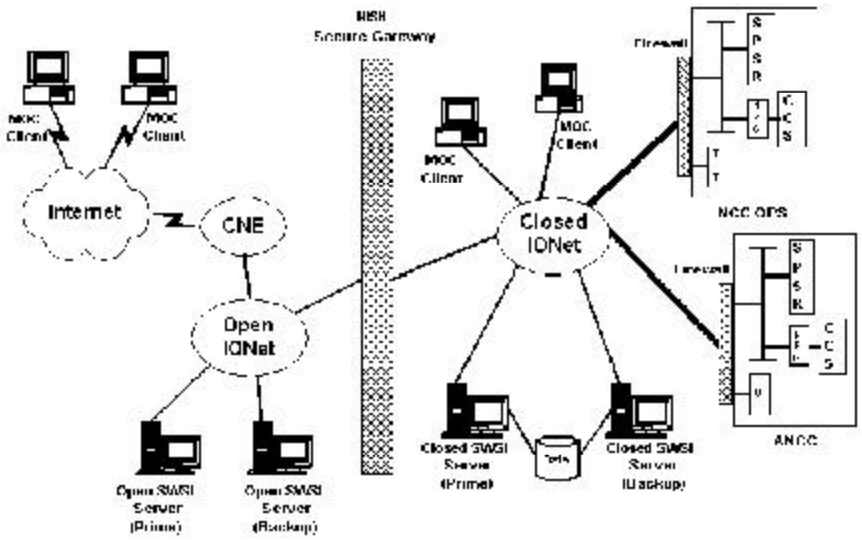
The SWSI development team is realizing design efficiencies, and ultimately implementation cost savings, by building upon work previously performed by the Realtime Software Engineering Branch/GSFC Code 584 on the Java-based Spacecraft Web Interface to Telemetry and Command Handling (Jswitch). Jswitch objectives are very similar to those of SWSI in that it provides a secure, platform-independent customer interface to a spacecraft Mission Operations Center (MOC) from any network, including the Internet.

The SWSI Development Facility is located at GSFC, Building 12, Room N12. The SWSI Team is currently baselining requirements for the system design and development. SWSI development is being accomplished on Sun workstations running the Solaris (UNIX) operating system. SWSI engineers have defined development tools and software, which include the Integrated Development Environment (IDE) JBuilder Professional. This development tool provides for source code editing, GUI design and layout, rapid compilation and dependency checking, and debugging. Other support software includes Solaris (Operating System), Sun Professional Developer Suite (C Application development), Oracle Server, Oracle Pro*C, Java 2 Standard Edition, HotSpot, InfoBus, Phaos SSLava, and JDBC Driver.

SWSI is currently scheduled to be operational by the summer of 2001.

By Jerry Rauser/CSOC GSFC Code 451 and Tom Sardella/GSFC Code 583

For further information, please contact Tom Sardella via email at Tom.Sardella@gsfc.nasa.gov or by telephone at (301) 286-7686.



System diagram depicting the SWSI

Spacecraft Now on the Internet!

GSFC Code 588's Operating Missions as Nodes on the Internet (OMNI) project has succeeded in communicating with an orbiting spacecraft using standard Internet protocols all the way to the spacecraft. This achievement is a continuation of earlier work done with Codes 451 and 581 that accomplished demonstrations of standard Internet Protocol (IP) communication through the Space Network (SN).

The previous demonstrations used a van impersonating a mobile spacecraft at GSFC. Communications were accomplished using IP from the van equipment, through the SN, across the Internet, and back to systems at GSFC. This equipment was also deployed on a cruise ship in the Black Sea last August to provide thousands of people around the world with live viewing (on the World Wide Web) of the total solar eclipse on August 11, 1999.

A view of the August 11 total solar eclipse

The next logical step in this program was to install IP software on a spacecraft, configure a ground station to support High-level Data Link Control (HDLC) framing, and interact with the spacecraft using standard Internet protocols. These on-orbit demonstrations used the UoSAT-12 spacecraft, launched in May 1999 by Surrey Satellite Technology Ltd. (SSTL). The ground station modifications consisted of simply installing a small Cisco router at the SSTL ground station in Surrey, England, and connecting a serial port on the router to the data lines on the station's transmitter and receiver. IP packets in HDLC frames traveled between the spacecraft and router, and were processed like any other Internet traffic.

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The UoSAT-12 spacecraft, used for OMNI demonstrations

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Initial tests consisted of using a standard Internet PING command to send packets from both GSFC and SSTL to the spacecraft and to receive echo responses. This process demonstrated standard Internet connectivity to the spacecraft. The next tests consisted of configuring the spacecraft to use Network Time Protocol (NTP) to access a time server at the U.S. Naval Observatory in Washington, DC. The spacecraft successfully used NTP to automatically synchronize its clock to within the ten millisecond resolution of its onboard clock. It continued to correctly reset the clock after ground controllers commanded the spacecraft clock ahead by three seconds.

Currently, we are conducting tests using the standard File Transfer Protocol (FTP) to upload and download files with UoSAT-12. More tests are planned over the next few months to demonstrate spacecraft telemetry flow and commanding using the User Datagram Protocol (UDP), which is similar to packets and frames used on spacecraft today. Further demonstrations will include a web server on the spacecraft, and other file transfer protocols for use over one-way or extremely long delay communication links.

The OMNI project is also currently working with GSFC Code 451 on demonstrations of IP communication to the Shuttle using the Low Power Transceiver (LPT) on a flight in 2001. These tests will use the full range of standard Internet applications, as well as new Internet protocols for security and mobile IP routing.

By Keith Hogie/CSC

For more information on all of these activities see the OMNI web site at http://ipinspace.gsfc.nasa.gov/.

Log on to the TDRSS On-line Information Center

Have questions about Tracking Data Relay Satellite System (TDRSS) or the Space Network? Check out the TDRSS On-line Information Center. New and updated site features include information about TDRS H, I, J and new links to the Demand Access Systems Engineering Website. Also included is a monthly calendar of upcoming events. We continue to maintain and support the link budget calculator, which will help you determine if your mission can be supported by TDRSS. Our Javascript search engine will help you locate the specific information you are looking for at the site. If you have further questions, you can email them to us using our feedback form, and we will direct your question to the appropriate expert. The answer will be returned 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:

- Tracking and Data Relay Satellites (including TDRS H, I, J)
- Demand Access
- The White Sands Complex, including WDISC
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay Terminal System
- TDRSS Telecommunication Services
- Customer Communication Systems and Products, including Transponders
- TDRSS Applications
- PORTCOM, ECOMM and TILT.

Plus much more…

Coming Attractions

Demand Access Available in 2002

Demand Access System (DAS) activities have begun in earnest. Drafts of the DAS Operations Concept and the DAS System Requirements Document have been published and are currently under review within Code 450.

The DAS Product Management Plan was approved by the Code 451 Configuration Control Board on June 19, 2000. The formal DAS System Requirements Review is currently scheduled for July 11.

DAS is expected to provide low rate (less than 150 Kbps) telemetry and tracking services to a wide range of new customers. DAS design goals include a simplified customer interface and the use of commercial standards for telemetry data distribution. Additionally, DAS services should be made available at relatively low cost, most likely via a 'subscription' service rather than a 'per minute' type of service. DAS is designed to be modularly expandable, allowing simultaneous service to many dozens of customers. DAS, which is expected to be operational in the first half of 2002, will provide global coverage, with almost no interruption of service as customers orbit the earth.

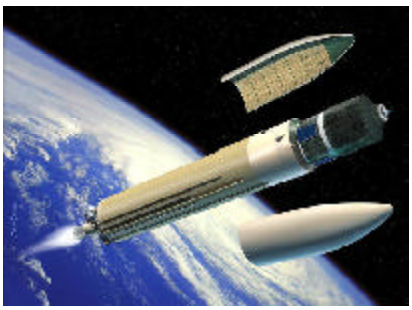
By Tom Gitlin/GSFC Code 451

For more information on DAS, please contact the author at (301) 286-9257 or via e-mail at tom.gitlin@gsfc.nasa.gov.

ATV and HTV: ISS Visiting Vehicles

You ask...Once the International Space Station (ISS) is inhabited by humans, other than the U.S. Space Shuttle and the Russian Soyuz/Progress, will there be other means of ISS re-supply and reboost? The answer is YES! The European Space Agency (ESA) and National Space Development Agency of Japan (NASDA) are in the process of designing and developing their versions of logistic resupply/reboost vehicles. The Automated Transfer Vehicle (ATV/ESA) and the H-II Transfer Vehicle (HTV/NASDA) are being funded, designed, and fabricated by their respective space organizations.

The vehicles will both launch into space atop Expendable Launch Vehicles (ELV). The ATV will use an Ariane 5; the HTV will utilize an H-II. Both will separate from the ELV into an autonomous "free-flyer" mode to approach the ISS. The vehicles will maneuver to attach to the ISS, provide logistic resupply to the station, and finally disembark from the ISS with waste to a destructive reentry into the Earth's atmosphere.



Artist's conception of the ATV launched on Ariane 5

Although very similar in functionality, each of these vehicles is unique with respect to various aspects of the mission profile. The capability of each vehicle differs slightly. The HTV is strictly a logistics resupply/waste discard vehicle. The ATV not only will carry ISS resupply/waste, but it will also reboost the ISS at planned intervals to assist in keeping the ISS at a safe altitude over its expected lifetime.

The vehicles' methods of attaching to the ISS are very unique. The ATV will attach to the ISS on the Russian Service Module (SM). As such, the ATV will be equipped with Russian certified automated docking mechanisms that will allow it to approach the ISS and dock directly to the SM, similar in fashion to Russian vehicles. The HTV will enter the Proximity Operations area to the grappling box where the Space Station Remote Manipulation System (SSRMS) will latch onto the vehicle and attach to Node 2 of the ISS.

In addition, the ATV operational scenario will provide for it to undock from the ISS and retreat into a Parking Orbit. The purpose of this plan is to allow Russian vehicles access to the SM if necessary. The ATV can linger in an orbit outside the range of the ISS until conditions are suitable for it to re-dock to the ISS-SM for continued exchange of services. HTV has no plan for a Parking Orbit in its mission scenario.

Although the HTV is not expected to be ready for launch until 2003, with the ATV to follow in 2004, planning for these vehicles is well underway. The GSFC Mission Service Program Office is working diligently to prepare for support of the ATV and HTV. GSFC

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engineers have been working very closely with the JSC ISS Program and International Partners (IPs) for two years, exchanging data, negotiating requirements, and even initiating TDRSS Compatibility Test planning. This exchange of data has been beneficial to GSFC as well as the IPs. GSFC is responsible for continuous interaction with the IPs and JSC, establishing open communications for planning, discussion of issues, and general system design/interface matters. In fact, GSFC personnel regularly conduct teleconferences with NASDA/HTV and ESA/ATV to discuss new aspects of mission support and to address issues and resolutions from previous meetings. GSFC is an active participant in Operations Technical Interchange Meetings at JSC, GSFC, and international locations such as Toulouse, France.

As ATV and HTV gradually approach their launch dates, key milestones are being met. Design reviews are starting and the GSFC Mission Service organization is helping to ensure vehicle planning personnel are considering all angles of Space Network communications. GSFC engineers recently provided expertise during the ATV System Preliminary Design Review (PDR). In addition, GSFC was invited to participate in the HTV Transponder PDR coming up in November 2000.

The GSFC Visiting Vehicle Team will continue to work with JSC and the International Partners as we strive to enter the Space Station era ready to support.

By John Smith/CSOC/ GSFC Code 451

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Artist's rendering of the ATV approaching the ISS

SN Range Safety: Are We There Yet?

It has been several months since an update on the Space Network (SN) Space-Based Range Safety Concept has been presented in *The Integrator.* In the intervening time, several events have taken place to further establish GSFC SN support for range safety.

As reported in the November 1999 issue of *The Integrator*, GSFC has been working with the KSC Advanced Range Technologies Office (RTO) to promote the concept of SN support for Range Safety as a new U.S. launch range technology. The focus is flight termination. In the case of Expendable Launch Vehicles (ELVs), flight termination is the total destruction of the vehicle before harm is caused to human life. During the process of evaluating the potential of the SN to provided range safety services for ELVs, the focus was projected into the future. Flight termination was extrapolated into an operations concept for Reusable Launch Vehicles (RLV), whereby the vehicle propulsion system is disengaged to allow for a controlled reentry. This idea can be further expanded to include critical communication for RLVs from launch through orbit to reentry and landing.

This concept was presented to other organizations with the idea of using a space-based platform to provide flight termination and more. KSC stirred the interest in the RLV community, and was invited to present information about space-based range service to an FAA customer forum at FAA Headquarters—the RLV Commercial Space Transportation Advisory Committee (COMSTAC). GSFC personnel presented the concept as a method to provide a critical communication link to RLVs from launch through reentry. The support was overwhelming. The RLV COMSTAC Board wrote a letter to the FAA officials promoting the concept and recommending to FAA they work with NASA to find a means for budgeting the work. This relationship continues to blossom, with the GSFC Team invited to various meetings and follow-on RLV COMSTAC forums.

Also during this time NASA GSFC agreed to work with Lockheed Martin (LM) Space Mission Systems to conduct basic tests relative to the concept. The testing included use of the Space Network and other NASA instrumentation to perform some proof of concept tests on an airplane at Dryden Flight Research Center. Several tests were conducted using TDRSS and a simulated launch head in a basic experiment configuration with existing, nonflight qualified hardware and systems. LM announced earlier this year that the testing was an overwhelming success. Press releases were provided to numerous news organizations, including *Space News* (March 20, 2000 - "Lockheed Demonstrates New Range Safety System").

At this time the LM testing is in a holding pattern due to funding issues. Although very basic in nature, testing unveiled the potential of this concept for all to see. The testing was a success from LM's perspective, in that they tried to "figure out a way to blow up a malfunctioning rocket with the same reliability and accuracy as the existing range network…" LM's test program, however, did not encompass the identical objectives of GSFC's program. GSFC's goal is to develop new vehicle technology for terminating flight propulsion (destruct or default attitude control) and to conduct very dynamic tests with reusable vehicles through support within NASA and DOD Range organizations.

The GSFC/KSC Range Team continues to focus on development of the multi-channel Range Safety transceiver and potential proof-of-concept activities. The transceiver under consideration is the Low Power Transceiver (LPT) being developed by ITT Industries under a current technology contract to the SN Project Office. The LPT is a state-of-the-art transceiver featuring low power consumption, multiple receive channels for TDRSS-compatible communication, and the potential for GPS onboard navigation.

The proof-of-concept endeavors include a range of candidate opportunities from investigations into a Wallops Recoverable Sounding Rocket program, and a payload for the X-34 program, to more recent interest from the X-43 program and LPT Shuttle payload testing.

Funding is tight, but the space-based range safety concept continues to garner strong support. Next, the GSFC team will travel to Toulouse, France to present the concept at SpaceOps2000. GSFC will continue to work with KSC and the range community on the concept with great hope of getting closer to seeing what the SN can do to "test the waters" of space-based range services.

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The Ultra Long Duration Balloon RF Test Completed

On May 12, 2000, Ultra Long Duration Balloon (ULDB) Engineers successfully completed S-band RF compatibility testing for the Motorola fourth generation transponders, which shall be used on board of the ULDB on its next flight in January 2001. The purpose of the test was to verify the performance of the transponders, and also to simulate the ULDB's communications capability via TDRSS S-band forward and return links. The ULDB RF equipment demonstrated that it could support MA return links up to 150 Kbps. There is a possibility that at least four balloons will fly in 2001 simultaneously, and with at least one ULDB mission a year lasting 100 days.

Another successful test of ULDB Recovery System Test was conducted on May 3, 2000. A full-scale drop test of the ULDB Recovery System was conducted at the National Scientific Balloon Facility in Palestine, Texas to validate the deployment of the full scale ULDB recovery system with the ultraviolet protective shroud. Additional information on this test can be found at *http://www.wff.nasa.gov/~uldb/hotnews.html*.

The ULDB Project is managed by GSFC Code 820, the Balloon Program Office. The objective of the Project is to develop balloon systems capable of supporting scientific observations above 99% of the Earth's atmosphere for durations approaching 100 days.

By Danh Nguyen / Lockheed Martin

For additional information, check out the web site at http://www.wff.nasa.gov/~uldb/index.html , Or contact Ted Sobchak at (301)286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

ULDB test flight, June 2000, in Fort Sumner, NM

Mission Services Projects Schedule Updated

A revised version of the **Mission Services Projects Schedule** is included in this issue of *The Integrator*. We will provide additional updated versions, as usual, in future issues.

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