AVIONICS SIMULATION, DEVELOPMENT AND SOFTWARE ENGINEERING

SIXTEENTH MONTHLY
TECHNICAL PROGRESS REPORT

September 6, 2001

Sponsored By:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Under:

Contract No. NAS8-00114

Purchase Order No. H-32831D, Task Order 001A, GPB Program Software Oversight
Purchase Order No. H-32832D, Task Order 002, ISS EXPRESS Racks Software Support
Purchase Order No. H-32833D, Task Order 003, SSRMS Math Model Integration
Purchase Order No. H-32834D, Task Order 004, GPB Hardware Support
Purchase Order No. H-32835D, Task Order 005, Electrodynamic Tether Operations and Control Analysis
Purchase Order No. H-32837D, Task Order 007, SRB Command Receiver/Decoder
Purchase Order No. H-32838D, Task Order 008, AVGS/DART SW and Simulation Support

MONTHLY PROGRESS REPORT NO. 16

Contract Title:	Avionics Simulation, Development and Software Engineering
Contract No.:	NAS8-00114
Contractor:	Control Dynamics, a Division of bd Systems
Date of Contract:	13 April 2000
Contract End Date:	12 April 2005
Reporting Period:	August 1 – August 31, 2001

1.0 Purchase Order No. H-32831D, Task Order 001A, Gravity Probe B (GPB) Program Software Oversight

Review of Work Accomplished

During this reporting period, bd Systems personnel continued to review and analyze the existing GPB software and system documentation and participate in the weekly recurring project status and engineering meetings conducted by the GP-B Program Office. Additionally, bd Systems personnel continued to assist the GP-B project in establishing the documentation database in the Marshall Space Flight Center (MSFC) Virtual Research Center (VRC).

bd Systems personnel continued to perform the extensive review and study of the software requirements, design, code, and methods of verification for the flight software. The MSFC certification of verification process for the GP-B program involves analysis of the T003 requirements and the derived requirements and determining the adequacy of the Stanford University verification of those requirements. bd Systems personnel continued to be involved this month in identifying T003 requirements that have derived software requirements and understanding these requirements and the method of verification.

During this period, bd Systems personnel supported ED12/bd Systems personnel in confirming ATC Safemode problems in software and documentation. These problems in documentation and the flight software involved threshold limits, units conversions, etc.

GP-B documentation was reviewed by bd Systems personnel on request by the GP-B Project Office. This documentation included the MOC Software Development Plan, the Science Mission Configuration Management Plan, the MOC Configuration control, IONET LAN Plan, The MOC Configuration Control, Science LAN, the Mission Operations Specification, and the Software Quality Assurance Plan. Comments were submitted to the Project Office.

bd Systems personnel continued to assist the Gravity Probe B project in establishing and maintaining the VRC database for GP-B documentation, drawings, etc. There are currently over 7,000 documents resident in the GP-B wing. This timely support continues to be beneficial to the GP-B

project and those MSFC personnel supporting the project. This activity is estimated to be 95 % complete. In addition, bd Systems personnel initiated the creation of VRC sub-wings for proprietary data storage and access.

In performance of the support to the Flight Software Group for GP-B software, bd Systems personnel continued to track the significant issues regarding GP-B software. Timing issues in the payload processors continue to be the most significant issues. Significant progress has been made by Lockheed Martin and Stanford University in the reporting period towards achieving an acceptable level for the payload processor Central Processing Units (CPU). The SRE timing is now estimated at 83% after selectively enabling/disabling routines based on guide star valid/invalid. Some GSS timing problems are still unresolved, particularly in the gyro spinup phase. Optimization of algorithms is projected for completion in September 2001.

During this reporting period, bd Systems personnel continued to participate in teleconferences with the IV&V personnel in West Virginia, who are performing IV&V on the GP-B flight software. The GP-B Criticality and Risk Assessment (CARA) produced by the IV&V personnel continues to be the process for prioritization of the software test cases to be reviewed by the IV&V organization. Lack of response by Lockheed Martin to IV&V comments continues to be a problem. The IV&V organization has identified the test cases and the comments for which a response is considered imperative.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 172.5
Total Hours Assigned: 1872.0
Estimate of Hours to Complete: 3.0
Cumulative Hours and Percentage of Completion: 1869.0, 99%

Non-Routine Tasks for Next Month

No non-routine tasks are anticipated for next month to be performed under this task.

Problems

There are no significant problems to report for this period.

Other

There is nothing to report for this time period.

Personnel Statistical Information

For this reporting period, 172.5 hours were expended on this task. The total hours expended through this reporting period is 1869.0. There were no safety mishaps or close calls.

2.0 Purchase Order No. H-32832D, Task Order 002, International Space Station (ISS) Expedite the Process of Experiments to Space Station (EXPRESS) Racks Software Support

Review of Work Accomplished

bd Systems personnel accomplished the technical responsibilities for this reporting period, as planned. A close working relationship was maintained with personnel of the Avionics Department Software Group (ED14), the MSFC Project Office (FD31), and the Huntsville Boeing Company. Work accomplishments included special tasks, supporting SRB activities, ATB activities, ESCP activities, participating in meetings, and coordinating issues between the Boeing Company and the MSFC Project Office.

Special Tasks

Continued to review the activities relating to investigating test failures of the B-RIC qualification unit. These errors are believed to be in the RS-422 serial card. The B-RIC test set is also under suspicion of faulty operation. Tests to investigate both anomalies are planned.

SRB Activities

During this reporting period, bd Systems personnel participated in Boeing's Software Review Board (SRB). Software Problem Reports (SPRs), software build activities, software load requests, and the schedule of events for the PSIVF and ATB are discussed and dispositioned by the SRB. The key activities for this month were planning the schedule of the ATB and PSIVF to support testing for Sustaining Software Release 2, and the development of software for the Habitant Holding Rack (HHR) in the ATB. The PSIVF schedule was also planned to support anomalies encountered during on-orbit operations of ER1 and ER2; and to support flight product development of flight software products. Also, the "Quick-Look Test Report" for the non-ARIS CSCI was reviewed.

ESCP Activities

The ESCP weekly meetings were supported. Subject material was reviewed including RIC characterization test status, auto load trade study, implementation plan for sustaining SPRs, and testing plans for Software Sustaining Release 2.

ATB Activities

Reviewed the schedule of activities for the ATB. The key activities this month were the development of the HHR software and the testing of the Software Sustaining Release 2 for both the ARIS CSCI and non-ARIS CSCI.

PSIVF Support

Continued to participate in discussions relating to the Qual-RIC repair. The failure was isolated to the Mil-Std-1553 circuit card, and is being returned to the vendor, AI-Tech, for repair. While the Qual-RIC is being repaired, the PSIVF is operating in a one RIC configuration. This configuration allows development of flight products and RIC characterization test activities to continue. The PSIVF has also supported the investigation of on-orbit software anomalies and the testing of software code modifications to "fix" the anomalies. After the "fix" was tested, it was incorporated into a new CSCI for both the ARIS and non-ARIS racks. A 72-hour endurance test was then performed on each CSCI.

Meetings Support

Supported meetings to discuss the development of the Rack Software Test Bed (RSTB).

Supported the post-test review of the 72-hour endurance test for the non-ARIS CSCI.

Supported meetings to discuss on-orbit operational anomalies for ER1 and ER2.

Supported teleconferences between MSFC and JSC to discuss Software Sustaining Release 2 testing and on-orbit loading.

Attended the ED14 bi-weekly group meetings and the ED14 monthly EXPRESS project review. Attended the FD31 weekly group meetings.

EXPRESS Workbook

The development of the EXPRESS workbook was continued.

On-Orbit Status

The EXPRESS Rack 4 (ER4) was activated on August 21, 2001.
The EXPRESS Rack 2 (ER2) was activated on May 24, 2001.
The Human Research Facility 1 (HRF1) rack was activated on May 18, 2001.
The EXPRESS Rack 1 (ER1) was activated on April 24, 2001.

Experiments within the racks continue to be activated and are being supported by the rack's hardware and software. However, there have been numerous anomalies with ER1 and ER2 and a "tiger team" has been formed to investigate these anomalies. Team members include personnel from MSFC, Boeing-Huntsville, Teledyne Brown, and bd Systems. The anomalies include, heartbeat counter not incrementing, loss of rack health and status telemetry, loss of science telemetry, and processor "lock up". New CSCIs that "fix" major problems in the ARIS and non-ARIS racks have been developed, and CDs containing the software (sustaining release 2) were delivered on the 7A.1 shuttle flight. Plans are being developed to request ISS crew time to load the software into ER1 and ER2 next month. Additional software releases are planed to "fix" other known problems.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 135.5
Total Hours Assigned: 1654.0
Estimate of Hours to Complete: 137.5
Cumulative Hours and Percentage of Completion: 1516.5, 92%

Non-Routine Tasks for Next Month

Non-routine tasks are not anticipated for next month.

Problems

There are no significant problems to report for this period.

Other

The MSFC mandatory safety training class was attended on August 22, 2001.

Personnel Statistical Information

For this reporting period, 135.5 hours were expended on this task. There was no safety mishaps or close calls.

Acronyms

ARIS	Active Rack Isolation System
ATB	Avionics Test Bed
B-RIC	Biological Research Project Rack Interface Controller
CD(s)	Compact Disc(s)
COTR	Contracting Officers Technical Representative
CSCI(s)	Computer Software Configuration Item(s)
CWC(s)	Collaborative Work Commitment(s)
DCMA	Defense Contract Management Agency
ER(s)	EXPRESS Rack(s)
ESCP	EXPRESS Software Control Panel
EXPRESS	Expedite the Process of Experiments to Space Station
FEU(s)	Functional Equivalent Unit(s)
FQT	Functional Qualification Testing
GSE	Ground Support Equipment
HHR	Habitant Holding Rack
HRDL	High Rate Data Link
HRF	Human Research Facility
IA	Independent Assessment
ID	Identification
IPR(s)	Interim Problem Report(s)
ISS	International Space Station
IT	Information Technology
IV&V	Independent Verification and Validation
JSC	Johnson Space Center
KSC	Kennedy Space Center
LOD	Letter of Delegation
MSFC	Marshall Space Flight Center
NASDA	National Aerospace Development Agency of Japan
NC	Non Compliant
ON(s)	Operations Note(s)
OPMS	On-Line Project Management System (Oracle database)
ORD	Operational Readiness Date
PEP	Payload Experiment Processor
PEP	Performance Evaluation Profile
POIC	Payload Operations & Integration Center
PR(s)	Problem Report(s)
PSCP	Payload Software Control Panel
PSIVF	Payload Software Integration & Verification Facility
RIC(s)	Rack Interface Controller(s)
RSTB	Rack Software Test Bed
S&MA	Safety & Mission Assurance
SPR(s)	Software Problem Report(s)
SQA	Software Quality Assurance
SRB	Software Review Board
SSPCM(s)	Solid State Power Control Module(s)
TBD	To Be Determined
TBE	Teledyne Brown Engineering
TCP/IP	Transport Control Protocol/Internet Protocol
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
UF	Unified Flight
WEI	Wildwood Electronics Inc.
WORF	Window Observation Research Rack

3.0 Purchase Order No. H-32833D, Task Order 003, ISS RMS Math Model Integration

Review of Work Accomplished

Timing studies were performed in real time and non-real time modes of operation of TOADS. For real time operation, the simulation performed well with an integration step size of 2 milliseconds and relinearization time of 4 seconds. These tests were run successfully in the V20 chamber on TLON and in the CDSL on UQBAR. Timing studies for non-real time analytical capture runs revealed the execution time for the dynamics cycle to be on the order of .025 seconds, about twelve times slower than real time. Since the scheduler works on clock time, the relinearization cycle called every 4 seconds was updating the dynamics about every .08 simulated seconds for an integration step size of .5 milliseconds. This was too frequent and the relinearization update rate was changed to 200 seconds. Before this change, relinearization updates were not occurring at the same time from run to run. This caused differences in the results for the same initial conditions. The change to the relinearization frequency resulted in consistent, repeatable updates and resulting time responses.

Trick code examination

Trick is a programming environment for the creation of dynamic and dynamic-controlled simulations. It allows for code creation with little attention to "overhead" items such as state integration and data recording. A considerable amount of time has been spent learning how to create Trick environment simulations. A tutorial, provided by Keith Vetter (LinCom Corporation) for NASA at the Johnson Space Center (JSC), was provided to aid in this effort. It describes the Trick environment capabilities and file architecture, and it provides a step-by-step walkthrough of the creation of a specific simulation. The lessons in the tutorial were completed, and a general understanding of the Trick system architecture and job processes has been reached.

Along with the Trick environment code, much of JSC's implementation of the contact force models for the Common Berthing Mechanism (CBM) was included. This code has been studied, and a document of notes was generated describing the nature of the CBM code Trick integration. The following is a list of subjects of particular interest to the generation of said document:

Variable conventions
Gateway function call to FORTRAN cbm code
Arguments to gateway functions
Contact type flags
Vector and matrix math function conventions
Cbm FORTRAN function flow
How to call FORTRAN functions from C code

The study of JSC's CBM code implementation allows for an easier method of incorporating TOADS contact models to the Trick environment.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 141.1
Total Hours Assigned: 1000.0 (bd Systems, Inc.)
Estimate of Hours to Complete: 394.5
Cumulative Hours and Percentage of Completion: 605.5, 60%

Non-Routine Tasks for Next Month

Non-routine tasks are not anticipated for next month.

Problems

None.

Other

There is nothing to report for this time period.

Personnel Statistical Information

For this reporting period, 141.0 hours were expended on this task. There was no safety mishaps or close calls.

4.0 Purchase Order No. H-32834D, Task Order 004, Gravity Probe B (GPB) Hardware Support

Review of Work Accomplished

Travel now not likely to LM before October 1, not only because their schedules do not presently contain enough detail, or advance notice, to participate in ED12 hardware testing there, but also because GPB contract changes now need to be made defining the communication interface between MSFC and Stanford/LM personnel.

The Control Gyro verification compliance matrix has had its final update. The Magnetic Torquer matrix will be reviewed with Byron Bartlow. The Star Sensor matrix was constructed with the specification text and routed to Don Hediger to fill in whether each specification is met and any comments needed for each one. The Magnetometer matrix will be reviewed and any updates made by Bartlow. This will result in our final version of all these matrices.

Safemode material, as related to ED12 items, was studied, including appropriate software, and concerns noted. These were updated several times. These concerns were then transmitted to Stanford/LM for comment. Also, safemode thresholds for ED12 items, as given in system and software documentation, were collected and checked for reasonableness.

The Control Gyro power budget history was checked to see that the sequence made sense. One question came out of this effort and it was routed to LM.

A contract modification is to be made concerning the final report. In addition to the updated compliance matrix report (which just updates the previous report), there is to be a safemode report instead of the Integrated Test Facility (ITF) report. No ITF testing was done due to GPB schedule slip. This new report will be based on the safemode work described above.

The weekly GPB meetings were attended at the Program Office and the Avionics Department. Other meetings for information gathering and FY02 planning were also attended.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 143.0
Total Hours Assigned: 1081.0
Estimate of Hours to Complete: 101.0
Cumulative Hours and Percentage of Completion: 980.0, 90%

Non-Routine Tasks for Next Month

Non-routine tasks are not anticipated for next month.

Problems

There are no significant problems to report for this period.

Other

There is nothing to report for this time period.

Personnel Statistical Information

For this reporting period, 143.0 hours were expended on this task. There were no safety mishaps or close calls.

5.0 Purchase Order No. H-32835D, Task Order 005, Electrodynamic Tether Operations and Control Analysis

Review of Work Accomplished

During the August reporting period, bd Systems continued to provide guidance and support to Dr. Stephen Canfield , David Johnson, his student from the Tennessee Space Institute and John Westerhoff, a student from the University of Illinois, Champaign-Urbana, IL also working with them. They are performing research studies into the dynamics of momentum transfer, electrodynamic reboost tether systems. They reported on their progress over the summer session. Although, their summer sessions were completed and they returned to their respective campuses for the beginning of fall classes, they are continuing their research using the modeling tools provided by MSFC and bd Systems as well as those they developed independently. Our support consisted primarily in providing modeling advice and assistance in the implementation of GTOSS in a PC environment. In addition, we observed an apparent anomaly in the GTOSS code whereby it seems to require exceedingly small integration step sizes to achieve convergence for the rotating tether systems of the momentum transfer tether configurations. This does not necessarily mean an error condition exists but may indicate certain calculations are performed out of order causing inefficient execution and unnecessarily long run times. I have referred this to the author of the GTOSS simulation Mr. David Lang. He is investigating this and as a related exercise, we are investigating addition of a variable step integration scheme with error checking and automatic step size control to GTOSS. As an example, GTOSS presently requires 0.5 microseconds to converge such that no significant change of rotational phase of the tether system is observed over a 2 orbit period, whereas, TSSIM using a 4 pass Runge-Kutta fixed step scheme achieves the same result using a step size of 1 second.

An additional activity performed during the month of August was an investigation into the feasibility of an electrodynamic tether as a source of reboost thrust to supplement or replace present propellant sources for maintaining the orbit of the International Space Station (ISS). As part of this activity, a brief search was made into micro-gravity requirements on ISS. The steady state g-level requirement within the micro gravity volume is 1 micro-g according to SSP 41000R, 15 March 2000, System Specification for the International Space Station, section 3.2.1.1.4.1. This would imply that 166 kg is the most an end mass could be for a 7 km long tether deployed from ISS without violating this requirement. Since upward deployment seems to be the most viable concept, we need a good estimate of how much power might be produced by an upper end mass within this mass limit. The 7 km tether length was an initial concept. With this, we can estimate how much drag compensation an ED tether would be able to provide and in turn how much benefit it would be to ISS. We also investigated an ED Tether Tug concept suggested by Ken Welzyn. The tug would be a separate system consisting of an upper body power supply, a lower body ballast mass connected by a conducting, ED tether. The tug would attach to ISS by a towing tether and would co-orbit with the ISS. It would provide its own electrical power and thrust. The towing forces would be along the towing tether and would counteract the drag without disturbing the micro-g environment. This concept seems to overcome concerns about disturbing the micro-g environment but many details still need to be worked such as how to stabilize the tug in a position in front of the ISS. This position is passively unstable and an active control appears required. To explore this concept further, we have built a GTOSS model of this system and made a few simulation runs.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 60.0

Total Hours Assigned: 530.0
Estimate of Hours to Complete: 12.0
Cumulative Hours and Percentage of Completion: 518.0, 97%

Non-Routine Tasks for Next Month

None expected.

Problems

There are no significant problems to report for this period.

Other

There is nothing to report for this time period.

Personnel Statistical Information

For this reporting period, 60.0 hours were expended on this task. There were no safety mishaps or close calls.

6.0 Purchase Order No. H-32837D, Task Order 007, Solid Rocket Booster (SRB) Command Receiver/Decoder (CRD)

Review of Work Accomplished

In this task, bd Systems is supporting the Flight Software Group/ED14 in the review and assessment of the Solid Rocket Booster (SRB) Command Receiver/Decoder (CRD) software being developed by Cincinnati Electronics (CE) as part of the device upgrade. Specifically, bd Systems was requested to review the software development process, the software requirements and the software verification and validation performed by CE.

The following tasks were accomplished this reporting period:

- Provided a summary oversight presentation and recommendation to ED14 management and the SRB project office personnel.
- Provided a summary presentation and recommendation for closeout of Problem Report PV4048884.
- Continued to penetrate the CRD software design and code.
- Continued to review the software test reports.

In the next reporting period, the plans are as follows:

- Participate in a review of the CRD qualification data package.
- Assist in developing the requirements for a software Independent Assessment (IA).
- Begin dialog with the NASA Independent Verification & Validation Facility personnel for the purpose of conducting an IA.
- Continue to penetrate the CRD software design and code, and test reports.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 95.0
Total Hours Assigned: 432.0
Estimate of Hours to Complete: 193.0
Cumulative Hours and Percentage of Completion: 239.0, 55%

Non-Routine Tasks for Next Month

No non-routine tasks are anticipated for next month to be performed under this task.

Problems

There are no significant technical problems to report for this period.

Other

There is nothing to report for this period.

Personnel Statistical Information

For this reporting period, 95.0 hours were expended on this task. There were no safety mishaps or close calls.

7.0 Purchase Order No. H-32838D, Task Order 008, AVGS/DART SW and Simulation Support

Review of Work Accomplished

During this reporting period, a new task was begun to provide support for the Advanced Video Guidance Sensor project in ED19. This task began on August 27, 2001 and involves the documentation and verification of the embedded software. Therefore, only one week of support was provided during this reporting period.

During this period, bd Systems personnel attended meetings, including the Systems Requirements Review for the Avionics AVGS/DARTS project. Review of documentation was begun. These are necessary and continuing activities in preparation for developing the initial draft of the software requirements document.

Hours Information

For this reporting period, the cost information for this task order is as follows,

Total Hours Incurred: 40.0
Total Hours Assigned: 2340.0
Estimate of Hours to Complete: 2300.0
Cumulative Hours and Percentage of Completion: 40.0, 2%

Non-Routine Tasks for Next Month

No non-routine tasks are anticipated for next month to be performed under this task.

Problems

There are no significant technical problems to report for this period.

Other

There is nothing to report for this period.

Personnel Statistical Information

For this reporting period, 40.0 hours were expended on this task. There were no safety mishaps or close calls.

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This monthly report summarizes the work performed under contract NAS8-00114 for Marshall Space Flight Center in the following tasks:
Purchase Order No. H-32831D, Task Order 001A, GPB Program Software Oversight
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